UBAYA
UNIVERSITAS SURABAYA

PROCEEDINGS BOOK

Enhancing Engineering Innovation Towards A Greener Future

InCITE 2019

INTERNATIONAL CONFERENCE ON INFORMATICS, TECHNOLOGY, AND ENGINEERING

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PROCEEDING BOOK OF INTERNATIONAL CONFERENCE ON INFORMATICS, TECHNOLOGY AND ENGINEERING 2019

Enhancing Engineering Innovation Towards A Greener Future

A collaborative activity jointly organised by:

FACULTY OF ENGINEERING
UNIVERSITAS SURABAYA

THE UNIVERSITY of ADELAIDE

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22-23 AUGUST 2019

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Preface

Welcome Remarks,
Chair of the Steering Committee

It is a great pleasure to welcome all of you to Bali and to the International Conference on Informatics, Technology, and Engineering 2019 (InCITE 2019) held by the Faculty of Engineering, University of Surabaya (UBAYA) in collaboration with The University of Adelaide, Australia and Sirindhorn International Institute of Technology (Thammasat University), Thailand. The first InCITE has been successfully held in Bali, Indonesia in 2017. We are very delighted to host the second InCITE here in Bali, Indonesia again.

There are more than 75 presentations in this conference. We welcome leading experts not only from Indonesia, but also from different parts of the world. The experts will share the knowledge and experiences in the fields of informatics, technology, science, and engineering. The main theme of this conference is **Enhancing Engineering Innovation Towards A Greener Future** in response to several world challenges including sustainable development, global convergence of information and communications technologies, climate change and global warming as well as the depletion of unrenewable natural resources. We hope this conference will provide you a good opportunity to get to know each other better and consolidate bonds of friendship and mutual trust.

We would like to express our sincere gratitude to the Keynote and Plenary speakers, International Scientific Committee, Steering Committee, and Organising Committee for their huge efforts to make this conference successful.

Thank you all for your support and attendance at InCITE 2019. Please enjoy the conference and Bali !

Asst. Prof. Djuwari, Ph.D.

Preface

Welcome Remarks,
Chair of The Organizing Committee

Welcome to Bali, Indonesia to all delegates and presenters. It is my pleasure and privilege to welcome all of you to the 2nd (second) International Conference on Informatics, Technology, and Engineering 2019 (InCITE 2019) held by the Faculty of Engineering, University of Surabaya (UBAYA) in collaboration with The University of Adelaide, Australia and Sirindhorn International Institute of Technology (Thammasat University), Thailand.

InCITE 2019 has received more than 75 papers to be presented in this conference. All papers represent four following parallel clusters: Green Design and Innovation, Green Manufacturing and Green Processes, Power System and Green Energy Management, and The Role of IT in Innovation Enhancement. Each cluster supports the main theme of the conference, which is **Enhancing Engineering Innovation Towards A Greener Future.** The engineering innovation is the key to increase our awareness in maintaining the sustainable growth and development in the world.

The Organising Committee of InCITE 2019 would like to express our sincere gratitude for the tremendous supports and contributions from many parties. The supports from The Faculty of Engineering of UBAYA, keynote and plenary speakers, our International Scientific Committee, the Steering and Organising Committees are really acknowledged.

The last but not the least, thank you for your supports, enjoy the conference and we hope through this meeting all of you can extend your networks and collaborations.

Asst. Prof. Putu Doddy Sutrisna, Ph.D.

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A systematic literature review for developing sustainability assessment tool: formulating the state of the art and future direction

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Abstract. Sustainability, with the concept of "triple bottom line", has been growing as a "*trending topic*" recently. It is no longer a paradox; it is now about how to turn this challenge or opportunity into day-to-day management decisions to achieve advantage in both financial performance and corporate sustainability. In conjunction with it, there is a growing need for a better way to develop, assess and measure organizations sustainability performance. This paper discussed a three-stage systematic literature review that is being deployed as the research framework, to scope how sustainability assessments have been developed recently and to formulate the State of the Art for future research. It reviewed 63 selected articles out of 875 papers from Science Direct database. Based on our review, as the novelty proposed by this publication, there are two major approaches used in developing sustainability assessment i.e. criteria-based and model-based approaches. Both approaches have similar popularity in publication: 57% for criteria-based and 43% for model-based. Each has its strengths and weaknesses, but the model-based approach was chosen for future development of the conceptual framework. Furthermore, the review indicated that several main concepts were being used for sustainability assessment and guided the future development into the concept of Business Process Management and Corporate Sustainability.

1. Introduction

Organizations are facing more challenges in the globalized world because society now demands them to be also responsible on creating a more sustainable world. They are forced to think the impact of their actions in a more diverse way to include social responsibility and environment responsibility. The application of sustainability concept has been interpreted differently by industry and academia in Indonesia. For example, Unilever, a well-known consumer goods manufacturer in Indonesia, helped to develop the welfare of farmers and suppliers of raw materials or to reduce the use of chemicals that had negative impacts to the environment through its "*Sustainable Living Plan*" program. Djarum Foundation, a prominent foundation in Indonesia, built building and laboratory facilities for universities through its corporate social responsibility program. Some related studies ([1], [2], [3], [4]) revealed that the sustainability concept has been applied in many aspects such as performance measurement, economic, educational and social life.

In order to achieve corporate sustainability as a competitive advantage, organizations need to manage their business process especially at the strategic level. Business processes are divided into: (a) core processes, (b) support processes, (c) managerial processes ([5], [6]). The role of business process

wasinitially mentioned by [7] and later developed by [8] who described that managing the core process will create competitive advantage of an organization, controlling the support process will enable competitive advantage meanwhile the managerial process will ensure sustainable competitive advantage.

In term of managing the business processes, a methodology for Business Process Improvement which is formed by [9] described that the initial phase of seven-step Business Process Improvement is the need of readiness assessment. To measure the readiness level of an organization before any business process improvements are made, an assessment tool that designed appropriately is obviously needed. Readiness of an organization can be measured through a well-designed assessment tool so that the result of its assessment provides the foundation for the analysis or improvement.

For that same purpose, the development of sustainability assessment tool becomes necessary; it will be a set of methods, forms or maps that organizations can use to assess their readiness in initiating sustainability efforts or to chart their progression in achieving their target of sustainability. It now turned out as some research questions, namely *"What sustainability indicators will be used? How the indicators should be selected? How the measurement process should be done? Is there any framework should be constructed to carry out the assessment process?"*. Therefore, this paper review is aimed to conduct a systematic literature review, to scope how sustainability assessments have been developed recently and to provide viewpoint and foundation for the development of sustainability assessment.

2. Research Method

A systematic literature review was introduced in this article as an effective method to review multiple research papers or publications, in which the process was conducted through three stages [10]:(1) stage of planning the review; (2) stage of conducting the review; (3) stage of reporting and dissemination.

Table 1. Three stages of Systematic Literature Review (SLR) as research method

Stage	**Activities**
Stage1	***Planning the review***
	Review basic concepts of sustainability and perform meta-analysis on sample of 15 related published articles, which aimed to:
	a. Gain comprehensive understanding
	b. Identify the terms for searching articles and publication year
	• Terms that being used to search for the paper in title, abstract, and keywords are: *(sustainability indicator OR sustainability metric) AND (sustainability assessment OR sustainability performance OR performance measurement OR sustainability performance measurement) AND (corporate sustainability OR corporate sustainability model OR strategic management)*
	• Publication year: *2010 - 2016*
	c. Determine targeted publishers
	• Targeted publishers: Science Direct, Emerald, Springer, Taylor & Francis, Wiley
	• In this review paper, the review process is initially attempted to Science Direct
	d. Define criteria for classifying the articles to support the analysis
Stage2	***Conducting the review***
	Selection of articles to be reviewed, based on the terms and criteria defined in previous stage:
	a. From title, abstract and keywords: filtering the papers with the defined terms. Total search: 875 articles.
	b. From full paper, skimming reading on introduction, research methods and conclusions, to select valid articles for the review, classifying articles according to the classification criteria. Valid: 63 articles (7.2%)
	c. From selected full paper: focused reading, deep understanding and analysis about sustainability indicator and corporate sustainability
Stage3	***Reporting & Dissemination***
	a. After selecting articles (2^{nd} round of previous stage) from electronic database Science Direct and after 30% reading (3^{rd} round on previous stage),
	b. Prepare initial draft of the review result to be published in the international conference.

Stage	Activities
	c. Conclude main aspects of SLR and future directions for conceptual framework of SAT to assess sustainability initiatives in corporate level

As recommended by [12] and deployed by [11], these stages of systematic literature review were also performed in this review paper, the detailed was shown in Table 1. In the first stage, the literature review was planned by reading the references (books) that contained basic concepts of sustainability as well as performing meta-analysis. The planning stage was aimed to: (a) gain the comprehensive understanding about the research topic, (b) identify proper terms for searching the paper in the next stage of review, (c) determine the targeted journal publishers or electronic databases and (d) define the criteria to classify the articles for data analysis.

3. Results & Discussions

After the planning stage of systematic literature review, the review process continued by searching the articles from scientific database Science Direct, gave the result of 875 articles whose titles, abstracts or keywords fitted the defined terms and publication years, then by skimming reading to introduction, research methods and conclusions, there were 63 (or 7.25% of 875) articles valid as selected papers for further analysis. For 63 selected articles, the meta-analysis was performed to collect information about: authors, publication year, publisher name, industry sector, underlying concept to formulate the indicators/models, and outcoming model/framework. The following results and discussions were made based on the meta-analysis.

Based on the review, to assess sustainability performance of an organization, there are two primary approaches in developing sustainability assessment:

A. ***Criteria-based approach.*** Many publications showed that the formulation of indicators in the sustainability assessment often used the concept of sustainability or Triple Bottom Line which comprises three aspects: people, profit and planet. The sustainability indicators can be derived from literature review ([13], [14]) or selected based on some criteria ([15], [16]). It designed a general set of sustainability indicators that are suitable to be applied in all sectors but it was limited to a specific industry [15] meanwhile [16] derived sustainability indicators to assess an eco-industrial park, those specific indicators were limited to be used for any other industries.

B. ***Model-based approach.*** Some sustainability assessments were also done through the development of a model. For example, [17] proposed the sustainability aspect into the Balanced Scorecard method [18], known as the Sustainability Balanced Scorecard (SBSC).

Table 2. Two primary approaches in formulating indicator, with their strengths & weaknesses

Approach	Strengths	Weaknesses
Criteria based selection	• Provides a general set of common sustainability indicators to easily be chosen • These common indicators also available for specific industry • Can be easily integrate with the current organization strategy as new key performance indicators	• Indicators in a criteria can be difficult to choose due to its similarities • Selection of the indicators can be subjective without measuring the appropriateness and quality of the indicators used. A right way of filtering the indicators are necessary. • Organizations might have difficulties in identifying whether they have achieved sustainability or not
Model based selection	• Create clear ideal model how a sustainable organizations operates and functions. • The gap between ideal and current conditions will make is easier to plan and develop process and activities • Create a more robust sustainability indicators because it is based on a proven ideal model	• Debates of how ideal model is actually ideal • Some models are industry specific, that might not easy to generalized • Some models might required a major changes in the current strategy of the organizations

	• With the ideal model in sight, organizations can develop stages to measure their closeness on achieving their ideal conditions

As mentioned previously, it was found that there were two primary approaches in formulation and selecting sustainability indicators, and based on the review, both approaches have their strengths and weaknesses as described as follows in Table 2. Then, both approaches were set as the criterion for classification. For criteria-based approach, it was found that some research determined the indicators directly (from literature review and underlying concepts then the indicators were formulated) or indirectly (a particular mechanism was applied to filter a set of indicators that being derived from literature review and underlying concept). The review showed that, from these 63 selected articles, there were 27 selected articles (43% out of 63) in model-based approach and 36 articles (57% out of 63) articles in criteria-based approach.For the criteria-based approach, it still can be divided into: 43% is those were not using any filtration methods (directly) to formulate the indicators and 14% is using certain filtration methods (indirectly).Descriptive statistics based on selected papers were conducted. Figure 1 showed that articles within these topics of interest (i.e. sustainability indicator or corporate sustainability model) have been increasing for the last five years, from 5 articles in 2012 to 23 articles in 2016. The same trend was also occurred to the articles which used criteria-based approach with no filtration (CNF) and model-based approach (M), there were 2 articles of CNF in 2012 increasing to 11 articles in 2016 and 1 articles of M in 2012 increasing to 9 articles in 2016. Given the number of articles, 1 article of criteria-based model with filtration (CF) in 2012, no related publication in 2011, 2012 and 2013, and 3 articles in 2016; it indicated articles of criteria-based approach with filtration were rare and had no trend in quantity year to year.

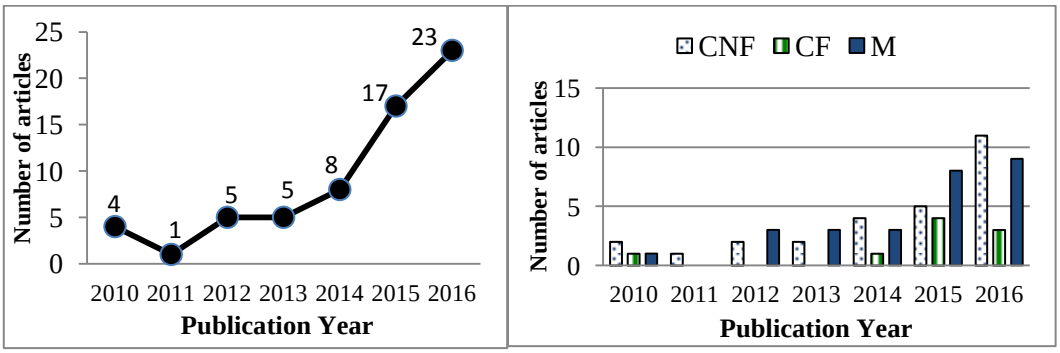


Figure 1. Distribution of number of publications per year
(left) for topics of sustainability indicators or models, (right) for specific classification
Notes: CNF: criteria-based approach no filtration, CF: criteria-based with filtrations, M: model-based)

Table 3 indicated that about 33% of the selected articles were discussing about sustainability assessment for general corporations, meanwhile 67% of them discussing the same issue for specific industry sectors which majority covered the sectors of supply chain & logistic, public service and information technology. Among 36 selected articles using criteria-based approach, environmental dimension was the highest percentage (89%) being used to assessment sustainability. However, the development of indicators for other dimensions, namely social and economics (81% and 64%) were also increased recently. Table 4 also summarized that qualitative and quantitative indicators have almost equal percentage of usage.

Table 3. Distribution of Industrial Sectors

Industry Sector	Percentage	# of articles
General corporation	33	21
Specific industry	67	42
For 42 specific industry sector, there were:		**# of articles**
Supply Chain & Logistics (e.g. retailer, port, logistics service provider)		6
Public Service (e.g. urban design, water service, park, electricity)		5

Information Technology (e.g. green IT, service centre, telecommunication service)	3
Manufacturing, Tourism, University,Micro Small Medium Enterprise	3 foreach industry
Automotive, Energy, Forestry, Mining, Textile	2 foreach industry
Fashion, Fishing, Forensic, Hospital,Local Government, Project Management	1 foreach industry

Table 4. Criteria-based approach: dimensions and type of sustainability indicators

Criteria-based approach	# of Articles	Dimensions of Sustainability				Type of Indicators	
		Environment	Social	Economic	Additional	Qualitative	Quantitative
No Filtration	27	23	20	16	12	20	16
Filtration	9	9	9	7	7	5	6
Total	*36*	*32*	*29*	*23*	*19*	*25*	*22*
Percentage		**89%**	**81%**	**64%**	**53%**	**69%**	**61%**

For model-based approach, there were 27 articles that being selected because the researches discussed the development of sustainability models using certain basic concepts. Table 5 listed the underlying concepts that used to develop the model. Given the percentage of usage, Business Process Management was placed as the most-frequent-used underlying concept; with the percentage of usage was 37%. It was followed by Corporate Sustainability and Supply Chain Management as the second and third highest percentages, with the percentages of usage were 33% and 22% respectively.

Table 5. Model-based approach: distribution of underlying concepts and developed models

Underlying Concepts	# of articles (percentage)	Developed Models
Business Process Management (BPM)	10 (37%)	Process Analysis Method, Green Performance Indicators, Sustainable Management System, Systemic Navigation Framework, Sustainability exploitation & exploration, Corporate Sustainability Activity framework, Triple-layered Business Model Canvas, Sustainability Business Model, Campus Sustainability Assessment, Sustainable Strategic Management
Corporate Sustainability (CS)	9 (33%)	Process Analysis Method, Green Performance Indicators, Sustainable Management System, Systemic Navigation Framework, Sustainability exploitation & exploration, Corporate Sustainability Activity framework, Sustainability Business Model, Campus Sustainability Assessment, Sustainable Strategic Management
Supply Chain Management (SCM)	6 (22%)	Sustainability SCM, Green SCM, Multi-methodological approach, Risk Management Approach, Sustainability Supply Chain Performance, Assessment of Supply Chain Sustainability Framework
Triple Bottom Line (TBL)	5 (19%)	Urban Water Service Sustainability, Economic and Socio-economic assessment, Efficiency Model, Triple-layered Business Model Canvas, Product life cycle phases
Engineering Management (EM)	4 (15%)	Energy Management Maturity Model, Energy Efficiency Model, Sustainable Systems Integration Model-Metrics Framework, Energy Efficiency Model
Balanced Scorecard (BSC)	3 (11%)	BSC Strategic Framework, BSC Model, Sustainability BSC (SBSC)
Product Life Cycle	1 (4%)	Product life cycle phases

4. Conclusion

This paper described on how the three-stage systematic literature review gave a scientific contribution in providing, for the best of authors' understanding, a helicopter-view about the expansion of the publications related to the interest topic. It started from (i) planning the literature review by defining specific terms to search thearticles, determining targeted publisher, publication year and classification criteria, (ii) conducting the review by skimming the title, keywords, abstract and reading the introduction, methodology and conclusion of selected articles, then (iii) reporting the result by concluding main issues and providing guidance for future directions.

Regarding to the interest topic i.e. the development of sustainability assessment tool, the systematic literature review filtered only 63 articles or 7.2% out of 875 articles from Science Direct electronic database; however, the distribution of number of publications has shown an uptrend within last five years. It identified two primary approaches that were used in designing the sustainability assessment i.e. criteria-based approach (assessment indicators were derived directly or indirectly from literature review) or model-based approach (the development of a certain model was done prior to the formulation of the assessment indicators).

In general, there were two major issues to be concluded from the result of the literature review. Firstly, both approaches had similar popularities in publications; there were 27 articles (or 43%) of 63 selected articles that using model-based approach, another 43% of them were criteria-based approach with no filtration and the rest 14% were criteria-based using a specific filtration method to select the indicators. Furthermore, the review indicated that the approaches were balance in strengths and weaknesses, for instance, it was easy for criteria-based approach to formulate a set of indicators, but it might be difficult because of the similarities among indicators and the subjectivity in selection. For future direction, with model-based approach, it could create a more robust indicator based on a proven ideal model but it might be difficult to find how ideal a model was. However, a model-based approach appears more appropriate because a model can be an identifier to distinguish an assessment tool from others; a model can describe the constructs and their relationships. Business Process Management and Corporate Sustainability Model will be studied further to determine the constructs of the model. The model will be developed for general corporations and will be validated by applying it to some case studies.

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Perceived kansei and performance-based usability impact on satisfaction for web-based applications

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Abstract. Kansei Engineering has been applied intensively for product design and development considering the deepest layer of customer needs, known as Kansei, which is related to emotional need or affect. This method has been extended into service design and innovation. It has been shown that Kansei's impact on customer loyalty is equally important as that of cognition or performance. A recent research in investigating the proportional effect of Kansei and performance on usability measurement for e-services has been conducted. It shows that both Kansei and performance is found to be equally significant as well. Then, a question is raised, whether they are antecedent of customer satisfaction. This study is proposed to investigate both perceived Kansei-based and performance-based usability measures on satisfaction. Both theoretical and practical implication is highly expected due to the growth of more human-computer interaction (HCI) features and services nowadays. A proposed applicative framework followed by an empirical study on how the perceived Kansei and performance-based usability impact on satisfaction for web-based applications is discussed.

1. Introduction

With regard to web service and web-based applications, usability analysis focuses on structure and behaviour rather than technical aspects. A web-based application is a program which can be accessed through a network connection using HTTP and runs inside a certain web browser. The usability of web-based application is of highly expected. Both impression and performance of the web-based application is significantly expected by the user. A recent study shows that both cognitive and affective process is associated with usability [1]. Cognitive deals with human capabilities, limitations and tendencies; whereas, affective is known as Kansei (in Japanese) concerns on human feelings and impression. Affect complements the whole cognitive evaluation, according to study by Hartono and Tan [2]. This study highlights the importance of emotional satisfaction in services, and how the service provider should take the impact of emotional needs on particular service attribute performance for the improvement prioritization.

In the area of Human Computer Interaction (HCI), both cognitive and affective aspects for usability have been implemented into electronic products, medical equipment, mobile phones and e-commerce sites [1,3,4]. In a case of HCI-based websites, the cognitive aspect includes ease of use, content, identification, delay and trust. More specifically, in usability study for e-commerce, its cognitive process covers navigation, interaction, layout, merchandise and information quality [5]. A recent study on the role of affect and cognition on customer satisfaction and loyalty shows that affect has the proportional weight to cognition which leads to customer satisfaction and loyalty [6].

However, affect has received little intention for the usability evaluation [1]. Hence, a study on how to investigate the impact of affect- and cognition-based usability on satisfaction is highly prospective.

There is still no comprehensive conclusion about the relationship between affect and usability and how its impact on user satisfaction. Some studies on the affect-based usability have been conducted [7]. However, some studies could not show that relationship [1]. Therefore, a study on the combination of cognitive and affective processes is highly expected to deliver more comprehensive information for user satisfaction.

A case study on web-based application is selected, or it is deemed related to website. The development of usable websites is important for e-business and e-commerce success today as online customers and users will feel, search, and experience products or services mainly through websites. A full usable website has been deemed to be a media for delivering positive attitude toward online shops, boosting engagement and revisit rates and also stimulating online purchase [8]. It is also stated that *difficult-to-understand* website content, inconsistent format, disorientation, poor interaction and reliability and ill-defined help functions are regarded as common problems for commercial websites [9].

Given this above background, this study has two objectives. First, it is to build an applicative research framework of perceived Kansei and performance-based usability impact on satisfaction for web-based applications. Second, it is to conduct a simple empirical test to investigate the effect of web-based application usability constructs on satisfaction.

This paper is systematically structured as follows. After the Introduction section, it is followed by a brief Literature Review. Afterwards, it continues to the Research Methodology and Framework, Result and Discussion, and is wrapped up with Conclusion and Further Research Recommendation.

2. Brief Literature Review

2.1 Usability for website and web-based application

The mutual interaction between human and computer is highly needed in designing and implementing a variety of computing systems. According to ISO 9241 [10], usability is defined as the extent to which a product can be utilized by particular users to obtain effectiveness, efficiency and satisfaction. Related to website or web-based application, it refers to the extent to which web can be used by specific users in achieving goals in terms of efficiency, effectiveness and satisfaction in a specified context of website or web-based application use.

According to Lee & Kozar [9], effectiveness represents the accuracy where the online users can achieve their goals (e.g., purchase, information gathering); efficiency is related to quick time and less cognitive effort to achieve goals (e.g., website with simple and consistent design features to make the pages easy to read and learn); and satisfaction is defined as the comfort and acceptability of a website to its users (e.g., real-time chat menu with customer support personnel).

2.2 Kansei, Performance and Satisfaction in web-based application usability

In website design and application, affect refers to impression or delight (known as Kansei in Japanese) whereas performance deals with cognition, according to the previous study on emotional needs and Kansei Engineering [1]. Delight, firmness and convenience are found to be determinants of customer satisfaction and loyalty toward the site [11]. Delight explains the affect, whereas, firmness and convenience are dominantly describing the performance or cognitive processes. Another study proposes a set of usability dimensions such as download delay, navigability, site content, interactivity and responsiveness which bring impact on the customer satisfaction, return possibility and frequency [12].

With regard to various constructs used in various usability studies, Prastawa et al [1] proposes two main factors (i.e., cognitive and affective processes) which bring significant impact on usability. Even though this approach has simplified the understanding of usability performance drivers, an

extended approach which is to investigate the proportional impact of affect and cognition on user satisfaction in a case of usable web-based application or website is prospective.

3. Research Framework and Hypothesis

Referring to what have been discussed in the Section 1 and 2 above, this study starts with the perceived performance-based and Kansei-based usability measurement, and then followed by the overall satisfaction measurement, as shown in figure 1. The measure variables were adopted from Prastawa et al. [1]. The details of them are provided in the Appendix. According to Helander and Khalid [13], perceived performance-based is related to cognition, which is something more on analytical and rational thinking, whereas Kansei-based is related to emotions and attitudes. Variables of both constructs explain how usability can be derived from both rationale and emotional aspects. For instance, "readability" explains the performance-based usability, it may relate to sentences and steps to operate the website that are easy to understand. For the Kansei-based usability, for instance, "appeal" is proposed. Appeal is related to the appearance of the web is interesting and eye-catching.

Apart from performance-based and affective-based usability constructs, the third construct to consider is overall satisfaction, which is only measured by 1 variable called as "overall satisfaction". The relationship among three constructs is shown in figure 1.

There are two hypotheses defined, i.e., H_1: there is a significant impact of perceived performance-based usability on overall satisfaction, and H_2: there is a significant impact of perceived Kansei-based usability on overall satisfaction.

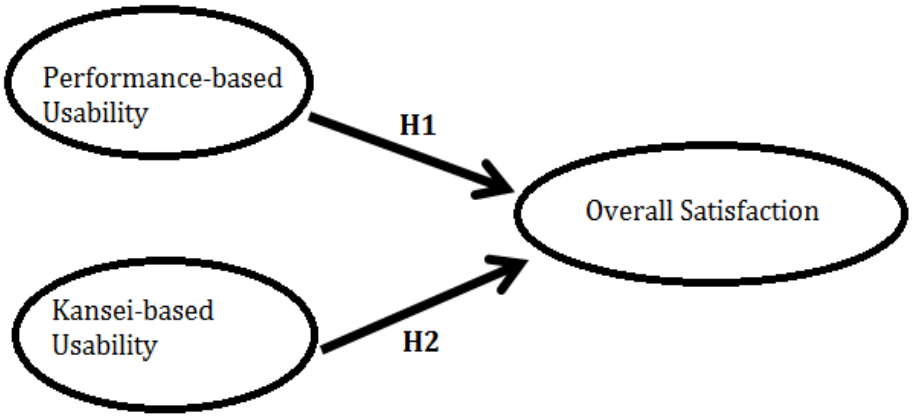


Figure 1. Conceptual framework of Performance- and Kansei-based Usability for web-based application**.**

4. Result and Discussion

A case study has been conducted in one of the famous web-based application operated in Indonesia, namely Tokopedia. The targeted subjects were those who have experienced the Tokopedia services in the last six months (October 2018 – March 2019) through the purposive sampling method. It is a non-probability sampling method when the researchers believe that they can achieve a representative sample through a sound judgment which may save time, effort and money. There were 35 respondents involved during the survey using the questionnaire (20 males and 15 females) with the age range from 20 to 40 years. One copy of the questionnaire was given to represent one group of participants (e.g., either one family or one single respondent). The questionnaire consists of three different parts, i.e., Performance-based Usability, Affective-based Usability, and Overall Satisfaction. It took about 10 minutes to complete a questionnaire.

4.1 Validity and reliability test for constructs

The analysis is performed using SmartPLS 3 [14]. It is Partial Least Squares Structural Equation Modeling (PLS-SEM) which focuses on the analysis of variance with condition of small sample size and little availability of tested theory. Confirmatory factor analysis (CFA) has been carried out for testing how well the measured variables represent the number of constructs. In other words, CFA is used to confirm or reject the proposed measurement theory. Model was deemed fit, as it satisfied the following criteria: root mean square residual (< 0.1), d_ULS and d_G (< the upper bound of the confidence interval), and normal fit index (> 0.7 and it is closer to 1). Reliability and validity tests (i.e., convergent validity, discriminant validity and reliability) have been conducted and are showed in the **t**able 1 and figure 2. In terms of convergent validity, all constructs were deemed acceptable since: (i) all item factor loadings in all constructs exceed 0.6, (ii) composite reliability in all constructs exceeds 0.7, and (iii) AVE in all constructs exceeds 0.5.

Table 1. Measurement of constructs**.**

Construct	AVE*	Composite Reliability	Cronbach's Alpha
Performance-based Usability	0.571	0.922	0.905
Kansei-based Usability	0.580	0.917	0.896
Overall Satisfaction	1	1	1

*average variance extracted

Referring to discriminant validity, these three constructs above were considered valid as the square root of AVE for each construct is greater than its corresponding inter-construct correlation coefficient [15]. Lastly, in terms of reliability, all three constructs show Cronbach's alpha values which exceed 0.6, thus, they were deemed acceptable.

4.2 Path coefficients and hypothesis testing

It was found that Kansei-based (known as affect or emotion) and performance-based (referred to cognition or rationale) usability account for 47.7% and 50.5% of their impact on overall satisfaction, respectively**,** as shown in **t**able 2.

Table 2. Parameter significance values**.**

Construct	Original Mean	Sample Mean	Standard Deviation	T Statistics	p values
Performance-based Usability	0.505	0.505	0.091	5.538	< 0.001
Kansei-based Usability	0.477	0.479	0.089	5.379	< 0.001

The first hypothesis (H_1) that perceived performance-based usability is positively related to overall satisfaction is supported by the results (T Statistics = 5.538, p value < 0.001). The second hypothesis (H_2) is also supported. Kansei-based usability is significantly positively correlated with overall satisfaction (T Statistics = 5.379, p value < 0.001). This study shows that both Kansei and performance-based usability have significant role and impact on overall satisfaction. They cannot be separated; they are a set of human-based experience evaluation in a service encounter. High value of R square of 0.918 explains both Kansei and performance are regarded as the significant predictors of overall satisfaction. Their impact on customer overall satisfaction is relatively equally balanced.

More specifically, the critical usability variables for both constructs (performance-based and Kansei-based) were defined according to high factor loadings (i.e., factor loadings ≥ 0.8). The most critical performance-based usability measures were interactivity (P3), logical navigation (P8) and easy back option (P9), whereas Kansei-based usability measures were salience (A4), appeal (A5) and reliability (A7).

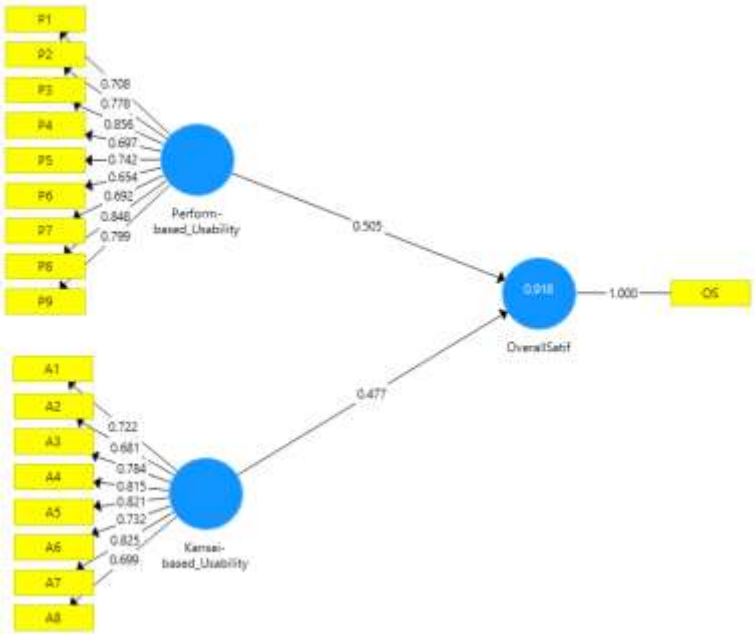


Figure 2. Structural model and path coefficients for web-based application case study.

5. Conclusion and Further Research

Kansei (which is related to affect or emotion) was found to be equally important as performance (known as cognition) in usability measurement which brought significant impact on overall satisfaction. This study complements the previous study on usability in web-based application by taking into account both performance and Kansei impact on overall satisfaction. This study is limited due to relatively small sample size and a single service setting. Future study should consider that concern.

6. Appendix

Performance-based and Kansei-based usability variables for web-based application, adopted from [1]

Performance-based usability variables	Kansei-based usability variables
P1. Error prevention a [usability – multiple similar tasks to be done easily]	A1. Colour [usability – conceptual image of the app]
P2. Error prevention b [usability – warning message to prevent possible errors]	A2. Brightness [usability – conceptual image of the app]
P3. Interactivity, Feedback, and Help [usability – multiple opportunities for interaction and communication]	A3. Harmoniousness [usability – compatibility and alignment of the app]
P4. Learnability [usability – appropriate information related to attributes sold]	A4. Salience [usability – convenient use of the app]
P5. Readability [usability – sentences that are easy to understand]	A5. Appeal [usability – appearance of the app is interesting]
P6. Memorability [usability – steps that are easy to remember]	A6. Comfort [usability – convenient use of the app]
P7. Easy Navigation [usability – guide to easy to operate]	A7. Reliability [usability – reliable and trusted app]
P8. Logical Navigation [usability – guide to logical to run]	A8. Attractiveness [usability – attractive and pleasing app]
P9. Easy Back Option [usability – return to the previous page]	

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Passive design implementation as sustainable development approach on vertical housing case study: Sentra Timur Residence

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Abstract. Vertical housing development is a solution to solve housing needs problem in Jakarta, which already have land limitation issue. However, the development also contributes to environmental degradation. Building uses materials and energy in the development process, and when it operates. Most of energy use in Heating, Ventilating, and Air Conditioning (HVAC) to create physical comfort for user. Passive design strategies applied to maintain comfortable temperature in building such as building orientation, shading, and ventilation, so energy usage could be reduced. The purpose of this research was to analyse the implementation of passive design in vertical housing, as an approach to achieve sustainable building. Observation carried on Sentra Timur Residence, one of vertical housing in East Jakarta. This research used building data to create mass modelling to help analyse the passive design implementation. The results show that some passive design strategies are applied such as building orientation, shading, and ventilation, mainly in housing unit. These strategies help to maintain thermal comfort inside the housing unit, so the users can feel comfort without using air conditioner. It reduces energy usage in the building so negative impact on environment could be minimize.

1. Introduction

Human activities contribute to environmental issues, such as climate change and air pollution. Development carried out in order to fulfill human needs, sometimes does not consider about the ecological impacts that cause the environmental degradation. Therefore, the concept of sustainable development arises, in order to reduce environmental impacts and on the other hand improve the quality of human life.

The United Nations assigns 17 Sustainable Development Goals (SDGs), which one of them is sustainable cities and communities. Cities only occupy 3% of the land area, but their energy use reaches 60-80%. Building is one of the elements in the city as a place for people to live, work, and do various activities. However, on the other side, building also contributes to environmental problems. Buildings produce 40% of existing carbon emissions, and use resources such as material, water and energy [1].

Jakarta is a high population density city, with about 10,3 million residents [2]. Besides humans, Jakarta is also filled with a lot of buildings, ranging from houses, offices and skyscrapers. With the increasing number of residents every year, it will affect the needs of housing.

Housing backlog based on ownership in Indonesia amounted to 13,5 million units in 2014, and handling target was 6,8 million units in 2019 [3]. Jakarta, as a densely populated city in Indonesia also become a target of housing development. However, this city is already had land limitation issue, so the development directed to vertical housing.

The building development need to consider sustainability aspect, since the building give negative impact to environment such as consume a lot of material, water, and energy [4][5]. Building also consume electricity to support the human activities inside, which is the source of electricity power supply mostly come from fossil power. So, building also contributes in producing emission [4]. Heating, Ventilating, and Air Conditioning (HVAC) is the most energy consumption in building [6] that needed to create thermal comfort for user. Human thermal comfort can be achieved when the average temperature is around 23ºC -27ºC [7].

Jakarta has high average temperature, around 28-31ºC [8], it means there is gaps to achieve thermal comfort. It needs some effort to reduce the temperature in the building. Air conditioner usually used to solve this problem, although it means there are more energy needed and emission produced.

In architecture, there are some strategies that can be applied, namely passive and active design. Different with active design that need mechanical device and high technology, such as air conditioner, passive design is applied through planning process that make building can adapt with the environment. Passive design strategies that commonly applied, such as building orientation, shading, and ventilation.

1) Building orientation
   Building orientation refer to the way building is placed on the site. The position of the building will affect the solar heat accepted by the building. Solar analysis could help to determine which direction the building should oriented. Usually, the building planner avoid north-west orientation because there is more heat exposure that accepted by the building, especially in the afternoon.
2) Shading
   Shading is used to control the amount of sunlight that expose the building. To apply shading strategy, there are some ways that can be use, first create façade that adaptive to sun movement, and the other way is using shading device such as trellises, roller blind, and curtain.
3) Ventilation
   Ventilation is important element in building, it useful to air exchange in the building. Through ventilation, fresh air can enter the room and replace the air inside.

East Jakarta is part of Jakarta with the highest resident population among the other regencies. To fulfil the housing needs, there are lot of residential developed in East Jakarta. Vertical housing development also increase, due to land limitation issue. One of vertical housing in East Jakarta is Sentra Timur Residence.

Vertical building consists of some housing units, and every unit need to fulfil thermal comfort for its user. This paper aims to find the passive design implementation in Sentra Timur Residence and analyse it effect to the building. Passive design could help building to achieve thermal comfort, so energy usage will reduce, and make building more sustainable.

2. Methods

2.1. Study Area

This study held in Sentra Timur Residence, one of vertical housing in East Jakarta. This building located in high density housing area, and the surrounding area is filled with lot buildings, as shown in

figure 1. Sentra Timur Residence consists of six towers, named orange, ruby, green, grey, yellow, and tosca tower, as the color of each tower.



Figure 1. Sentra Timur Residence Location.

2.2. Data Collection

This study used building drawing such as plan, section, and elevation to create mass modelling. This model then analysed using solar path software. Other data such as solar movement, temperature, and map used to help identified the issue. Observation also carried to identify the implementation of passive design in the building.

3. Results and Discussion

3.1. Building Orientation

Figure 2 shown the orientation of Sentra Timur Residence building and sun path in Jakarta. There are six towers, and as it shown in the figure 2, none of the building exactly face east-west orientation. Two towers face southeast-northwest orientation, and four towers face southwest-northeast orientation. These orientations make the housing units not directly exposed to sunlight. Thus, the potential of heat entering the building through wall and openings can be reduced.

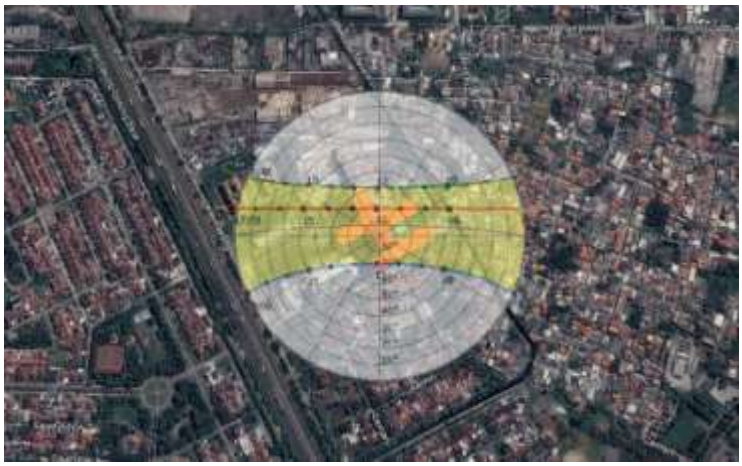
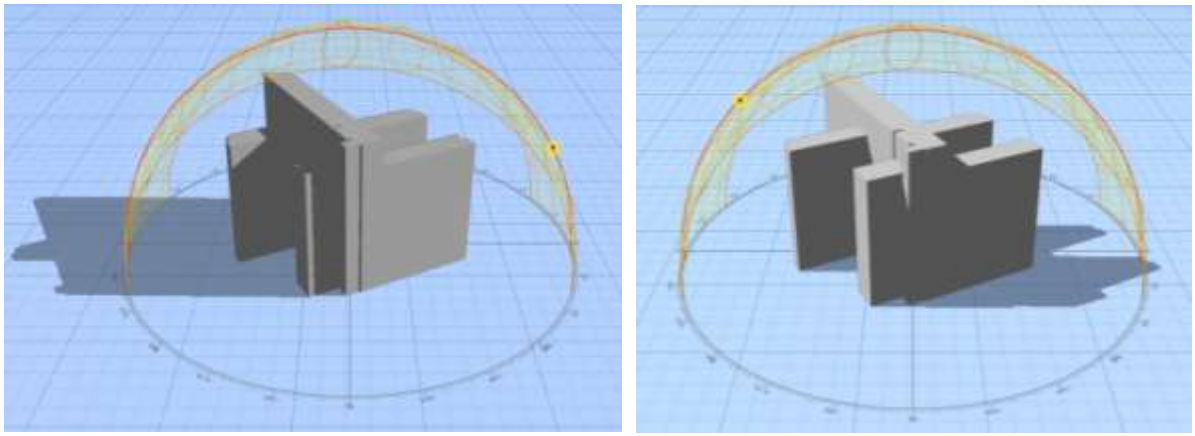


Figure 2. Sentra Timur Residence Building Orientation.

3.2. Shading

Shading is useful for eliminating the heat of the sun entering the building. Shading can be achieved by façade design or using shading device. In Sentra Timur residence buildings, shading is formed from an asymmetrical building mass. The towers position and height difference of the towers form shading for each other as can be seen in figure 3.

In figure 3a shows the condition when the morning when the sun rises, it can be seen that shading on the west side makes the units on that side cooler. Figure 3b shows the situation in the afternoon where the sun is on the west side. It can be seen that the shading formed covered many sides of the housing units.



(a) (b)

Figure 3. Sentra Timur Residence Building Shading.

3.3. Ventilation

Figure 4 showed the unit plan of Sentra Timur Residence, which consist of living room, two bedrooms and toilet. Each unit is designed to have windows facing outwards. This window is a vent to put fresh air into the unit. The windows position in the room are in the bedroom 1 and living room. Considered the configuration of the room and windows, the room that needs air conditioner is the bedroom 2 due to the absence of ventilation to flow fresh air inside. The use of air conditioner in the living room and bedroom 1 can be reduced by utilizing ventilation.

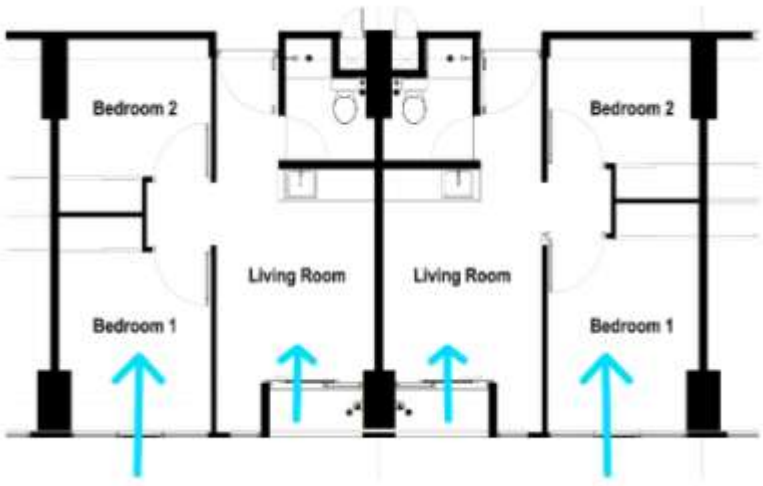


Figure 4. Housing Units Ventilation Illustration.

4. Conclusion

Sentra Timur Residence building applied passive design strategies, such as building orientation, shading, and ventilation. These strategies help to create thermal comfort inside the housing units, so air conditioner usage could be reduced. It means the energy usage also reduced and make the building more sustainable to contribute achieving SDGs number 11, sustainable cities and communities.

Acknowledgments

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Development and usability evaluation of virtual guide using augmented reality for Candi Gunung Gangsir in East Java

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Abstract. Despite being one of Indonesian cultural and historical heritage, Candi Gunung Gangsir failed to attract many visitors especially from the younger generations. Lack of attraction and supporting facilities in the vicinity is one of the reasons. This research aimed to develop an interactive virtual guide enabled by augmented reality that will increase the attractiveness of the object. The methods used in this research are product design and development steps with consideration of human computer interaction, and usability. Primary data of customer needs are collected on and off site through questionnaires and interviews. Customer needs are then used to generate several product concepts to choose 1 final concept from through concept selection methods. Literature review and interviews are conducted to create an accurate story line for the virtual guide. The chosen concept is then developed to become a final application which also tested against the customer needs through a survey method. The result of this research is an offline Android-based augmented reality application to scan the 17 markers to show a 3-D virtual guide character on the marker and inform the visitor about history of that particular spot. The usability testing was conducted to 20 respondents and revealed that the application can attract them to visit Candi Gunung Gangsir.

1. Introduction

Candi Gunung Gangsir, located in a housing complex in Beji, Pasuruan, Indonesia, is believed to be built at the end of the 11th century or at the beginning of the Majapahit era and was once used as a shrine to worship the God of Prosperity. Despite being a cultural and historical heritage, it failed to attract many visitors especially from younger generations. Our preliminary survey observed the visitor to this site on a weekend barely reach 20 persons due to lack of attraction and supporting facilities in the vicinity. Although it has undergone a restoration, some parts of Candi Gunung Gangsir is already destroyed which make it difficult for casual tourist to interpret the site [1]. To help improving the attractiveness of the site, this research aimed to develop a mobile augmented reality application that can serve as a virtual guide for the visitors.

The application can also be used to preserve important knowledge regarding the architecture and history of the site and it will help to transmit the knowledge in a more effective way [2] by overlaying the information onto point of interest [3]. The increasing adoption pace of augmented reality (AR) in the tourism sector [4] should make it easier to implement the application. Candi Gunung Gangsir is an outdoor site which provide a challenge in designing the application so that it must consider the ergonomic factors and product usability. Since there is no personal guide available at Candi Gunung

Gangsir, we consider to create an application that can serve as a virtual guide for the visitors and bring us another challenge to create a good story line as it will be delivered in a virtual environments [5].

2. Related works

Using AR in to enhance engagement from user has gained more popularity as AR can help to create mixed reality by including virtual elements into an actual physical environments [6]. AR provide a means of improving users' experience and satisfaction. The use of AR in marketing is a promising and growing field [7] and it allows brand to enter consumer's domestic space with virtual offerings and has been practiced by leading brands such as IKEA, Wayfair, and Sephora [8] where the application enables customer to virtually trying products. By providing additional information about the offering, AR can enhance a customer's real-world experience in interesting ways [9]. A personalized AR application should help customers in dealing with too much information provided by a common search engine [10].

The AR applications are also effectively implemented in the tourism business. Garau [3] used AR to improve the tourists' experience in Costello, Italy. AR has also been used for preservation purposes where knowledge of a heritage site is saved in the application. Haydar et.al [11] used AR to reconstruct underwater archaeological site and compared it with the virtual reality (VR). The historical information regarding Roman Theater at Byblos are used to reconstruct the site virtually [1]. Recently, Mah et.al [12] has generated a virtual tour to preserve the cultural heritage of Tampines Chinese Temple in Singapore. A mobile AR based on semantic web technology has been developed to provide contextual information about Injeongjeon Hall in South Korea [13]. In Indonesia, Affan et.al [14] implemented AR as information and promotion media for Dieng tourism area.

Application design is not over once the application is ready to be released, it has to be reviewed for quality and improvement. A quality assessment helped the designer to identify shortcomings of the application's functionality [15] and use the information to improve the application. Usability is a popular metric for assessment where some design goals are used as the measurement dimensions [16]. Barnett et.al [17] used usability to evaluate mobile games users' experience in the view of first-time users. Yuan and Chee [18] evaluate their design of virtual tour guide using two dimension i.e. user satisfaction and agent's believability. Tahyudin and Saputra [19] used 4 dimensions i.e. text, graphic, animation, and interactivity to assess the user satisfaction of their application.

3. Development process methodology

The application development process is started with an exploratory data collection for users' insights through questionnaire targeting 100 respondents with age range of 17 – 25 years old, the number of respondents is adequate to represent the population based on Slovin's Formula with error tolerance of 10%. The data obtained from the survey are then used as considerations during the generation of application concepts.

The concept generation are done systematically by utilizing the concept combination table. Of the generated concepts, a selection process is done by comparing concepts against each other by using customer needs and its weight as selection criteria until one final concept is selected. The selected concept is then developed into a final product (Android application).

In order to get a better and more accurate information that will be conveyed through the application, we conduct in-depth interview with the historian and supported by literature review so we are able to plot the story line of the object's history which is the main content of the application. Beside the story and timeline, we also gather data regarding cultural aspects including how the people dress that is required to create the main character appearance in the application.

The augmented reality application is mainly developed using Unity 3D software while the assets (components) are developed using several other software such as:

- Corel Draw and Adobe Photoshop: designing markers, user interface, and 2D virtual guide character
- Cinema 4D, Zbrush, and Marvellous Designer: generating 3D character

- Adobe Audition: sound assets
- Android SDK: to create .apk file
- Vuforia SDK: to enable application reading the marker through android phone camera

After the application is developed, a usability testing is done by questioning 20 respondents fit to the target user group to ensure the human computer interaction is well considered using 6 dimensions of usability [16] including: functionally correct, efficient to use, easy to learn, easy to remember, error tolerant, subjectively pleasing. We chose this metric because of its simplicity but can provide sufficient early feedback on the application without making it too hard for users to fill a more complex feedback questionnaire.

4. Results and discussion

4.1. Users insights, concepts generation, and concept selection

From the survey of 100 respondents, the frequency of visiting historical site is quite high as 67% claimed to visit at least once a year and the most visited site is Candi Borobudur. Only 11 respondents said that they already visited Candi Gunung Gangsir which confirms the lack of visitor to our object. 89% of respondents stated that they want to get more information on the history of the site and preferred the information to be conveyed through a video presentation and augmented reality instead of brochure, audio-only and in-site guide. The respondents preferred offline mobile applications (64%) while the file size should not exceed 300MB (74%). We investigate that there are 10 equally important needs that are expected to be delivered by the applications: easy to use, security, interesting interface, low file size, using augmented reality technology, using 3D objects, informative audio, and subtitle.

These insights helped us to generate 8 application product concepts by varying color scheme, type of marker, and the style of the virtual guide character as shown in Table 1. The evaluation of the concepts is done through concept screening that left us with 5 concepts which then passed through the concept scoring which use the customer needs and its weight as the selection criteria where the score was given by comparing each concept with a reference concept.

Table 1. Concept Combination

Marker Type	Color Scheme	Character Style
Geographic	Basic	Modern character
Printed	Mixed	Classical Majapahit

The chosen concept is an augmented reality virtual guide application with basic color scheme, printed marker instead of geographical marker, and main characters designed to resemble the Majapahit era styles.

4.2. Content and assets generation

The main content of the application is information regarding the areas of interest within the main building of the site. We observe at least 14 areas of interest in form of relief carving on the body of the building and the photograph of the areas are unique enough to be used as markers to be scanned by the AR camera. Several examples of the markers are presented in figure 1. We also designed 3 additional markers as the place-holder for supporting information i.e. welcome greetings, the site architectural, and urban legend. The information required for creating the content is primary gathered from in-depth interview with experts from Cultural Heritage Conservation Center (BPCB) Jawa Timur and supplemented by secondary data from the report on Candi Gunung Gangsir restoration in 2013. The data also helped us in designing the virtual guide character to resemble the persons from Majapahit era. We designed 4 characters as shown in figure 2. The male characters are designed to wear sarong, while the female characters wrapped in seamless fabric. These characters are animated and dubbed during the presentation of each area of interest



Figure 1. AR markers using areas of interest

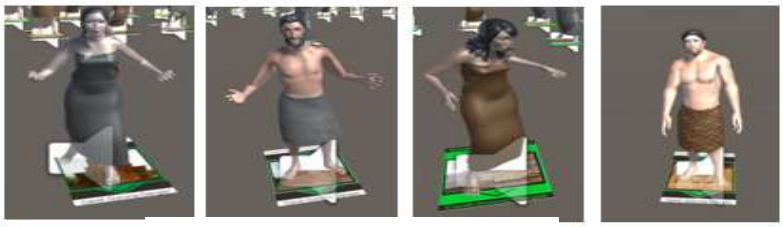


Figure 2. The virtual guide characters



Figure 3. User interface

The next process is designing the application's user interface (UI) while ensuring the application must be easy to use. We chose a simple yet ergonomic user interface as shown in figure 3. The colour scheme is putting dark background and bright text to make it suitable with broad-daylight exposure. To align with the history of the site, we chose green background as it represents land fertility which can become a source of prosperity. The first button on the main page is designed to open the camera so that the user can scan the markers for virtual guide presentation. The second button will display text-based information of the site. Clicking the last button will close the application. The application file size is 146 Megabytes which is considered acceptable, it can run in Android 4.0 version or newer, and smoothly run on smartphones with 2GB of RAM.

4.3. Markers' placement

The markers will be placed near the relief carving so that the users can scan the marker while seeing the actual relief. The placement map is shown in figure 4. The marker is printed to fit into an A3 paper size (297 mm x 420 mm) where the virtual guide character will pop-up on. The best viewing distance should be at 100 cm from the marker so that the virtual guide will be visible in full adult person size as illustrated in figure 5.

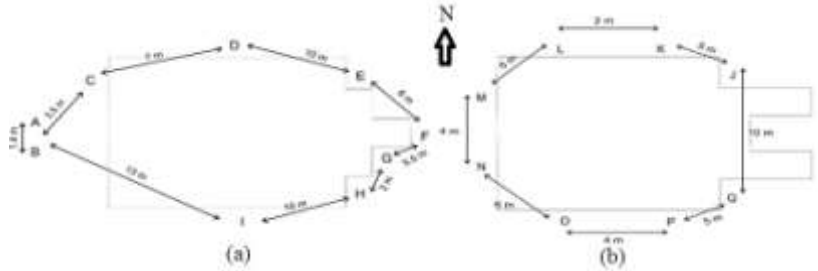


Figure 4. (a) markers placement on the ground floor of the building. (b) markers placement on the first floor of the building

4.4. Product and usability testing



Figure 5. Suggested viewing distance and virtual guide size illustration

Product and usability testing were done by installing the application on a smartphone and have it tested by 20 respondents that belong to our target user group i.e. aged between 17 – 25, living in urban area. The survey was conducted in Surabaya instead of in Candi Gunung Gangsir premise as it will enable us to measure the interest to visit the site after testing our application. We used the purposive sampling techniques to choose our respondents.

The respondents were asked to fill out post-trial questionnaire consist of 6 usability questions using 5-point Likert scale and 1 binary question to assess their interest in visiting Candi Gunung Gangsir should the application is available on the site. The result of the usability questions is summarized in table 1 which indicates positive response for the application as the mean of each dimension is at least 4. The test also suggests that 90% of the respondent agrees that the application will increase their interest in visiting Candi Gunung Gangsir. We believe that the application would be able to help the site attract more visitors.

Table 2. Usability testing result

Dimension	Mean	Std. Deviation
Functionally Correct	4,85	0,36635
Easy to use	4,80	0,41039
Easy to learn	4,90	0,30779
Easy to remember	4,60	0,50262
Error tolerant	4,40	0,50262
Subjectively pleasing	4,85	0,36635

5. Conclusion and further research

This paper provides a systematic approach in designing a mobile augmented reality application that will serve as virtual guide in Candi Gunung Gangsir, East Java that should help the site to attract more visitors especially from the younger generations. Virtual guide should give visitors a better experience and better information regarding the history of the site. The application can as well preserve the site's history and architectural information and transfer it in a more engaging virtual environment to the visitors. The usability evaluation shown a positive feedback on the application and give early hint on the raising interest to visit Candi Gunung Gangsir.

As the application is only a part of a total solution to improve attractiveness of the site, further research area can be explored such as making the virtual guide become interactive with the visitors by implementing artificial intelligence and resemble a personal guide who can take questions and give answers. Other research can also take the implementation as the focus and measure by how much actual visitor that the site can attract.

Acknowledgments
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Combined structural equation modelling – artificial neural networks model for predicting customer loyalty

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Abstract. Customer loyalty becomes considerations by service providers to be maintained for reducing the churn rate. Many researches proposes factors that are significantly influencing customer loyalty, and apply them for prediction on it. Based on mathematical models, loyalty prediction methods are developed and involve new approaches including machine learning. This research aim is predicting customer loyalty using the combination of structural equation model (SEM) and artificial neural networks (ANN). The methodology starts by applying SEM for selecting statistically significant factors affect the loyalty. The linear SEM model ensures this relationship by fulfilling statistical hypothesis and fulfilled assumptions. Once selected factors are found, these factors are treated as inputs for ANN modelling. ANN is selected because of its ability in nonlinear modelling for enhancing its prediction. ANN then learns the relationship between those inputs and the loyalty in real time as any additional observation recorded in. Based on trained ANN, prediction of customer loyalty based on input factors could be done. Case study is taken at a Hotel by asking 130 customers. SEM inputs includes tangibles, facility, and staff attitudes, meanwhile loyalty scores becomes output. Combination of SEM-ANN has successfully predicts the customer loyalty and bring up chance for improvement strategies.

1. Introduction

Customer loyalty becomes one of important targets in marketing strategies. Many research discuss about how to improve customer loyalty by practicing customer relationship management. Main reason why this loyalty should be noticed by product or service provider is about its effect on frequent customer purchase exclusively [1], and of course it leads to dominate the market. Once the providers identify factors influencing customer loyalty, then customer service and relationship can be designed [2]. Some quantitative methods have been developed in measuring customer loyalty (see [3]), and some of them focuses on predicting customer loyalty. Service or product provider uses this prediction to gain information about what customer relationship strategies should be deployed based on significant influencing factors (see [4]). Moreover, the prediction model can retrieve customer perception data taken from periodic survey to improve individual loyalty prediction, as done by [5]. Some researchers apply mathematical model to predict the loyalty, such as logistic regression [6], discriminant analysis [7], and artificial neural networks [8]. Some of them even combine the prediction model with data mining techniques (see [5]).

However, applying only mathematical model to determine factors influencing the customer loyalty has limitation in updating the fitted model with periodically survey data, the researcher needs to re-fit the model with new data and re-analyse it based on statistically significant factors. On the other side, implementing only artificial neural networks (ANN) model for predicting customer loyalty lead to

ineffectiveness, where this model involve all the factors without considering their statistical significance, absence of these such statistical hypthesis also lead the ANN to black-box modeling which is hard to be interpreted by researchers.

The objective of this research is proposing alternative framework in combining the mathematical structural equation model (SEM) for determining factors influencing the customer loyalty with prediction techniques of it based on artificial neural networks (ANN). This framework apply iterative ANN fitting based on updated customer survey data to improve the prediction accuracy. Along with amount of data collected by survey periodically, this iterative procedure forms simple data mining technique in loyalty prediction.

2. Literature review

2.1. Customer loyalty

In [9], mentioned that customer loyalty is a customer emotion that comes to the product or service provider, in spite of the presence of another competitor, more financially lucrative offers on the market. Providers should create strategies for improving this loyalty by determining specific factor, action, and activities to increase the indicator values of loyalty. Predicting customer loyalty could be useful for designing customer relationship management and improve customer perception about benefits they received from service or product providers [10].

2.2. Structural Equation Modelling (SEM)

Since firstly proposed by Sewall Wright at 1921, structural equation modeling (SEM) becomes important tools for understanding relationship between latent and indicator variables in terms of reflective and formative causality. [11]. an example of simple SEM shown in Figure 1.

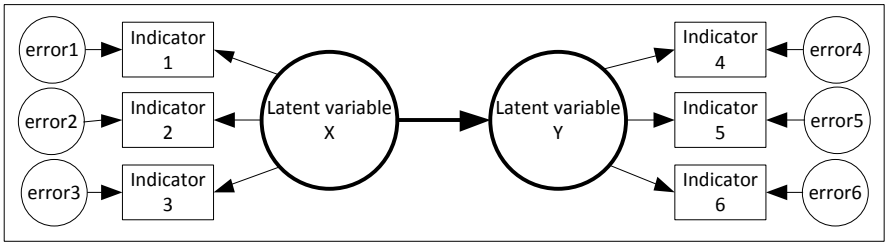


Figure 1. Simple SEM model

In this research, SEM model takes part in determining significant factors or variables that affect the customer loyalty. Indicator variables are measured by valid and reliable questionnaire taken from survey activity. Theses significant factor then are treated as input in ANN model for loyalty prediction.

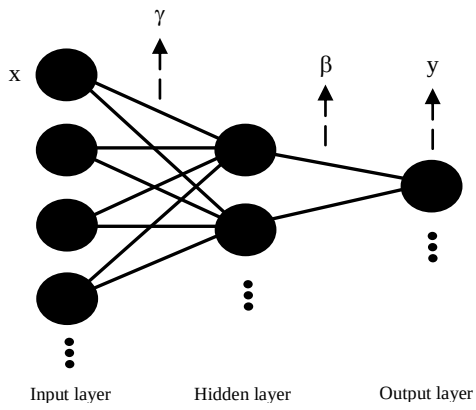


Figure 2. Single hidden layer ANN model

2.3. Artificial Neural Networks model (ANN)

Many research apply ANN for several purposes, and some of them use it as part of data mining system (see [12]). It is a complex mathematical model that has flexibility for modelling nonlinear causality among variables, and some literatures categorize it as an artificial intelligence model [13]. However, ANN didn't provide any statistical hyphotesis testing for their input variables, and modeling process lead to black-box analysis [13]. General ANN architecture with single hidden layer that is used in this research shown in Figure 2. Each node in a layer is connected (as weights) with another nodes at closest layer. General mathematical model of ANN shown in equation (1)

$$\boldsymbol{y} = \sum \boldsymbol{\beta_j}\, \boldsymbol{f}\left(\sum \boldsymbol{\gamma_{ij}} \boldsymbol{x_i}\right) + \boldsymbol{\varepsilon} \qquad (1)$$

where i represents number of inputs, j expresses number of hidden nodes, and function f is pre-determined activation function commonly uses logistic function. The ANN learning or training process estimates the weights γ_{ij} and β_j based on observed input (x) and output y (target) variables. Once the weights is estimated, then this model uses new observed input data to predict its output. Some paper have succesfully combined the SEM and ANN for predicting such targeted variabel based on questioennaire responses (see [14] and [15])

3. Proposed framework

The proposed customer loyalty prediction framework consists of four steps including iterative ANN weight updating process. Charted steps shown in Figure 3.

- First step, research on customer loyalty should be conducted based on ordinary survey using pre-determined variables potentially influence the loyalty. Next, all observed survey data leads the fitted SEM model to find significant *X* variables that affect customer loyalty (*Y* variable).
- Second step, all significant *X* variables obtained from SEM then treated as input for ANN model. ANN learning process also involve *Y* variable as response or targeted output. The ANN produces weights used for prediction of customer loyalty.
- Third, as new customer comes and fills the questionnaire, provider could predict the loyalty based on his/her answer using ANN prediction. Every new recorded data from new customer gives information for the ANN to update its weights and improve prediction accuracy
- Fourth, ANN would update the weights by using re-learning process as new customer data recorded. Once the weights updated, ANN uses these new weights to predict loyalty of another new customer, and then again update the weights iteratively.

The framework involve iteratively updating ANN weights, more data from new customer then more accurate the loyalty prediction. These steps forms simple data mining process for customer loyalty prediction based on combination between SEM and ANN model.

4. Implementation result

4.1. SEM modelling

Framework in figure 2 takes case study on a digital printing service provider. Twenty variables shown in Table 1, measured in likert scale questionnaire filled by 100 customers that have been using this service. All predictor variables are involved in SEM model to find the significance ones. SEM path model shown in figure 4 . Based on common analysis in SEM on some statistical goodness of fit test including Akaike's Information Criterion (see [17]), significance predictors then chosen. ANN modelling needs these predictors as input for predicting customer loyalty.

4.2. ANN modelling

As significance predictor variables was determined by SEM modelling, ANN started the learning process by first create its architecture (see figure 5). As shown in Table 1, there are 8 predictor should be involved in ANN, including two dimension. This information is needed by ANN to set the input layer with 8 nodes, and set the single hidden layer with two nodes. The learning process then started with back-propagation algorithm [13], and the weights result shown in Table 3. The Akaike's Information Criterion (AIC) also used to compare model performance between ANN and SEM.

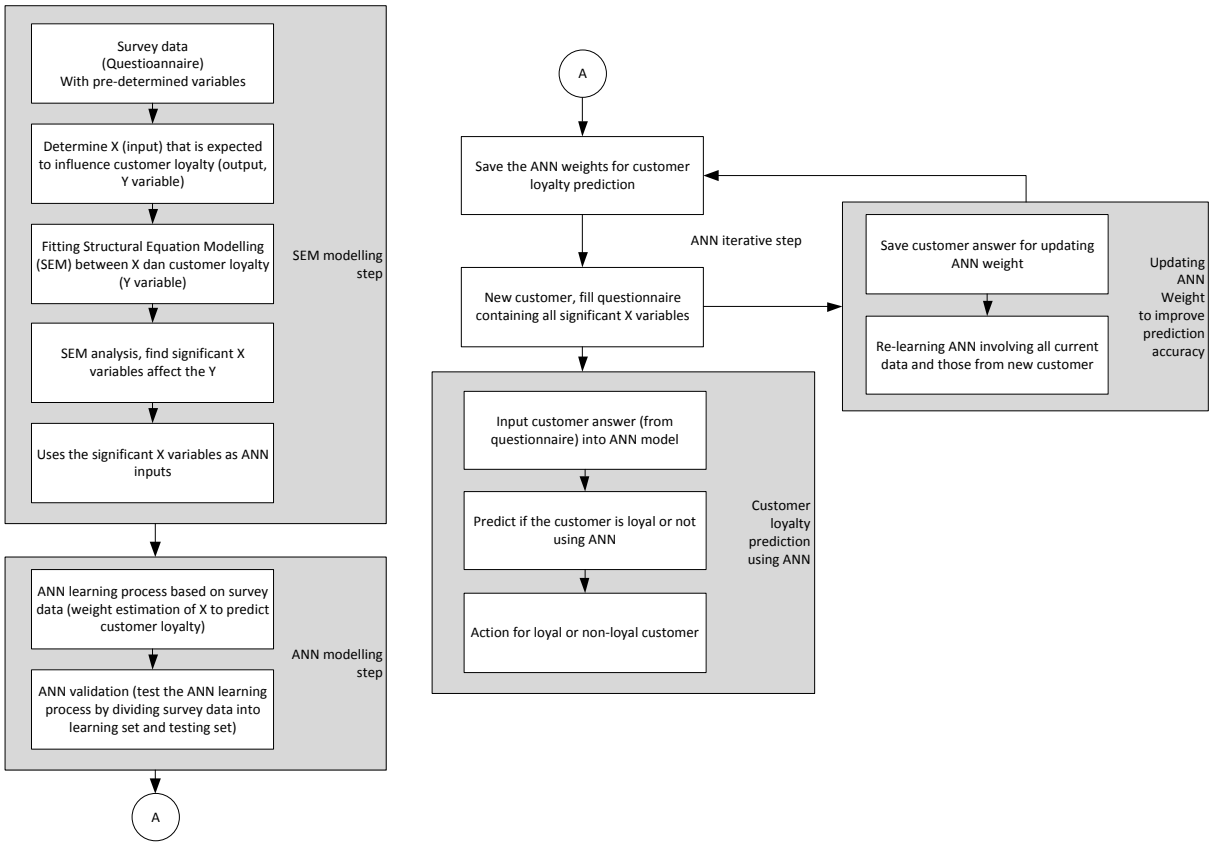


Figure 3. Proposed SEM-ANN framework

Table 1. Predictor and response variable in SEM

ID	Variable	Code	Predictor Significance	Variable dimension	Dimension Significance	Goodness of fit
1	Various service	M1	No			
2	Latest technology equipment	M2	Yes			
3	Price according to quality	M3	Yes			
4	Competitive price	M4	No			
5	Friendly staffs	M5	No			
6	Experienced staffs	M6	Yes			
7	Responsive staffs	M7	No	Marketing mix dimension (predictors)	Significant	Akaike's Information Criterion (AIC) for SEM model -19.378
8	Effective promotion	M8	No			
9	Easy access information	M9	No			
10	Modern interior design	M10	Yes			
11	Clean and comfort environment	M11	No			
12	Strategic location	M12	No			
13	Easy to find location	M13	No			
14	Simple order procedure	M14	No			
15	Monitored order progress	M15	Yes			
16	Satisfaction for service provided	S1	Yes			
17	Fulfilling customer expectation	S2	Yes	Satisfaction dimension (predictors)	Significant	
18	Customer comfort and trust	S3	Yes			
19	Empathy and care	S4	No			
20	Excellence service	S5	No			
21	Response (target) variable	T1	Customer loyalty			

4.3. Customer loyalty prediction

New three customer with new answer then asked with only statistically significant variables, because SEM model has selected them for ANN inputs, and remove insignificant ones. Answers shown in

Table 2. These new data then becomes input in learned ANN to predict their loyalty, the result in Table 3.

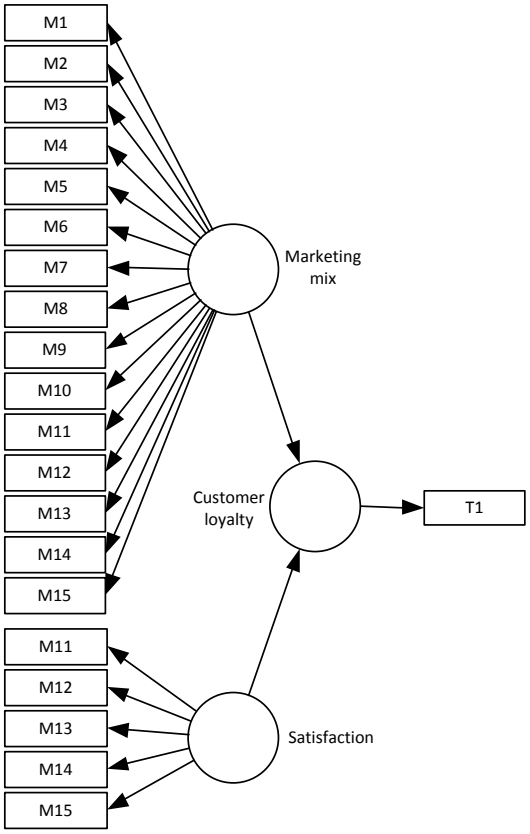


Figure 4. SEM path model

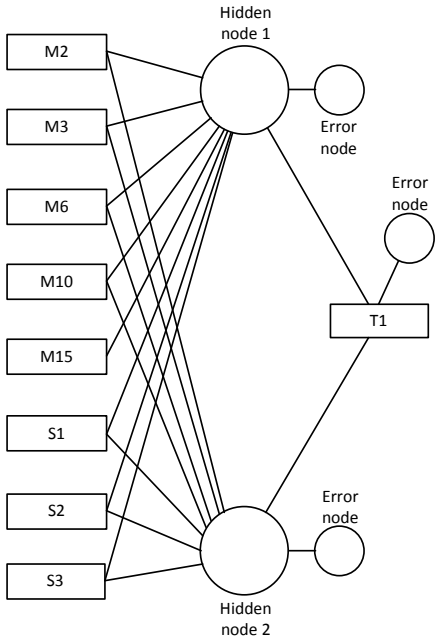


Figure 5. ANN path model

Table 2. New customer loyalty prediction by ANN *(8 input nodes, 2 hidden nodes)*

New Customer 1 questions	Answer (Likert scale)	New Customer 2 questions	Answer (Likert scale)	New Customer 3 questions	Answer (Likert scale)
M2	3	M2	3	M2	5
M3	3	M3	3	M3	4
M6	4	M6	4	M6	4
M10	4	M10	4	M10	4
M15	5	M15	4	M15	5
S1	4	S1	5	S1	5
S2	4	S2	5	S2	5
S3	4	S3	5	S3	5
Predicted loyalty	3.08 (loyal)	Predicted loyalty	3.83 (loyal)	Predicted loyalty	4.42 (loyal)

Table 3. Updated ANN weights

ANN path	Previous weights	Weights after updating	ANN path	Previous weight	Weights after updating	Goodness of fit
M2 → hidden unit 1	1.419	0.045	M2 → hidden unit 2	0.834	0.745	
M3 → hidden unit 1	0.267	0.551	M3 → hidden unit 2	-1.258	0.465	
M6 → hidden unit 1	2.217	-0.23	M6 → hidden unit 2	-0.338	-0.33	AIC for ANN model -48.9398
M10 → hidden unit 1	1.409	0.223	M10 → hidden unit 2	-0.571	0.674	
M15 → hidden unit 1	3.153	0.211	M15 → hidden unit 2	2.079	0.326	
S1 → hidden unit 1	1.843	-0.341	S1 → hidden unit 2	0.325	0.152	
S2 → hidden unit 1	0.799	-0.315	S2 → hidden unit 2	-0.028	0.571	
S3 → hidden unit 1	1.228	-0.027	S3 → hidden unit 2	-1.863	0.298	

Hidden unit 1 → T1	0.787	0.218	Hidden unit 2 → T1	-0.472	0.912	

4.4. Updating ANN weights

These data from new customer then becomes new raw input for ANN in updating the weights. Using similar learning process, ANN then update the weights and produce new ones, shown in Table 3. Every new raw data involved in ANN would then updated the weights. This iterative procedure is repeated as new customer continuously comes to the provider, and ANN prediction becomes better with more data inputted in. The AIC criterion also shows better (smaller) than SEM model.

5. Concluding remark

Framework proposed in Figure 3 has successfully implemented, including iterative procedures to improve prediction accuracy. With additional programming techniques, this frameworks becomes a simple data mining system for predicting customer loyalty, as there are steps for saving customer answer and updating the ANN weights continuously and should be automatically.

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How the Indonesian ecologically conscious millennials value upcycled clothing?

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Abstract. Upcycling is a form of green action in the area of product management and it is a new emerging trend nowadays. According to the findings of previous researches, Ecologically Conscious Consumer (ECC) tends to purchase more sustainable products, including environmentally-friendly fashion products. However, though upcycled products are classed as environmentally-friendly products, there has not been any research yet confirming that ECC in developing country like Indonesia value and have interest in purchasing it. The aim of this research was to identify green consumer behaviour in Indonesia towards upcycled clothing. An online survey was conducted through online questionnaires to find the relationship between green consumer in Indonesia and environmentally-friendly fashion, also how the ECC value upcycled clothing as a form of eco-friendly fashion. The research showed that Indonesian millennials are mostly environmentally conscious and adopt green buying behaviour. It was found that many of green consumers in Indonesia are unfamiliar with the word 'upcycling', but some of them have already purchased it as form of sustainable deeds. Mostly the participants valued upcycled products more than recycle products for the ideas and they are valued as work of art. Profound statistical analysis was used to get the result of this research.
Keywords: upcycle, green consumer, ecologically conscious, sustainable clothing

1. Introduction

Fashion is one of the biggest and most successful business and industries in the world. It is stated by JEC Democratic, Bureau of Labor that almost 1.8 million people work in fashion industry and there are more than 200,000 textile and fashion products manufacturers in the United States (US). This phenomenon does not only happen in US, but also in other countries which shows that fashion industries are making very impeccable growth. Despite its success, it is nothing new for fashion industry to be considered as one of the biggest contributors of this world's pollution. The production process that turn raw materials into fashion products like garments, bags, shoes has negative impacts on environment, including water and air pollution, toxic chemicals and waste, etc. Kawamura stated that fast fashion as business model has made over-consumption among the consumers and leads to large numbers of waste [1]. This happens all around the world, including Indonesia which is ranked as top ten biggest textile producing countries in the world.

During the past decades, consumers' concern about environmental issues like excessive waste issue, global warming, water and air pollution have increased [2]. Consumers also started to show environmental awareness where they realize that their buying behaviour can directly affect environment. This type of consumers is called Ecologically Conscious Consumer or Ecologically Concerned Consumer (ECC), and it is defined as group of people who seek to buy / purchase products that does not have damaging impacts on the environment [3].

While fashion companies have to compete with each other in attracting consumers and make over consumption, consumers themselves have to 'make space' by throwing away or donating their clothes. This process is called post-purchase process in garment/clothing consumption which involves recycling, re-using, discarding and destroying clothing [4]. In this case, generally ECC tend to support recycling process more than destroying and discarding clothing since garments materials that are made from nylon and polyester is categorized as plastics contain toxic and non-biodegradable. Up-cycling is different from other forms of recycling because it is a conception of adding value to used products. Traditional recycling ways like down-cycle and recycle involve process like melting down and reconstructing process, and this process produce much CO2 which is not that friendly for the environment. In the other hands, up-cycling is considered less harmful.

Upcycling is now a trend and it has gained attention and popularity among the green fashion consumers. Some news suggest that it is popular on online marketplaces as well [5]. Upcycling should be studied further to place fashion in a more sustainable and environmentally friendly condition. However, like new other grounds, not many people are aware of this trend. The purpose of this study is to gain insights about the green consumers' behaviour of upcycled products in Indonesia since buying behaviour of fashion ECC is often considered complicated and unpredictable [6].

2. Literature Review

2.1 Upcycling as repurposing of clothing

Products repurposing (such as clothing, tools, etc.) has undeniably gained much attention these days, especially in literatures about manufacturing and production [7]. This phenomenon happened as an impact of increased social responsibility [8]. Innovators have developed extraordinary ways to reuse and repurpose materials waste. However, even though the word 'upcycling' is still unfamiliar for some people, it is not a new phenomenon. It has been done by people in 1930s and 1940s when people prefer to reuse their old stuffs than buying new ones.

Upcycling is a form of repurposing product in which the product itself is broken down into separate materials – which is called 'down cycling', and using those separated materials, make a new product out of it. Both recycling and upcycling are popular in developing countries that do not have many resources. Upcycling is often thought as creative way to reuse products. The main thing that differentiate upcycling from recycling, is that upcycling was meant to 'upgrade' the used products – nicer, better quality, etc. Therefore, upcycling demonstrates more effective and beneficial way in reusing the broken-down materials. For example, upcycling gives the designers to use textile waste to create new fashion, re-invent the style and adjust it with the current style. Many researches have confirmed that many discarded garments still have good quality at the disposal time, and with upcycling, people can optimize products' use and reduce waste materials. Researchers also found that upcycling process allows the consumer / users have some kinds of 'attachment' to the products. This product attachment is an emotional experience that users feel when experiencing the products [9]. Upcycled products are combination of used products with different end uses which probably have many stories behind. For those reasons, upcycled garments are usually more expensive than usual recycled garments. Even though the upcycling market can worth more than a hundred million dollars worldwide, not many countries in Asia support this practice. Korean upcycling market cannot reach the numbers that upcycling markets reached worldwide. This supports in their research that stated that many Asians do not really like wearing second-hand clothes [10]. However, even though it has been stated that upcycling markets in Asia do not expand as big as ones worldwide, the demand for the products are increasing.

2.2 Millennial Ecologically Conscious Consumer (ECC)

In recent years, almost every consumer started to purchase products that don't cause environmental problems. This happens because the environment nowadays is way more important than it was before to them. This type of consumer is called ecologically conscious consumer nowadays. Generally, Ecologically Conscious Consumers are aware of environmental problems that lead to eco-friendly lifestyle, such as green purchase, goods disposal, etc. ECC knows that by purchasing products that are

not harmful for environment, they can contribute to ecological preservation. There are several studies studying the variables influencing ecologically-conscious behaviour of consumers. Anderson and Cunningham characterized that green consumers usually 40 years old and above – with high level of education and higher social status. On the contrary, some researchers do not find any significant relations between age, sex and ecologically conscious behaviour [11]. However, Lu, Bock, and Joseph expressed that consumers in general are not driven to stop using certain products only to boycott the environmentally harmful products [12]. They think that price, design, and qualities are also important factors for them in choosing products. Generation Y, often termed as Millennial Generation, is a recent population, comprised of people in the age of 18 – 34 years old. According to Vermillion and Pearl, this group tends to be environmentally conscious than other age group [13]. Moreover, the educated millennials also tend to worry more about their health and community. However, they also seem to care more about their social status, which indicates that their intentions buying environmentally-friendly product might not always because they really care about the environment.

RQ1 Are millennials consumers ecologically conscious?

RQ2 How does millennials consumers' environmentally conscious behaviour affect their buying behaviour?

RQ3 How do the millennial consumers accept and value recycled and upcycled clothing as a form of supporting environmentally-friendly product?

3. Method

Quantitative study was chosen as the methodology of this research and the author picked survey as the data collection method. Survey method was conducted to get substantive outcome and ease the spread of questionnaires to the participants. Non-probability sample consisting of undergraduate students in several universities in Indonesia was recruited for this study. Purposive sampling technique was chosen because the questionnaires needed to be given to specific group of people and have certain characteristics: millennials, well-educated, and ecologically-conscious.

Firstly, faculty members and staff from each university were briefed and given the online questionnaires via email. Next, they emailed the link to the students' representatives and those representatives explained to their friends about the purpose of the survey. Interested students were suggested to give feedbacks and answers of the questionnaires in two weeks. Although non-probability sampling (purposive sampling) was used, the students that participated in the study have many interests and characteristics. The questionnaire itself was divided into several sections based on the issues being identified. It consisted of several sections with Likert scales as measurement that indicates the participants answer from 'never' to 'strongly agree'. The first 5 questions determined the demographics of the participants. The next few questions were meant to gauge their behaviour towards the environment. Data was analysed statistically by measuring frequencies, descriptive, and also using chi - square tests that allow the author to get the profound statistical result.

4. Discussion

The author received a total of 107 responses from graduated and non-graduated millennials, 54.2% of which were female and the rest (45.8 %) were male respondents. 88.8% were already graduated or still studying in college, and 11.2% do not go to college/ did not graduate. Most of these participants are from art and design background which are about 43% followed by social in 31.8%, STEM (Science, Technology, Engineering and Mathematics) for 16.8%, and the rest are health and others. More importantly, 63.6 % of these participants are not familiar with the word 'upcycling'. One important and fundamental factor analysis was done on the questions measuring their environmental consciousness. Overall, this first analysis seeks to distinguish millennials' behaviour towards environment. Ahn and Park (1998) stated to be ecologically conscious consumers, they need to have eco-friendly lifestyle and have green purchase behaviour. These 4 items questioned stated that mostly these participants can be considered as ECC. Regarding to the first research question, it seemed that age, sex, and major background do not influence their environmental consciousness. Overall, all millennials are likely to be environmentally aware and conscious. Table 4.1. Shows the percentage of Likert Scale answers towards the environmental related items.

Table 4.1. Principal component regarding to environment.

No	Items	Agree	Neutral	Disagree
1	I always look for rubbish bin when I am about to throw away rubbish	95.3	4.7	0
2	I always check the label of product to find out whether it's environmentally friendly	37.4	42.1	20.6
3	I am aware that garment industry has bad impact on environment	74.8	19.6	5.6
4	It is important for me to buy environmentally-friendly product	63.6	27.1	9.3

The following analysis seeks to identify consumers' environmentally conscious behaviour and its effect on their buying behaviour. To answer this, crosstab analysis was done on the environmental concern segment and their 'green' fashion consumption. Chi-square test was done to see whether the independent variables were "fit". Green Fashion Consumption here was marked by green waste disposal habits, like clothes donation, and alson green purchase like buying second-hand clothing, and fixing broken clothes. Those who tend to be environmentally conscious much likely adopt green fashion consumption. There were several items regarding to these two segments, however there were three variables that crossed with asymp. Sig value <= 0.05. Table 4.2 indicates both dependent and independent variables which has valid correlations, and this answered the research question number two, the environmentally conscious millennials tend to have a green buying behaviour. There is a positive relationship between those two variables.

Table 4.2. Cross tabulation of Environmental Consciousness and Green Fashion Consumption Components

No	(Environmental Consciousness)	(Green Fashion Consumption)	As
1	I always look for rubbish bin when I am about to throw away rubbish	I always feel good donating my old clothes	.033
2	I always check the label of product to find out whether it's environmentally friendly	I love to buy secondhand clothing	.050
3	It is important for me to buy environmentally-friendly product	I tend to modify and fix my broken clothes than buy a new one	.004

Research question number 3 was the main question in this research. Frequency analysis was done using SPSS and overall, millennials tend to agree to swap clothes and buy second-hand clothes which indicate that they mainly have green purchase behaviour. However, the numbers are not significantly different for 'swap clothes' variables, the author had a chance to gain further information and this was because of pride. They do not mind swapping clothes with strangers, or even buying them, it is just their self-image they are worried about. Table 4.3 shows the frequency percentage of millennials recycled and upcycled clothing buying behaviour.

Table 4.3. Millennials Recycled and Upcycled Buying Behaviour

	Items	Agree	Neutral	Disagree
1	I like to swap clothes with my close friends and families	43.9%	25.2%	30.8%
2	I like buying secondhand clothes	61.7%	16.8%	21.5%
3	I buy secondhand clothes because it is cheap	50.5%	23.4%	26.2%
4	I buy secondhand clothes because it has unique style	55.1%	22.4%	22.4%

	Items	Agree	Neutral	Disagree
5	I prefer modified clothing than the unmodified ones	16.8%	43.9%	39.3%
6	I like buying upcycled clothing	55.1%	33.6%	11.2%

From the table above, it can be informed that millennials indeed love buying recycled and upcycled products. However, it is hard to know the buying intentions, whether it is as an act of environmental consciousness or they were only appreciating a work of 'art'. This might support , Lu, Bock, and Joseph (2013) who indicates that even the most environmentally-conscious consumer do not always buy product over 'environmental concern'. The author took further analysis in the 21.5% who disagree in buying second hand clothes. With the Asymp. Sig of .000, it is confirmed that they dislike buying them over cleanliness reason.

Unlike the previous segments, here demographics play a consequential part. The cross-tab analysis between two variables (Sex and Modified-Unmodified Clothes), also Major background and Upcycled Clothes were undertaken which lead to an interesting result. Male participants tend to like unmodified one (recycled clothes), while female participants has bigger number in 'Agree' and 'Neutral' than male.

Table 4.4. Sex and Modified Clothes Variable Counts

			Modified over the unmodified ones			Total
			D	N	A	
Sex	Male	Count	23	23	3	49
		Expected Count	19.2	21.5	8.2	49.0
	Female	Count	19	24	15	58
		Expected Count	22.8	25.5	9.8	58.0

Interesting results also came in the case study of 'Tesco bag'. On the questionnaires, the author gave an example of upcycled clothing that was made of an old shopping bag from a certain supermarket in England. Crosstab analysis was undertaken between major and their interest in certain upcycled products variables, and with the asymp.sig .002, the people who interest most in the upcycled products were from Art and Design background. In contrary, the people who likely to disagree were from STEM background.

Table 4.5. Major and Upcycled Products Cross Tab

			Case 01 Tesco Bag Upcycled			Total
			D	N	A	
Major	Art and Design	Count	6	8	32	46
		Expected Count	11.6	10.7	23.6	46.0
	STEM	Count	11	4	3	18
		Expected Count	4.5	4.2	9.3	18.0
	Social	Count	7	11	16	34
		Expected Count	8.6	7.9	17.5	34.0
	Health	Count	1	0	0	1
		Expected Count	.3	.2	.5	1.0
	Others	Count	2	2	4	8
		Expected Count	2.0	1.9	4.1	8.0

5. Conclusions

In general, Indonesian millennials are considered to be ecologically conscious, and there are no correlations between gender, age and their behaviour. This behaviour is the one that leads to their green buying behaviour, which has been proven, is very much related. However, during their purchasing time, it is not clear yet whether the intention of their purchase is underpinned by their environmental consciousness. In some ways, millennials also take design, price, and style into consideration. Subsequently, their green behaviour also leads to their acceptance and how they value recycled and upcycled products. Even though they are not familiar with the word 'upcyling', unconsciously Indonesia millennials have taken part in such area Though both male and female participants fully agreed that upcycled products has to be more expensive than regular products because of the 'sense of art', not everyone choose to buy it more than the recycled ones. Female participants can accept upcycled products more than the male ones, but this does not mean that male participants reject it. From the questionnaires, the author can conclude that male participants prefer recycled ones because they do not want too many modifications (style-related). This study also proved that participants from art and design background tend to have more interest in upcycled clothing with its 'uncommon and peculiar style' than others from other background.

This research will be able to help brands and retails to target the environmentally-conscious fashion consumer and develop their awareness in green fashion consumption. Also, for educators and students, the findings of this research can be used for further observations in upcycling area.

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Animated video as health promotion tool for community supplementary feeding

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Abstract. The efforts carried out by the POSYANDU under Sawahan health center to increase maternal awareness and knowledge of the importance of supplementary feeding (PMT) and also to monitor children's growth were completed in the form of counselling and distribution of supplementary food. Counselling given once a month in the form of discourse often makes participants lose interest quickly and forget the materials given. Whereas distribution of the free PMT does not encourage participant to independently provide additional food for their children. This research developed an animated video using the prototyping method. The animated video was constructed under the guidance of public health experts and nutritionists. The video supported with animated images and interesting colour combinations is expected to attract the attention of the participants to pay attention to the material provided. Evaluation was conducted by giving pre test – post test and distributing questionnaires. The results of the pre test – post test showed that the nutritional knowledge from 35% participants was increasing. The questionnaire results showed about 93% of health cadres stated that the video could help them in nutrition education. In addition, after the video demonstration was over, health cadres stated that the video can motivate POSYANDU participants to control the child's growth independently and increase creativity in processing food for their children.

1. Introduction

Human needs food that contains balanced nutrition to keep the body healthy. Balanced nutrition is the nutrition consumption derived from carbohydrates, proteins and minerals in proportional amounts according to the needs of one's body [1]. Supplementary feeding containing balanced nutrition must be carried out from the time of pregnancy to the elderly, especially during pregnancy until the first 1000 days of birth [2][3]. If there is an imbalance in the intake of nutrients into the body, a child may experience growth disorder, such as a decrease in intelligence, difficulties to concentrate, shorter stature compared to their age (stunting), obesity, and susceptibility to disease [4].

Nutritional status is the condition of the body which is the end result of the balance between nutrients that enter the body and its utilization [5]. Assessment of nutritional status of children under five years old is based on 3 types of indicators. Then, the results are compared with standard values of WHO (Z Score). Three types of indicators used are the child's weight for age, the child's height for age, and the child's weight for height [6]. Nutritional status of children under five years old based on the three types of indicators can be seen in Table 1 [6].

Table 1. Categories of Nutritional Status of Children Under Five Years Old

Indicator	Nutritional Status	Z-Score
Weight / Age	Severely malnourished	< -3.0 SD
	Moderate malnourished	-3.0 SD until <-2.0 SD
	Normal	-2.0 SD until 2.0 SD
	Over nutrition	>2.0 SD
Height / Age	Severe Stunting	< -3.0 SD
	Moderate Stunting	-3.0 SD until <-2.0 SD
	Normal	≥ -2.0 SD
Weight / Height	Severe wasting	< -3.0 SD
	Moderate wasting	-3.0 SD until <-2.0 SD
	Normal	-2.0 SD until 2.0 SD
	Overweight	>2.0 SD

Children under five years old's nutrition problems in Indonesia in 2016 and 2017 can be seen in Figure 1 [6]. Figure 1 shows that the percentage of malnourished children under five years old in 2016 and 2017 was17.8%. The percentage of stunting children under five years old increased from 27.5% to 29.6%, and the percentage of underweight children under five years old decreased from 11.1% to 9.5%whilethe percentage of obese children under five years old increased from 4.3% to 4.6%. This data shows that there were still quite a number of children under five years old who were experiencing nutritional problems, especially malnutrition and stunting. The government's efforts to overcome the nutritional problems of children in Indonesia are regularly monitoring the nutritional status of children under five years old, providing counseling on nutrition, and providing supplementary feeding through the local POSYANDU. POSYANDU (Integrated Service Post) is one form of community-based health efforts carried out by, from and with the community, to empower and provide facilities to the community to obtain health services for mothers, infants and children under five years old [7]. The existence of POSYANDU is expected to reach the community in the remote area.

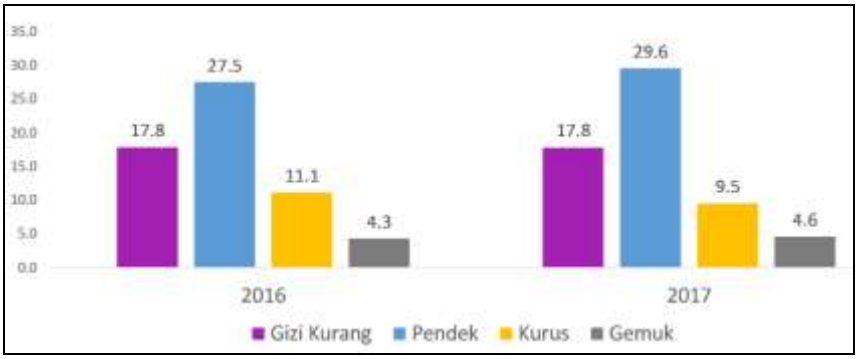


Figure 1. Children under five years old's nutrition problems in Indonesia in 2016 and 2017

Sawahan subdistrict is a region in the city of Surabaya, East Java, Indonesia with the second most population in the city of Surabaya [8]. In 2016, the population of Sawahan subdistrict reached 230,001 people consisting of 64,708 families [9]. The population density of Sawahan subdistrict reached25,454 people / km^2 spread over on 6.93 km^2area[10]. Sawahan Health Center is one of 3 health services in Sawahan subdistrict. Sawahan Health Center manages 76 POSYANDU. Data from the POSYANDU, Sawahan Health Center in 2018 shows that there are still a large number of malnourished children in this area as seen in Table 2. The high number of malnourished children years old in the Sawahan Health Center area is due to the fact that most mothers in that area have limited knowledge of nutrition, so that supplementary feeding that should be given to maintain balanced nutritional in the long term during the child growth period is potentially not implemented by the mother. For this reason, continuous education should be carried out to increase the maternal awareness and knowledge

of the importance of PMT to fulfill children's balanced nutritional intake and independently monitor child's growth as an early detection of child's growth disorders.

The efforts that have been carried out by the POSYANDU in the Sawahan Health Center area were periodically conducting nutrition counselling, monitoring the nutritional status of children through weighing the body and measuring height, sharing experiences between mothers of children under five years old, and distributing supplementary food. POSYANDU usually hold meetings twice a month. The first meeting is to weigh children weight and measure the children height and the second meeting is to provide counselling and free distribution of supplementary food. The meetings that were held twice a month made communication with mother of children under five years old and control on nutrition status of children under five years old less intensive, so it caused several events to be missed.

Table 2. The Number of Malnourished Children Under Five Years Old in Sawahan Health Center Area in 2018

Month	Number of Malnourished Children Under Five Years Old		Month	Number of Malnourished Children Under Five Years Old	
	Male	Female		Male	Female
January 2018	14	17	May 2018	17	16
February 2018	14	17	June 2018	17	16
March 2018	14	15	July 2018	17	15
April 2018	14	15	August 2018	15	14

Based on the results of questionnaires distributed in two POSYANDUs, 83% of mothers never monitored their children's growth, except when weighing children weight and measuring height at the POSYANDU, which was conducted once a month. Actually, the results of this measurement were recorded on each child health card (KMS) which had been distributed to them others. KMS recorded children's growth based on age, weight, and gender in graphical form. This reality shows the lack of mother's awareness to monitor their children's growth.

Based on the direct observations in three POSYANDUs and discussion with cadres, it was found that during this time, counselling was conducted in the form of discourse. Participants usually took their children with them when attending counselling session. Counselling in the form of discourse often made participants lose interest quickly, so children tend to do other activities to attract the attention of their mother. This condition caused in the mother's attention shifting to their children so that counselling material was not delivered well and even forgotten. The results of the observation also showed that there were only a small number of mothers who attended counselling from beginning to the end. Most of the mothers came for a while and went home carrying free supplementary food. This condition showed that mothers came only to get free supplementary food so that it could be said the free distribution of supplementary food did not educate and motivate mothers to independently strive for nutritionally balanced supplementary food for their children.

Based on the results of discussions with several mothers, it was found that the mothers had provided supplementary food for their children so far. The food provided was usually the same as the food eaten daily by the rest of the family. The mothers' problem was their children did not like to eat nourishing food which had been prepared. This was caused by variations in ingredients (types of vegetables and fruit) to make food and food served were limited so that it was not interesting for their children. On the other hand, mothers were lack of creativity in creating new types of food. This condition showed the lack of awareness of the importance of consuming balanced nutritious food and creativity to create new types of food from various kinds of local vegetables and fruits.

This research developed an animated video as a health promotion tool. This video is expected to attract participants 'attention so it could increase participants' knowledge of nutrition, motivate the mothers to prepare balanced nutritious food for their children independently, and increase participants' awareness to monitor their children's growth periodically.

2. Methodology

The research was developed using prototyping method. The first step was to find out the existing problems. It was done by carrying out observations of counselling activities in threePOSYANDUs in the area of Sawahan Health Center, reading the relevant documents, and distributing questionnaires to participants to two POSYANDUs. POSYANDU as the objects of research which were selected using simple random sampling method. Based on the data obtained, the content of the video was organized for developing a prototype. The content of the video was organized under the guidance of public health experts and nutritionists. An animated video was created according to the prototype. To ensure that the video was in accordance with user needs, validation was done. The first validation was carried out by conducting a pre-test and post-test about understanding nutrition at a POSYANDU. The POSYANDU where pre-test and post-test was conducted was determined by simple random sampling method. The second validation was done by demonstrating videos in front of health cadres, and health cadres were asked to fill out the questionnaires afterwards.

3. Results and Discussion

Animated video that was made is expected to enrich the method of delivering knowledge about the importance of providing nutritionally balanced supplementary food for the prevention and curative malnourished children under five years old. This video could be used by health cadres as a counselling tool on nutrition. Videos were designed in 6.02 minutes and supported animated image and interesting colour combinations in the hope that they could attract the attention of mothers and their children so that the mother's concentration on the counselling is not distracted.

The animated video was supplemented with information about the children's needs (see Figure 2), symptoms of malnourished children (Figure 3), Malnutrition factors (Figure 4), and types of supplementary foods for children by age (Figure 5). In addition, the animated video was supplemented with how to read children health card (Figure 6) in the hope that mothers can monitor independently their owned children's growth and was also supplemented with several food recipes (Figure 7) and demonstration of food making for children in hopes of increasing awareness of the importance of consuming various vegetables and fruits as well as increasing the creative ability to process food for their children. This animation video could be played repeatedly independently by mothers so that the material that was missed or forgotten could be recalled.

One of the goals of creating animated video was to increase the maternal knowledge on nutrition. To evaluate the increasing of maternal knowledge, pre-tests and post-tests of understanding of supplementary feeding were conducted at a POSYANDU. Pre test was given before nutrition counselling using animated video and post test was given after nutrition counselling using animated video. In the pre test of the 10 questions, 55% of the mothers could answer 4-6 questions correctly and 45% could answer 7-8 questions correctly. While in the post test of 10 questions, 20% of mothers could answer 4-6 questions correctly and 80% could answer 7-8 questions correctly. These results indicated an increase in knowledge of mothers about nutrition even though no participant could answer 100% of the questions correctly.

To find out the level of usefulness of animated videos for cadres in providing nutritional counselling, video demonstration was conducted in front of 60 health cadres and after that health cadres were asked to fill out questionnaires. Based on the 29 questionnaires that were returned, results were obtained as shown in Table 3. Table 3 shows that about 93% of health cadres agreed that the video helped in conducting nutrition counselling. After the video demonstration was over, health cadres stated that the video can motivate POSYANDU participants to control the child's growth independently and increase creativity in processing food for their children.

Table 3. Results of the Video Animation Questionnaire

Questions	Disagree	Less Agree	Agree
The video helps health cadres to motivate mothers to provide nutritious food for their children	3.45%	3.45%	93.1%
The video helps health cadres educate mothers about how to read children health card	0	6.9%	93.1%

The content of the video is easy to understand	0	6.9%	93.1%
The video has an attractive appearance	0	6.9%	93.1%
The video has a clear and understandable voice	0	3.45%	96.55%



Figure 2. Children's needs



Figure 3. Symptoms of Malnourished Children



Figure 4. Malnourished Factors



Figure 5. Types of Supplementary Foods for Children by Age

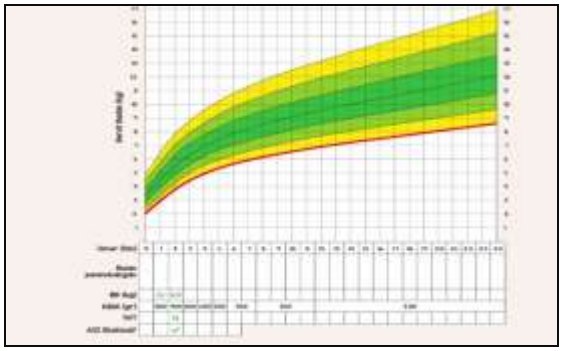


Figure 6. How to Read Children Health Card



Figure 7. Food Recipes

4. Conclusions

In 2018, there were still around 30 malnourished children under five years old in Sawahan Health Center. It shows that there was lack of maternal awareness and knowledge of the importance of consuming balanced nutritious food and lack of control their children's growth. The efforts that had been carried out had several problems. For this reason, in this research, an animated video was developed to overcome the existing problems. To ensure the usefulness of the video for the mothers, pre test – post test about mother's understanding on nutrition were conducted. The results of pre test – post test showed that the animated video could improve nutrition knowledge of the mothers about 35%. In addition, questionnaires were distributed to health cadres after they watched the video to ensure that the video is useful as health promotion tool. The results of the questionnaire showed that about 93% of health cadres agreed that the video helped in conducting nutrition counselling, motivate

POSYANDU participants to control the child's growth independently and increase creativity in processing food for their children. Participants' enthusiasm when they watched the video demonstration indicated the video could attract attention of the participants. This condition is expected to improve the nutritional quality of children in the area Sawahan Health Center in the future.

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Slow - fashion: case study of tenun sesek as local wisdom from Pringgasela, East Lombok, West Nusa Tenggara

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Abstract: This study was based on fast - fashion that currently affecting environment, as the largest emitter of sewage is nearly equal the mining industry are oil, gas and mineral. The presence of slow - fashion movement among the Indonesian people, is thought to be a solution of issues caused by fashion industry these days. This study was designed to introduce *Tenun Sesek* as Pringgasela's local wisdoms, East Lombok, West Nusa Tenggara, as one of the other examples of the slow - fashion practices that have been done since the ancient era. The method in this study is descriptive qualitative with data collection, using interviews, observation and documentation. The study showed that manufacturing process of *Tenun Sesek* has change in its a process, there is no spinning yarn from cotton fiber, the weaver prefers to use woven yarn manufacturers to accelerate the process of making *Tenun Sesek*. The high selling price of *Tenun Sesek* is only suitable for high - end fashion products and commensurate with the benefits obtained based on the design, production and consumption side, but to introduce *Tenun Sesek* Pringgasela to the public, it can be through lifestyle products design such as clutch bags, shoes, wallets that require less *Tenun* material.

1. Introduction

Rapid fashion developments allow people to be more concentrated on following the trend that change every season. From 2000 to now the world's clothing production increase twice as big and consumer behavior has changed from 15 years ago [1]. Consumers are more consumptive in change their wardrobe to be more up - to - date and there is no many last in their wardrobe. This is because fast - fashion is developing in accordance with latest trends. Fast-fashion dominates the fashion industry makes clothing prices more affordable for consumers, this is because of production costs, fabrics and supporting materials are expensive. The need for cheap fabrics and materials make the needs of polyester fibers in the world reaches 31.25 million tons, increase over the past 15 years [2]. Polyester fiber is artificial fiber which made from thermoplastic, producing stronger fabric fiber that are cheaper and easier to care for than natural fibers such as cotton or linen, but thermoplastic fibers can't be recycled like plastic property. Because of the inclusion of fashion industry in the fast - fashion product of is waste derived from the weaving process, dyeing cloth using chemical dyes, waste from the making of clothing like rag to used clothing. The waste effect of fashion business contributes to the biggest waste after waste a pollution from mining industry are oil, gas and mineral. Contrary to the fast - fashion, slow - fashion is now in motion. Slow - fashion is haven't been widely known in Indonesia, when actually the Indonesian have practiced this slow - fashion in the making of traditional fabric or *wastra* in accordance with the traditions of ancestor who were put down by descent, are done

in day's life. The tropical nature's riches in Indonesia, water sources and biodiversity has made Indonesia rich in natural fibers and natural pigment for dyes of textiles is. When traditional textile production concern with environmental, human, social and cultural aspects in their quality, that would describe it as slow - fashion practice. *Batik, Tenun,* hand embroidery and other traditional Indonesian techniques have the potential to be explored as a slow - fashion source that can be a solution to various issues due to the impact of fast - fashion such as environmental damage due to waste, socio-economic changes to consumer behavior [3]. *Tenun Sesek* as one of Indonesia's local content as one of the slow - fashion that has been developed by the people of Pringgasela, East Lombok, West Nusa Tenggara. *Tenun Sesek* is passed down from the ancestors to be an Eco - friendly process, from cotton fibers or other natural fibers made with natural dyes, it was used rituals or fulfilling of the need for clothing, but *Tenun Sesek* itself has changed from the manufacturing to the socio-economic impact of weavers. *Tenun Sesek* is hand-made and sizable selling price because of complicated and long way process. The age of progress, fashion trends and the need for society to keep up with the tradition of wearing weaving at more affordable price, weavers do not need to spin cotton fibers and dye yarn. Weavers simply buy industrial yarn and are chemically and solid on order. The changes in this process have result in lower price but the natural state is polluted by the wastes of chemical dyes. This *Tenun Sesek* is one example of Indonesian *wastra* which has undergone many process changes, among the many changes in the process are the use of yarn with synthetic dyes because of producing a lower selling price and affordable.

Based on study about Traditional fabric or *Wastra* which has been reviewed before, a study of *Tenun Sesek* Pringgasela is still no researcher's writing. It was study intended to introduce how the slow - fashion practice based on the process of making *Tenun Sesek* continuation of the utilization of the weaves of these still performed by weavers in Pringgasela, East Lombok, West Nusa Tenggara.

2. Literature Review

2.1. Slow Fashion Concept

The term slow - fashion became popular with a writing of Kate Fletcher in 2008 in her book entitled Sustainable Fashion and Textile. Fashion industries begin to think about environmental stability over the impact of waste that has damaged the earth. Slow fashion has been a topic of discussion in the textile and fashion industry for the past few years. The concept of slow - fashion is based on sustainability processes in fashion industry that combine design processes with high quality, small lines, regional productions and fair conditions of labors. In the slow - fashion concept, it must also be understood that slow fashion combines the concept of using greener fibers that are eco - friendly, biodegradable, utilizing technology that can reduce waste and pollution or consider the movement of the production through supply chain. The majority of the researchers agree that the slow - fashion concept does not mean an overview of the slow down the textile manufacturing process and apparel supply chain. But it is more a holistic emphasis to create a sustainable process that includes design planning, production sourcing and consumer education. There are elements that exist in the slow fashion concept [4], these elements include: 1) placing value on local resources and economies; 2) transparency in the production system; and 3) Creating products with longer usable life. The concept of slow fashion has given challenges to apparel companies to make effort to sustainable, environmental and ethical practices into their product designs, selection of production techniques that emphasize the quality, craftmanship, experienced labor and provide education to consumers so that they can play an active role in making informed decisions regarding their apparel selection.

Based on the model framework bellow, it can be concluded that the product with the slow-fashion concept is no longer referring to fashion trends, but rather emphasizes the concepts of sustainability, eco - friendly and ethical practices. Having a longevity usage, more as an investment because it has good quality and can be worn in the long term but is able to meet the needs in terms of the opportunity to wear clothing. Produced using production techniques that emphasize product quality by considering the expertise of their workers or craftsmen (not emphasizing mass production using industrial

machinery) this is also included with consideration of the socio-economic side of the products made by well - paid labor.

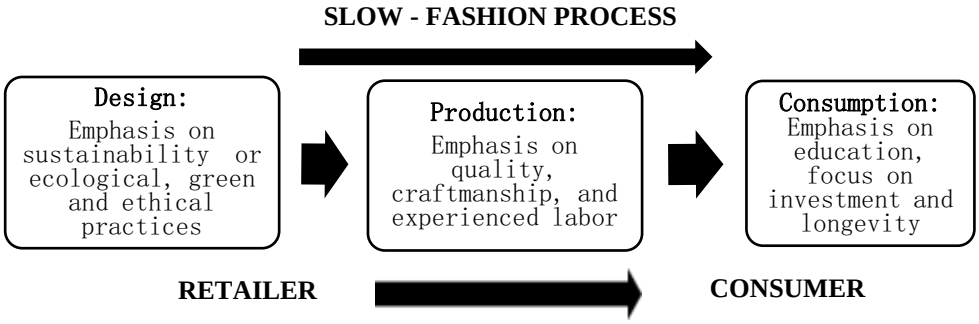


Figure 1. Framework model for the slow - fashion process [4]

2.2. Overview Studies

Research carried out related to slow - fashion and *Tenun* in Lombok Island area include:

Table 1. Other studies related to slow - fashion and *Tenun* in Lombok Island before

Studies	Result
Mardiyanti & Ismadi (2016)	The exploratory of symbolic meaning of cloth and the value of the function of *Tenun* of the Dusun Sade.
Darma & Priyadi (2015)	The exploratory of the diversity of plants used as a dye for the Sasak tribal fabric in Sukarara, Central Lombok, West Nusa Tenggara.
Pookulangara & Shephard (2013)	The exploratory study analyzed consumers' perception of purchasing slow-fashion garments using focus groups. Four themes emerged (1) Slow-fashion defined; (2) Slow - Fashion Product Attributes; (3) Slow - fashion as a Lifestyle; (4) Slow - fashion into Retail Mainstream, implications for retailers have been suggested.
Johansson (2010)	Research and study on what the concept slow - fashion implies, how and if it could make the fashion industry Sustainable and see if there is a structure or model for how such a business would look like. The objective is also to study today's consumer behavior and how we could and should consume according to a slow fashion approach

Through this research, it is expected to educate the public about slow - fashion practices in the process of making *Tenun Sesek* Pringgasela and inspire other researchers to study other Indonesian Literature, so they can be known and inspired by fashion designers, textile artists both local and foreign in working on sustainability design.

3. Methodology

The methodology of this study uses a descriptive qualitative approach. The method of collecting data in this study use interview, observation and documentation techniques. This interview and observation technique were chosen to gather information about the process of making *Tenun Sesek* and the lives of

weavers in Pringgasela. The selected resource person was a companion of LPSDM (Lembaga Pengembangan Swadaya Mitra) who had settled in Dusun Daya Gubuk for 5 years and 2 senior weavers who were still active and consistent in dyeing and weaving yarn using natural dyes to date. The documentation technique is needed to support this research in the form of photos of the process of making yarn weaving dyes and weaving processes in the village of Pringgasela.

4. Discussion

West Nusa Tenggara is one of the regions in Indonesia that has developed the weaving of Warp *Ikat* because it is located in coastline [8]. According to 2018 data at the Pringgasela village office about the number of weavers in the Dusun Gubuk Daya, there are approximately 420 weavers. Interview results from 3 sources found that from the data of 420 weavers, only 168 people (40%) were still actively weaving in their homes, only a few wants to weave using yarn dyed with natural dyes. The rest weave using synthetic dyes, this is because not all weavers are yarn dyers, the tradition of dyeing yarn with natural dyes is descent by their family who are hereditary as weavers and not all weavers receive this inheritance. besides that, the process of dyeing yarn with natural dyes takes a very long time due to a complicated process. The loom used by weavers in Pringgasela Village is a type of *Gedokan*, a manual loom that is only done by women. There are 3 types of yarns used in *Tenun Sesek*, namely: *kapas* yarn, cotton yarn and Mercer yarn. The three types of yarn are based on the same type of cotton, but with different finishing process. The selling price of natural dye will be very expensive, to weave one sheet of *Tenun Sesek* measuring 300 x 60 centimeters involves approximately 4 to 7 people. The selling price of *Tenun Sesek* that uses natural dyes is approximately Rp.750,000 to Rp.1,500,000, depending on the work of motif and the type of yarn that used. *Tenun Sesek* that use mercerized yarn reach the most expensive price between the use of two other threads.

The process is started with yarn dyes. Yarn dyes are used using ingredients from plants, and produce a variety of colors needed to make motifs according to the wishes of the weavers. As previously observed before that coloring materials that are widely used in the West Nusa Tenggara area include: Mangifera Indica (Mango), Indigofera Tinctori (indigo) Swietenia Mahagoni (Mahoni) [6]. However, there are several other materials that are new findings in this research, they are Mangosteen peel (Garcinia mangostana L), the cover skin of coconut (Cocos nucifera) and bark of jackfruit wood (Artocarpus heterophyllus) and many also using secang bark (Caesalpinia sappan L) but this secang bark is bought from Java. The colors produced from these materials depend on the use of alum fixation (Kal (SO4) 2), lime (Ca (OH) 2) or tunjung (Fe SO4). Coloring materials can be used repeatedly by boiling. If these ingredients can no longer give color, burned for cooking needs, the ashes can be used to clean the moss and wash kitchen utensils. Pasta from tarum leaves produces indigo blue. To produce black, it requires a long coloring process because the thread has to be dipped in an indigo vat and repeated in the soil repeatedly to get the desired color. Tarum leaves and branches after the immersion process can be drained and then burned. Ash from twigs and leaves of tarum is used as natural fertilizer in the fields and becomes a coloring mixture when dyeing yarn. The next steps are preparation weaving, include: 1) *Nenasin* is the process of wiping yarn with sticky rice starch or sticky rice porridge; 2) *Memuyun* is spun yarn process; 3) *Menghane*, is the process of forming a line motif for warp threads; 4) *Nyusuk Suri* is the process of inserting the thread into the *suri* (weaving comb); 5)*Begulung* is the process of rolling the warp thread in accordance with the length of the fabric in a row; 6) *Meleting* is the process of rolling the weft thread. The next process is *sesek* or weaving. Tenun is called sesek because during the process there is a sound of "sek sek". The weaving process is the longest process among other processes. *Tenun Sesek* that use natural and synthetic dyes are certainly different. Weaving that uses synthetic dyes is very bright, solid and colorful. Weaving that uses pale natural dyes with not many color choices, this is one reason many weavers in this village have used weaving yarns colored with chemical dyes to keep up with market demand.



Figure 2. Various color of *Tenun Sesek* with natural dyeing

Based on the manufacturing process of Weaving Sesek Pringgasela if related with the theory of Slow-Fashion Process [4] has advantages and disadvantages that can be considered, including:

Table 3. Advantages and disadvantages of Tenun Sesek as Slow-Fashion Product

Slow – Fashion Process	Advantages	Disadvantages
Design	1. Eco friendly, natural dyeing waste does not pollute river water and soil, the result of combustion of residual staining can be plant fertilizer. 2. Safe for health for both users and weavers because they contain no chemicals at all. 3. Suitable for any fashion trend.	Limited colors, cannot get bright and solid colors.
Production	1. Cheaper, the coloring material is taken from the surrounding environment without exploiting nature. 2. Increases mutual cooperation during the process of making *Tenun sesek.* 3. Improves family living standards, if the ability and experience of *Tenun sesek* making are developed in the family for generations.	1. Requires more labor, a piece of *Tenun Sesek* (60x400 cm) requires 4-7 people for steps of process. 2. Requires a longer time because natural dyeing must be done repeatedly for darker and bold color
Consumption	1. Has a high investment value. Having a limited market for *wastra* collectors, a piece of old, vintage and handmade *Tenun* has a high selling price if it has good conditions. 2. Have educational value about the tradition and philosophy of *Tenun Sesek*	*Tenun Sesek* are made from natural fibers and naturally colored are susceptible to attack by fungi, moths, ants and even mice. So that it requires more effort to keep it in good condition.

From the explanation above it can be said that the price of *Tenun sesek* is quite expensive but commensurate with the benefits obtained based on the design, production and consumption side.

4. Conclusion

The manufacturing process of *Tenun Sesek* has change in its a process, there is no spinning yarn from cotton fiber, this is due to changes in values in the community because the food needs in the village are higher and growing staples such as rice and secondary crops have economic value higher. In addition to changes in value due to food needs, also due to the high demand from the community for

the *Tenun Sesek*, which is more affordable. The coloring process of weaving yarns using natural dyes really considers the preservation of nature around Pringgasela. The concept of slow fashion must begin with educating the public about a long way process of making *Tenun Sesek* of making *wastra* from other regions in Indonesia. With education about materials, processes and results based on this transparent production process, it is expected that the public can understand that buying *wastra* not only buys a piece of cloth or clothing but also has the philosophical values behind the making of *wastra* and enhancing weaver's life and improving socio - economic live standard. Consistent with concept of slow - fashion in the process of making *wastra* also means developing a lifestyle to love and preserve the environment, the discipline of processing waste and centering on the expertise of artisans or makers will not be irreplaceable. *Tenun Sesek* or *wastra* from other regions has a high selling price but commensurate with the advantages obtained based on the design, production and consumption side, so that it is not possible to be used as fast - fashion products and high - end fashion designs with longevity use are required. However, the way to introduce *Tenun Sesek* to the public can be through lifestyle products design such as wallets, clutch bags, shoes that require less material so the selling price of those product can be reached by the public.

Based on the results of the above conclusions, it can be a recommendation for other researchers to develop the interest of the younger generation of Pringgasela to continue and develop the tradition of *Tenun Sesek*, to develop slow-fashion research on *Tenun Sesek* about design product that can be developed, retail processes, consumer interest and sustainable fast-fashion focusing on *Tenun Sesek*.

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Expertise-based decision makers' importance weights for solving group decision making problems under fuzzy preference relations

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Abstract. The quality of a decision is influenced by the level of expertise of the Decision Makers (DMs). In Group Decision Making, alternatives' scores are obtained by integrating the DMs opinions and the importance weights of the DMs greatly affect the resulted value. Expertise level is defined as the ability to differentiate consistently and expressed as the CWS-Index, a ratio between the Discrimination and Inconsistency. The DMs give their evaluations in pairwise comparison of Fuzzy Preference Relations (FPR) and the additivity property of FPR generates the estimators needed to get the CWS-Indexes and the expertise-based ranking of DMs. The weights of the DMs are obtained by using Induced Ordered Weighted Averaging (IOWA) operator and Basic Unit Monotonic Increasing functions and the resulted weights are used to evaluate the available alternatives to get the best one based on Fuzzy Majority and IOWA operators. This paper proposed an expertise-based weight allocation method for DMs and a numerical example is discussed to illustrate this expertise-based model to get the best alternative and it concluded that the higher the DMs' expertise level, the higher his/her weight, and these weights affect the alternatives' score and the rank of the alternatives.

1. Introduction

Experts have the ability to think differently and this ability underlies the high quality of their decision making [1]. In Group Decision Making (GDM), a group of Decision Makers (DMs) with different expertise, interest and background have to evaluate several alternatives to be chosen in a selection process. The value of each alternative is obtained from group assessment that synthesizes all the DMs' individual values by aggregating their values mathematically [2]. Since the DMs have different expertise, knowledge and background, their individual values should be aggregated by using different importance weights. Assigning inappropriate importance weights of DMs can lead to incorrect results in obtaining the final selection [3], therefore researches related to GDM and DMs' Importance weight are increasingly developing [4] .

Researches related to the DMs' importance weight have been carried out previously. In the beginning, the DMs' importance weight were determined subjectively based on people's views on the DMs, for example an influential person determining the DMS weight directly [5] and a group of assessors who were considered experts assessing the DMs to obtain their importance weights [6] The subjectivity and difficulty of the assessors to evaluate DMs correctly has the potential to lead to biased decisions.

The DMs' importance weight can be determined objectively by observing the results of their assessment on a set of alternatives. The DMs' weight can be determined based on group consensus [7], in the sense that DM whose opinion increases consensus is given a larger weight. In addition, DM who assigned larger weight is the DM with a smaller deviation or smaller distance [8] from group composite value. The consistency of DM evaluations towards alternatives was also used to determine the weight of the related DM in several researches [9]. The DMS' weights that are obtained objectively are considered better than the DMs' weights that are determined subjectively, but there are still some decision biases that need to be considered, for example opinion that are approved by most people are not necessarily the right opinion and all of the above studies have not considered the expertise level of the DMs where the more expert a DM is the better the quality of the decision will be. There are several researches related to expertise level, for example expertise-based DM ranking [10-12] and expertise-based DMs' importance weights [13]. In these studies, DMs assessed the alternatives in the form of Fuzzy Preference Relations (FPR) and the DMs' weights obtained are objective and based on their expertise but these weights should be revised since those researches have not considered reciprocal relations of FPR since an expert can certainly compare the value of two alternatives smartly. If he judges the first alternative is better than the second alternative by some degree, then the reciprocal relation ensures that there is no need for him to re-evaluate by comparing the second alternative to the first one. This study proposes the revised version of expertise-based DMs' importance weights considering reciprocal relations and illustrated by examples used in prior expertise-based researches.

2. Literature reviews

2.1. Expertise level of the decision makers

An expert in a particular field is someone who has a strong background in this field. Shanteau et al [14] defines expertise as the ability to differentiate consistently, expressed as CWS-Index as shown in (1).

$$\text{CWS-Index} = \frac{\text{Discrimination}}{\text{Inconsistensy}} = \frac{\text{variance of different alternatives' values}}{\text{variance of the same alternative's values}} = \frac{\frac{\sum_{j=1}^{n} r(M_j - GM)^2}{n-1}}{\frac{\sum_{j=1}^{n}\sum_{i=1}^{r} (M_{ij} - M_j)^2}{n(r-1)}} \quad (1)$$

Where:
- r : The number of replications
- M_j : The average of individual values for case-j
- GM : The grand mean of all individual values
- n : The number of different cases
- M_{ij} : The individual value for replication-i case-j

The evaluated DMs must repeat their assessment to obtain a measure of inconsistency.

2.2. The FPR and additive consistency property

Chiclana et al [15] proposed GDM model where a group of m experts $E = \{e_1, e_2, ...e_m\}$, $m \geq 2$ evaluate a set of n alternatives $X = \{x_1, x_2, ...x_n\}$, $n \geq 2$ in FPR $P \subset XxX$ having a membership function $\mu_p : XxX \rightarrow [0,1]$ and represented by means of the n x n matrix $P = (p_{ij})$. p_{ij} is the preference degree of x_i over x_j. $p_{ij} > ½$ means x_i is preferred to x_j, $p_{ij} = ½$ means indifference between x_i and x_j.

The FPR *P* has a reciprocal relation as shown in (2) and the matrix *P* as shown in (3)

$$p_{ij} + p_{ji} = 1 \quad (2)$$

$$P=\begin{bmatrix} 0.5 & p_{12} & p_{13} & p_{14} \\ 1-p_{12} & 0.5 & p_{23} & p_{24} \\ 1-p_{13} & 1-p_{23} & 0.5 & p_{34} \\ 1-p_{14} & 1-p_{24} & 1-p_{34} & 0.5 \end{bmatrix} \quad (3)$$

Additive Consistency (AC) property of FPR among three alternatives x_i, x_j, x_k $(i,j,k = 1,2,\ldots,n)$ yields 3 formulas (εp_{ik}^{jg}, g=1,2,3) to estimate p_{ik} as in (4), (5) and (6).

$$\varepsilon p_{ik}^{j1} = p_{ij} + p_{jk} - \tfrac{1}{2},\ j \neq i,k \quad (4)$$

$$\varepsilon p_{ik}^{j2} = p_{jk} - p_{ji} + \tfrac{1}{2},\ j \neq i,k \quad (5)$$

$$\varepsilon p_{ik}^{j3} = p_{ij} - p_{kj} + \tfrac{1}{2},\ j \neq i,k \quad (6)$$

For every element of the matrix FPR p_{ij}, there are 3x(n-2) replications (3 formulas and $j \neq i,k$) and has the range of [-0.5, 1.5]. If the reciprocal relation is considered, the 3 formulas are just one formula and the number of replications is reduced to (n-2). To keep the range of estimated value of p_{ik} between [0,1], all of the element p_{ik} should be transformed using $f(x)=\frac{x+a}{1+2a}$ and the range changes from $[-a,\ 1+a]$, $a>0$ to $[0,1]$ [15].

2.3. The induced OWA operator

Yager [16] proposed an n-dimensional OWA Operator $F: I^n \to I$ where $F_w(a_1,a_2,\ldots,a_n) = \sum_{j=1}^{n} w_j b_j$, b_j is the jth largest element of input arguments $(a_1,a_2,\ldots,a_n)$, w_j is the ordered weight, and $w_j \geq 0$, $\sum_{j=1}^{n} w_j = 1$. The Induced OWA Operator is an OWA Operator using the order inducing variable as the ordering of the input arguments. An n dimensional Induced OWA Operator $F: I^n \to I$ where $F_w(\langle u_1,a_1\rangle,\langle u_2,a_2\rangle,\ldots,\langle u_n,a_n\rangle) = \sum_{j=1}^{n} w_j b_j$, u_i is the order inducing variable, a_i is the input argument, w_j is the order weights and $w_j \geq 0$, $\sum_{j=1}^{n} w_j = 1$, b_j is the input argument with the j-th largest the order inducing variable value. The OWA weights can be obtained by using Basic Unit Monotonic Function (BUM) $Q:[0,1]\to[0,1]$, $Q(0)=0; Q(1)=1; Q(x)\geq Q(y)$ *if* $x \geq y$ as follows [17]:

$$w_j = Q(R_j) - Q(R_{j-1}) \quad (7)$$

where $R_j > R_{j-1}, w_j \geq 0$, $\sum_{j=1}^{n} w_j = 1$. The accumulative value of the DMs' weights is associated with the BUM as in Figure 1, hence the DMs weights will never negative ($w_j \geq 0$) with the total weights are one.

2.4. Quantifier guided dominance degree

Quantifier Guided Dominance Degree (QGDD) quantify the dominance of alternative-x_i over all of the others in a fuzzy majority as in (8).

$$QGDD_i = F_q(p_{ij}^{Group}, j = 1,2,\ldots n, j \neq i) \quad (8)$$

The ranking of alternatives are determined based on ranking of their QGDD.

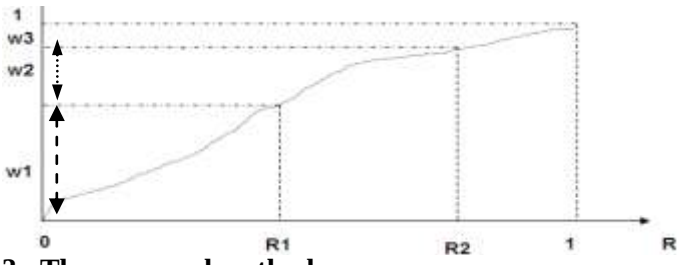


Figure 1. The OWA Weights from BUM

3. The proposed method

The steps used to select alternatives proposed in this study are as follows:

1) Combine shanteau's expertise level and the AC property of FPR. The DMs' assessment must be given in FPR and we don't need repetition to measure consistency in expertise, and we get the CWS-Index for FPR in equation (9) and yield the CWS-Indexes and DMs' rank [12].

$$\text{CWS-Index} = \frac{\text{Variance of different 'pairwise comparisons between two alternatives'}}{\text{Variance of the same 'pairwise comparisons between two alternative's'}} \quad (9)$$

2) Combine the ordered CWS-Indexes and BUM, the accumulated logarithmic ordered CWS-Indexes are used as the horizontal axis of the BUM. Herowati et al [13] used BUM $Q(R)=R^n$, $n \leq 1$ and this research revises the BUM to be a straight line, $Q(R)=R$ to ensure that the DMs with the same expertise level will assigned the same weight and there are only (n-2) replications in this study instead of 3(n-2) in [13] since the previous study didn't consider the reciprocal relation as in equation (2).
3) Aggregate the individual FPR of all DMs by using the weights generated from the previous step to form a FPR group and this value is used in the selection process using the concepts of QGDD.

4. Illustrative example

We provide a numerical example to illustrate the proposed method. Suppose 5 DMs $E = \{e_1, e_2, e_3, e_4, e_5\}$ assess a set of four alternatives $X = \{x_1, x_2, x_3, x_4\}$ in form of Matrix FPR P as follows:

$$P_1 = \begin{bmatrix} 0.50 & 0.40 & 0.40 & 0.40 \\ 0.60 & 0.50 & 0.40 & 0.70 \\ 0.60 & 0.60 & 0.50 & 0.70 \\ 0.60 & 0.30 & 0.30 & 0.50 \end{bmatrix} \quad P_2 = \begin{bmatrix} 0.50 & 0.30 & 0.40 & 0.45 \\ 0.70 & 0.50 & 0.65 & 0.60 \\ 0.60 & 0.35 & 0.50 & 0.45 \\ 0.55 & 0.40 & 0.55 & 0.50 \end{bmatrix} \quad P_3 = \begin{bmatrix} 0.50 & 0.90 & 0.60 & 0.70 \\ 0.10 & 0.50 & 0.30 & 0.40 \\ 0.40 & 0.70 & 0.50 & 0.60 \\ 0.30 & 0.60 & 0.40 & 0.50 \end{bmatrix}$$

$$P_4 = \begin{bmatrix} 0.50 & 0.40 & 0.80 & 0.70 \\ 0.60 & 0.50 & 0.60 & 0.35 \\ 0.20 & 0.40 & 0.50 & 0.10 \\ 0.30 & 0.65 & 0.90 & 0.50 \end{bmatrix} \quad P_5 = \begin{bmatrix} 0.50 & 0.70 & 0.80 & 0.60 \\ 0.30 & 0.50 & 0.65 & 0.55 \\ 0.20 & 0.35 & 0.50 & 0.40 \\ 0.40 & 0.45 & 0.60 & 0.50 \end{bmatrix}$$

1) Estimate each element Matrix P_4 by using one of the formula 1, 2 or 3 to generate 2 estimated value as shown in column 3 and 4 of Table 1. For each element there are 3 values (r=3), i.e. the original value and 2 estimated values. Transform the values outside the range of [0,1] by using transformation function $f(x) = \frac{x+0.1}{1+2x0.1}$ as shown in column 5,6,7 of Table 1.

$$\text{Discrimination} = \frac{\sum_{j=1}^{n} r(M_j - GM)^2}{n-1} = \frac{1.01042}{(12-1)} = 0.09186 ; \text{Inconsistency} = \frac{\sum_{j=1}^{n}\sum_{i=1}^{r} (M_{ij} - M_j)^2}{n(r-1)} = \frac{0.93750}{12x(3-1)} = 0.03906$$

$$\text{CWS-Index for DM} - 4 = \frac{0.09186}{0.03906} = 2.3518$$

CWS-Indexes for DM-1, DM-2, DM-3, DM-4 and DM-5 subsequently are 3.8395, 22.039, 52.1267, 2.3518 and 18.757 and the DMs rank is DM-3, DM-2, DM-5, DM-1 and DM-4.

2) The rank of the DMs obtained in step 1) and the CWS-Indexes are ordered as in Table 2, then the ordered CWS-Indexes were transformed by using the logarithmic function and accumulated and normalized. The normalized(Accumulated(Log(CWS-Index))) is the horizontal axis of the straight line BUM and we get the DMs' importance weights as in the last row of Table 2.
3) Aggregate the individual FPR of all DMs by using the importance weights to form a FPR group and calculate the QGDD by using fuzzy majority function 'Most' which has the weights to compare with the other three alternatives (1/15 , 10/15, 4/15).

$$P_{Grup} = \begin{bmatrix} 0{,}500 & 0{,}609 & 0{,}589 & 0.579 \\ 0{,}391 & 0{,}500 & 0{,}505 & 0{,}517 \\ 0{,}411 & 0{,}495 & 0{,}500 & 0{,}490 \\ 0{,}421 & 0{,}483 & 0{,}510 & 0{,}500 \end{bmatrix}$$

p_{12} calculation to illustrate the aggregation process from individual FPRs to group FPR:

$$p_{12} = 0{,}105x0{,}4 + 0{,}2539x0{,}3 + 0{,}3247x0{,}9 + 0{,}0702x0{,}6 + 0{,}2407x0{,}7 = 0{,}609$$

The first row of the FPR group is the group value of the first alternative, the second row are the value for the second alternative. The QGDD for all the alternatives are calculated by using fuzzy majority 'Most' with the weight (1/15 , 10/15, 4/15) and the element matrix values have to be ordered before the calculation. For example QGDD for alternative-2 are as follows:

$$QGDD_2 = F_q(p_{2j}^{Grup}, j = 1,2,...,n, j \neq 2) = \tfrac{1}{15}x0{,}517 + \tfrac{10}{15}x0{,}505 + \tfrac{4}{15}x0{,}391 = 0{,}4755$$

Table 1. Example of CWS-Index calculation for DM-4

Before Transformation				After Transformation					
Element Matrix	Original Value	Estimated values		Original Value	Estimated values		M_j	$r(M_j - GM)^2$	$\sum_{i=1}^{r}(M_{ij} - M_j)^2$
$_{12}p$	0.40	0.70	0.85	0.4167	0.6667	0.7917	0.6250	0.0469	0.0729
$_{13}p$	0.80	0.50	**1.10**	0.7500	0.5000	1.0000	0.7500	0.1875	0.1250
$_{14}p$	0.70	0.25	0.40	0.6667	0.2917	0.4167	0.4583	0.0052	0.0729
$_{21}p$	0.60	0.15	0.30	0.5833	0.2083	0.3333	0.3750	0.0469	0.0729
$_{23}p$	0.60	0.75	0.90	0.5833	0.7083	0.8333	0.7083	0.1302	0.0313
$_{24}p$	0.35	0.80	0.20	0.3750	0.7500	0.2500	0.4583	0.0052	0.1354
$_{31}p$	0.20	**- 0.10**	0.50	0.2500	0	0.5000	0.2500	0.1875	0.1250
$_{32}p$	0.40	0.10	0.25	0.4167	0.2917	0.1667	0.2917	0.1302	0.0313
$_{34}p$	0.10	0. 25	0.40	0.1667	0.2917	0.4167	0.2917	0.1302	0.0313
$_{41}p$	0.30	0.60	0.75	0.3333	0.5833	0.7083	0.5417	0.0052	0.0729
$_{42}p$	0.65	0.80	0.20	0.6250	0.7500	9,2500	0.5417	0.0052	0.1354
$_{43}p$	0.90	0.75	0.60	0.8333	0.7083	0.5833	0.7083	0.1302	0.0313
TOTAL								1.0104	0.9375

Table 2. The DMs' importance weights calculation

	DM-3	DM-2	DM-5	DM-1	DM-4
CWS- Index	52,1267	22,0390	18,7570	3,8395	2,3518
Log(CWS-Index)	1,7171	1,3432	1,2732	0,5843	0,3714
Accumulated(Log(CWS-Index))	1,7171	3,0603	4,3334	4,9177	5,2891
R=Normalized(Accumulated(Log(CWS-Index)))	0,3246	0,5786	0,8193	0,9298	1,0000
$Q(R) = R^{\alpha} = R$	0,3246	0,5786	0,8193	0,9298	1,0000
DMs' Importance Weights	0,3246	0,2539	0,2407	0,1105	0,0702

Table 3. Comparison of the results of the selection process

	Expertise-based DMs' weights (0,11, 0,25, 0,33, 0,07, 0,24)		DMs' Average Weight (1/5 , 1/5, 1/5, 1/5 , 1/5, 1/5)		Inverse Expertise-based DMs' weights (0,25, 0,11, 0,07, 0,33, 0,24)	
	QGDD	Rank	QGDD	Rank	QGDD	Rank
Alternative -1	0,588	1	0,564	1	0,556	1
Alternative -2	0,475	2	0,504	2	0,516	2
Alternative -3	0,469	3	0,439	4	0,392	4

Alternative -4	0,468	4	0,471	3	0,475	3

Table 3 shown that expertise-based DMs' importance weights yields alternatives ranking 1, 2, 3, 4. If the aggregation process uses DMS' average weights or for all the DMs, then the alternatives ranking are 1, 2, 4 and 3. The use of average as DMs' importance weights does not have any effect if we want to choose one best alternative. But if we want to eliminate one unwanted alternative, the results will be different from results based on expertise. The third case, inverse expertise-based uses of DMs' importance weights in reverse manner where the more expert a DM is, the smaller the weight and yield the same result with the second case. In this illustrative example, the expertise of the DMs are assumed to be unknown and not determined by the people's subjective view of these DMs. Expertise from DMS are determined based on their assessment of alternatives by using the Shanteau's concept, experts are those who can distinguish alternatives consistently and expressed by the CWS Indexes and the integration of DMs opinion using expertise-based weights yield different rank of alternatives and it is expected to produce a better decisions

5. Conclusion

This paper revises expertise-based DMs' importance weights by considering reciprocal relations since o it is more realistic when assessed DMs are carrying out their assessment task.The application of expertise -based DMs weights in this paper shows that DMs weights affects the alternatives' score and the alternatives' rank and it is expected that expertise-based DMs' weights leads to a better decisions.

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Measurement of student satisfaction and loyalty using service quality model for higher education (HedQual) at industrial engineering department University of Pelita Harapan

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Abstract. The Department of Industrial Engineering (IE) at Pelita Harapan University (UPH) strives to continually improve the quality of its services. Previous studies conducted in 2010 and 2015 using service quality model from Parasuraman.IE UPH wants to increase their student satisfaction, therefore IE UPH needs to measure it with a customized model because of the distinctive nature of the service. This study develops the ServQual Model for IE UPH, which is named HedQual. The HedQual predicted has a positive influence on student's satisfaction and loyalty. The most important construct of service quality for IE UPH Students was also measured using consensus. Data collection is done using a questionnaire and distributed to all IE UPH students. The model tested using PLS-SEM (Partial Least Square – Structural Equation Modeling). The final model shows that HedQual consists of Academic and Non-academic. HedQual, Reputation and Learning Outcome have a significant and positive effect on Student Satisfaction. Student Satisfaction has a significant and positive effect on Student Loyalty. The most important service quality for IE student from the consensus calculation is the attitudes and sincere interests of lecturers in helping students.

1. Introduction

University ofPelitaHarapan(UPH) is a private university in Indonesia that adheres to Christianity principles. By providing good and complete facilities, UPH tries to provide the best education for students. Industrial Engineering (IE) is one of the study programs offered by UPH Karawaci, Tangerang which always want to improve its service quality.

IE UPH has conducted research to assessits service quality (ServQual) in 2010 and 2015 to improve the service quality provided for students. The research in 2010 using general ServQual model that consists of 5 dimensions as follows: Tangible, Reliability, Responsiveness, Assurance, and Empathy.The results show that student expectations were higher than perceived levels of service quality provided by IE UPH [1]. Those studies only measure the gap or the difference between expectations and perceptions. The other research combining ServQual and Kano models into Quality Function Deployment (QFD) to improve the service quality of IE UPH [2]. Both of these studies using general ServQual model. Studies to improve the service quality should be tailored made because of the uniqueness of service, which differs between providers.

Research by Hartono (2008) is the development of a service quality measurement model (ServQual) developed specifically for high school called HisQual with 7 dimensions, namely Tangible, Reliability, Responsiveness, Assurance, Empathy, Learning Outcomes, and Personality Development [3]. Hartono et al. in 2017 also conduct research on important factors that influence

students in choosing Industrial Engineering and the continuation of this research is needed [4]. Therefore, this study continues the research of Hartono et al. This study aims to create a ServQual model for IE UPH called HedQual and test the predictive relationship between constructs in the HedQual, Student Satisfaction and Loyalty and find out the most important part of the service for IE students based on the model.

2. Methodology

Service Quality was first introduced by Parasuraman in 1988 and gain popularity until now for its generic ability to assess the quality of service. In this paper, ServQual that was introduced by Parasuraman called general ServQual model that uses 5 dimensions (Tangible, Reliability, Responsiveness, Assurance, and Empathy) because of researcher around the world use this ServQual model to assess a different kind of service. However, the service itself has specific characteristics and not always appropriate to use general ServQual model. Several researchers have modified the general ServQual model to assess service in education. Table 1 shows the position of this research compare with other ServQual model in education with the addition of two well-known ServQual model from Parasuraman and Grönross [3,4,5,6,7,8,9,10,11,12,13,14].

Table 1. Research position

Researcher and year	Instrument	Research area	Data source	Note
Parasuraman et al. (1988)	ServQual with 5 dimension: Reliability, Empathy, Tangibles, Assurance, Responsiveness	General Service		Published
Owlia dan Aspinwall (1998)	4 dimension: Academic Resources, Competence, Attitude, Content	Higher Education (Engineering) in England	College student	Published
Grönroos (2000)	7 dimension: Professionalism and skills, attitude and behavior, accessibility and flexibility, reliability and trustworthiness, service recovery, serviscape, reputation and credibility	General		Published
Munaf F (2002)	Integration Servqual (general model) with QFD	Higher Education (Engineering) in Indonesia	College student	Unpublished
Abdullah (2005)	Development of ServQual Model for Higher Education	Higher Education in Malaysia	College student	Published
Hartono J (2005)	Model ServQual Parasuraman et al. (general model)	Highschool in Bandung, Indonesia	Highschool student	Unpublished
Mahapatra and Khan (2007)	5 dimension: Learning Outcomes, Responsiveness, Physical Facilities, Personality Development, Academics	Higher Education (Engineering) in India	Student, Alumni, Parent, Employer	Published
Hartono N (2008)	Integration ServQual, Kano and QFD (development of ServQual Model)	Highschool in Bandung, Indonesia	Student, Parent, Teacher	Unpublished
Annamdevula & Bellamkonda (2012)	Development of ServQual Model, HiEdQual	Higher Education in India	College student	Published
Gupta & Kaushik (2018)	ServQual Dimension Comparison in Higher Education	Higher Education		Published
Hartono N and Laurence (2017)	ServQual (development ServQual model)	Higher Education (Engineering) in Indonesia	College student	Unpublished
Verma & Prasad (2017)	Development of SerQual Model (MeQual)	Higher Education (Management)	College student	Published
Mattah, Kwarteng, and Mensah (2018)	Development of SerQual Model	Higher Education in Ghana	College student	Published
This research	Development of ServQual Model for Industrial Engineering University of Pelita Harapan, called HEdQual	Higher Education (Engineering) in Indonesia	College student	

The steps in developing HedQual was comparing service quality dimension in education as presented in Table 1. The item in the questionnaire developed from those previous studies and adding several items from interview to IE UPH students. The final item was 63 with HedQual 55 item, Student Satisfaction 4 item and Student Loyalty 4 item. HedQual results in 5 dimension: Reputation, Tangible, Academics, Non-academic Aspect, Learning Outcomes. The respondent is a population of IE UPH active students with results from 130 only 57 was usable filled questionnaire.

Validity test using the Pearson correlation shows that all item is valid because all Pearson Correlation values > r table value (0.2609). R table value obtained from the degree of freedom (df) which is 55 and the level of significance 0.05 is 0.2609. The reliability test result is 0.976 shows good reliability. The data shows that 70.18% male and 29.82 female. The class of 2015 is the biggest percentage of response, shown by 38.6%. Followed by a class of 2018, class of 2016, class of 2017 and 2014 which is 26.3%, 17.54%, 14%, and 3.5 respectively.

The initial conceptual HedQual model consists of Reputation (R), Tangible (T), Academics (A), Non-academic (N) and Learning Outcome (L) which form a second order construct for HedQual. HedQual is an independent variable, while Student Satisfaction (SS) and Student Loyalty (SL) are dependent variables. The initial model is shown in Figure 1. In this initial model, there are 8 hypotheses to be tested as follows:

H1: Academics is dimension (second-order construct) of HedQual
H2: Learning Outcome is dimension (second-order construct) of HedQual
H3: Non-academic is dimension (second-order construct) of HedQual
H4: Reputation is dimension (second-order construct) of HedQual
H5: Tangible is dimension (second-order construct) of HedQual
H6: HedQual has a significant and positive influence on Student Loyalty
H7: HedQual has a significant and positive influence on Student Satisfaction
H8: Student Satisfaction has a significant and positive influence on Student Loyalty

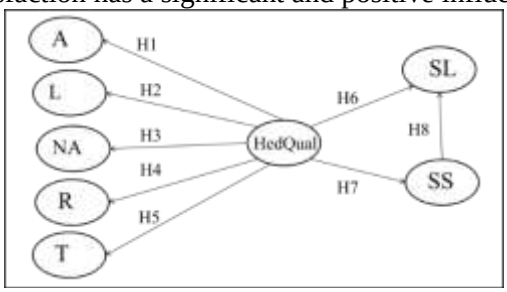


Figure 1. Initial Conceptual Model

The PLS-SEM has been a subject of debates whether to use or not to use PLS [15]. The PLS path modeling is a full-fledged SEM method that can handle both factor models and composite models for construct measurement, estimate recursive and non-recursive structural models, and conduct tests of model fit [16]. Sarstedt Hair points out that researchers have to clarify the difference between a conceptual measurement approach and statistical estimation perspective to choose specific SEM method and its appropriateness [15]. The PLS has advantages for exploratory research and important statistical tool for management, organizational research and other social sciences disciplines [17]. This research uses the PLS-SEM because developing a model using exploratory research that fits with IE UPH and not for generalization of the model.

The steps in PLS-SEM was imported data in the form of CSV file and constructing Path diagram. The model then evaluates after determining the number of bootstraps samples, in this research using 1000 as the number of bootstraps sample. Evaluation of the initial model consists of 2 stages: evaluation of measurement model (outer model) and structural model (inner model).

3. Results

The results of output outer loading show that several indicators have a value below 0.7 in the factor loading and has to be eliminated from the model. Results of PLS shows the indicators that must be eliminated are A1, A2, A3, A4, A5, A6, A7, A8, N1, N2, N4, and N13. All indicators in the construct of Reputation (code R), Tangible (code T), and Learning Outcome (code L) also be eliminated.

After re-testing, it can be seen that all construct indicators have a value of loading factor > 0.7. The AVE value of all constructs > 0.5 thus meet the convergent validity requirements. Based on the values of Cronbach's Alpha and Composite Reliability, all constructs have value >0.7 that shows good reliability. Result of construct validityand reliability depict in Table 2 shows that the evaluation of the outer model is good. Evaluation of the inner model (structural model) wasfrom the R-square value and significance test. Table 2 also shows the R-square for the initial model shows the prediction of the structural model is moderate to high. The significance test with significance level 0.05 shows that construct indicator with t-statistics > 1.96 model is valid. The hypothesestest results are in Table 3.

Table 2. Construct validity, reliability and R square of initial model after deletion

Variable	Average Variance Extracted (AVE)	Cronbach's Alpha	Composite Reliability	R Square Adjusted
Academics	0.662	0.927	0.940	0.873
HedQual	0.657	0.971	0.973	
Non-academic	0.751	0.966	0.971	0.949
Student Loyalty	0.817	0.925	0.947	0.617
Student Satisfaction	0.765	0.896	0.928	0.619

Table 3. Hypothesis test result

Hypothesis	t-statistics	Note	Hypothesis	t-statistics	Note
H1	47.827	Proven	H5	-	Not proven
H2	-	Not proven	H6	0.275	Not proven
H3	131.005	Proven	H7	14.919	Proven
H4	-	Not proven	H8	7.134	Proven

4. Discussion

Based on the results of the initial model evaluation, the model needs to be modified. The modification was based on other research and exclude the variable that was not proven in the hypothesis test. The initial model was modified by pulling out Reputation and Learning Outcome fromHedQual. The Reputation construct is connected with Student Satisfaction and Student Loyalty, while the Learning Outcome is connected with Student Satisfaction. Research by Eryilmaz (2016) said that students' intentions for collaboration in the future are influenced by the reputation and image of universities [18]. This finding is supported by research conducted by Barusman (2014) which states that perceptions of reputation and image of higher education have a positive and significant influence on student satisfaction and loyalty [19].

Tangible construct is retained as a second-order HedQual construct to see whether this construct affects HedQual after the Reputation and Learning Outcome were eliminatedfromHedQual. In addition, the relationship between the construct HedQual and Student Loyalty was removed because the initial model hypothesis test showed that the relationship between the two constructs was not proven. These findings lead to the formation of the following hypothesis:

H1: Academics is dimension (second-order construct) of HedQual
H2: Non-academic is dimension (second-order construct) of HedQual
H3: Tangible is dimension (second-order construct) of HedQual
H4: HedQual
H5: Learning Outcome has a significant and positive influence on Student Satisfaction
H6: Reputation has a significant and positive influence on Student Loyalty
H7: Reputation has a significant and positive influence on Student Satisfaction
H8: Student Satisfaction has a significant and positive influence on Student Loyalty

Figure 2 shows the modification model. The steps of PLS-SEM is the same as the previous steps.

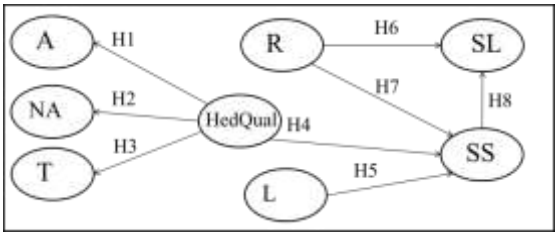


Figure2. Modification Model

The final modification model shows that all indicators of constructs have a loading factor > 0.7 and AVE > 0.5 that shows the convergent validity requirement is met. Based on the values of

Cronbach's Alpha and Composite Reliability, all constructs have value >0.8 that shows good reliability. The outer model evaluation is in good category thatshown from composite reliability and Cronbach's Alpha > 0.8 depict in Table 4. Table 4 also shows the R-square and the hypotheses test results are in Table 5.

Table 4. Construct validity, reliability, and R-square of final modification model

Variable	Average Variance Extracted (AVE)	Cronbach's Alpha	Composite Reliability	R Square Adjusted
Academics	0.662	0.927	0.940	0.873
HedQual	0.657	0.971	0.973	
Learning Outcome	0.644	0.815	0.878	
Non-academic	0.751	0.966	0.971	0.949
Reputation	0.666	0.875	0.909	
Student Loyalty	0.817	0.925	0.947	0.630
Student Satisfaction	0.764	0.896	0.928	0.795

Table 5. Hypothesis test result

Hypothesis	t-statistics	Note	Hypothesis	t-statistics	Note
H1	51,881	Proven	H5	4,575	Proven
H2	134,539	Proven	H6	1,384	Not proven
H3	-	Not proven	H7	2,146	Proven
H4	3,706	Proven	H8	8,160	Proven

Based on the results of the R-Square it can be seen that the constructs of Academics, Non-academic, and Student Satisfaction have values that fall into the strong category in predicting, while Student Loyalty which is included in the moderate category in predicting. This shows that most variations in the construct ofStudent Loyalty are explained by 37% factors not included in the model. The next stage is the significance test using the significance level of 5% using the bootstrapping procedure where t-value > 1.96 states that the hypothesis is proven.

The modification model results outperform the initial model. The interesting part is that tangible is deleted both in initial and modification model because all indicators of tangible have a loading factor < 0.7. Thus, it can be said that IE UPH students do not consider the Tangible construct such as the appearance of buildings, facilities, and the university environment as a factor that influences the quality of services. In addition, the overall value of R-Square in the modification model tends to be the same or higher than the initial model. Thus, the evaluation results in the modification model show that the model predicts constructs better than the initial model. The final model shows that HedQual consists of Academic and Non-academic, HedQual together with Reputation and Learning Outcome has a significant and positive effect on Student Satisfaction, and Student Satisfaction has a significant and positive effect on Student Loyalty.

The consensus was carried out to know what the most important factor in service quality is for IE UPH students. The consensus is a general agreement from the respondents and calculated using the equation from Tastle and Wierman [20]. The consensus range between 0-1 where the number closest to one shows the highest level of agreement of the respondents. The calculation results for the item based on the Level of Importance from the questionnaire were listed in Table 6 for the top five highest scores.

5. Conclusion

IE UPH service quality is valued by its students from Academic and Non-academic quality. HedQual, Reputation and Learning Outcome affects positively to Student Satisfaction and thus affect positively to Student Loyalty.The consensus showed that IE UPH students consider lecturers as the most important part in service quality, shown by the position of A15,A10, A9,A16,A14 in the first, second,fifth, sixth and ninth in level of importance. The most important service quality for IE student

from the consensus calculation is the attitudes and sincere interests of lecturers in helping students.The reputation also considers as important, shown by R2, R1 and R4 at fourth, seventh and eight position in the level of importance. Lecturers and Reputation should become major concern to improve for IE Department to give the best service quality for their students.

Table 6. Consensus-based on level of importance

No	Code	Questions	Consensus
1	A15	When students have a problem, the lecturer shows genuine interest in helping to solve it	0.7650
2	A10	The lecturer showed a positive attitude towards students	0.7648
3	L3	Students get the skills to use software (statistics & techniques)	0.7582
4	R2	IE UPH has a high reputation	0.7530
5	A9	The lecturer handles students in a caring and polite manner	0.7497
6	A16	Availability of lecturer for guidance and advice	0.7485
7	R1	IE UPH has a professional image	0.7473
8	R4	IE UPH has good accreditation	0.7467
9	A14	Lecturers understand the academic needs of students	0.7459
10	N12	Students was treat equally and respectfully by staff	0.7431

Acknowledgment

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Development initial model of intention to use Halodoc application using PLS-SEM

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Abstract. There is only a few research about the doctor's consultation application in Indonesia. The purpose of this study was to examine the predictive relationship between constructs regarding the intention to use Halodoc application using Partial Least Squares-Structural Equation Modeling (PLS-SEM). This initial model consists of perceived usefulness, perceived ease of use, graphical user interface, the reliance of use, and user satisfaction. SmartPLS 3.0 is used for PLS-SEM analysis. The R-square value for the reliance of use, intention to use, perceived ease of use, user satisfaction and perceived usefulness was 55.3%, 52.8%, 54.2%, 42.5%, and 29.3%. The significance test shows that graphical user interface has a positive influence on perceived ease of use, perceived usefulness and perceived ease of use have positive influence to the reliance of use, the reliance of use has positive influence to user satisfaction, user satisfaction has positive influence to intention to use significantly. This model can explain at a moderate level shown from R-square, and there are 9 of the 15 hypotheses accepted.

Introduction

CNBC reports that it is predicted nearly 3.7 billion people or 72.6 percent of internet users using their smartphone to access the web in 2025 worldwide with one of the most growth is in Indonesia from among other five contributed country [1]. Nielsen reports in 2018 also show that there is increasing smartphone users in Indonesia market and in line with the advertising expenditure for mobile products [2]. The increasing number of applications in Indonesia is also quite rapid, one of which is the emergence of various applications that offer consulting services with doctors, including Halodoc, Alodokter, Go-Dok, KlikDokter, Apasakitku, Dokter Diabetes, Dokter Chat, On Com, and Yesdocin Indonesia. FDA (Food & Drug Administration) defines mobile health apps as a medical device and are an accessory to a regulated medical device or transform a mobile platform into a regulated medical device. Doctor consultation application is a health care application and means for users in terms of service services to consult a doctor online [3].

There are not many studies on doctor consultation applications and previous research has discussed the description of smartphone use by health professionals and patients [4], making mobile health application design [5] and profiles and preferences of doctors consulting application users in Indonesia [3]. The Technology Acceptance Model (TAM) model that was first introduced by Davis in 1985 is a model developed to specifically explain the factors that influence user acceptance of various computing technologies among end-users [6]. A number of studies in the field of marketing have adapted TAM in their research and are still used in recent research as a theoretical foundation [7,8,9]. Jung et al research about the intention to use smartphone application show that the behavior of smartphone users was influenced by user perception [10]. End-user point of view regarding the

intention to use mHealth application introduced by Altmann and Gries [11]. This research develops the initial model using the theoretical basis of previous research for Indonesia. Halodoc is chosen as a reference because based on Silalahi et al. research, Halodoc is one of the most frequently used applications in Indonesia with a percentage of 43.2% and Playstore shows data that Halodoc is the top 3 medical applications with more than 1 million downloads in August 2018 [12]. The purpose of this study was to examine the predictive relationship between constructs regarding the intention to use Halodoc application. The results will benefit for academic as a contribution in knowing from the end-user point of view when using the doctor consultation application and also present opportunity for Halodoc and similar application to adjust their marketing to increase users of their application.

Methodology

The first step in this research is preliminary study and literature review to find gaps in the previous research. To our best knowledge, this research is the first research to understand factors that drive the customer to use a doctor consultation application in Indonesia. Our case study is Halodoc Application. Model conceptualization was using the variables that use in the previous research from literature. Table 1 shows the variable and source and Figure 1 depict the initial model with hypotheses.

Table 1. Variable used in this research

Variable	Source
Perceived Usefulness	Perceived Usefulness (Davis 1985,Jung et al. 2016, Altmann et al. 2017); Using mobile health application as a tool in the initial medication (Thinukool et al. 2017, Silalahi et al. 2018)
Perceived Ease of Use	Perceived Ease of Use (Davis 1985, Jung et al. 2016, Altmann et al. 2017); Experiment (Thinukool et al. 2017, Silalahi et al. 2018)
Graphic User Interface	Graphical User Interface (Thinukool et al. 2017, Silalahi et al. 2018)
Reliance of Use	Reliability (Altmann et al. 2017); Reliance on the use of application functionally (Thinukool et al. 2017)
User Satisfaction	User Satisfaction (Jung et al. 2016)
Intention to use	Intention to use (Jung et al. 2016)

Hypotheses for the Initial Model with a proposed relationship based on theories, as follows:

H1a: Perceived Usefulness affects the Intention to Use Halodoc application (Altman et al. 2017)
H1b: Perceived Usefulness affects Reliance of use (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H1c: Perceived Usefulness affects User satisfaction (Jung et al. 2016)
H2a: Perceived Ease of Use affects the Intention to Use Halodoc application (Altman et al. 2017)
H2b: Perceived Ease of Use affects Reliance of use (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H2c: Perceived Ease of Use affects Perceived Usefulness (Davis 1985, Jung et al. 2016)
H2d: Perceived Ease of Use affects User Satisfaction (Jung et al. 2016)
H3a: Graphical User Interface affects the Intention to Use Halodoc application (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H3b: Graphical User Interface affects Perceived Ease of Use (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H3c: GUI affects Perceived Usefulness (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H3d: GUI affects Reliance of Use (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H3e: GUI affects User Satisfaction (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H4a: Reliance of Use affects the Intention to Use Halodoc application (Altman et al. 2017)

H4b: Reliance of Use affects User Satisfaction (proposed, based on Thinukool et al. 2017 and Silalahi et al. 2018)
H5: User Satisfaction affects the Intention to Use Halodoc application (Jung et al. 2016)

For simplicity, the variable was coded as follows: Graphical User Interface (GUI), Intention to Use (I), Perceived Ease of Use (PE), Perceived Usefulness (PU), Reliance of Use (R), and User Satisfaction (US).

The questionnaire was built based on the model and test for face validity. The partial least square structural equation modeling (PLS-SEM) chosen for this research because the use of PLS-SEM is for prediction, theory development, and to explain model which is fit with this research. The (PLS-SEM) is different from covariance-based structural equation modeling (CB-SEM). The focus of PLS is optimizing prediction of the endogenous constructs versus CB that focus on fitting the model [13].

Data collection is done by distributing questionnaires to Halodoc's users using google forms. The response is 139, however only 40 response that can be used for data processing, which is only 28% usable data. Due to time constraints and difficulties in getting respondents, the 40 responses were processed. The usable data is in small size (under 100), however, the data is sufficient for processing because the benefit of PLS-SEM is it can use small sample sizes and does not assume the data has a normal distribution [13,14].

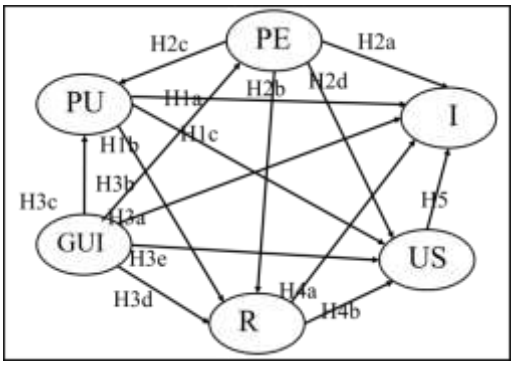


Figure 1. Initial model intention to use Halodoc application

The validity test using Pearson correlation shows that all question is valid and the reliability test using Cronbach's alpha shows that the instrument reliability is high, shown by the Cronbach's alpha is 0.955. Respondent characteristics shows that 72.5% are female, 77.5% age between 18 to 22 years old, 97,5% are single (not married), 65% are students, 55% high school graduate, 35% has income between 1.5 to 3.5 million rupiah, 55% are live in Tangerang Indonesia, 70% are new users (new to 6 months), 30% said that the reason choose Halodoc because easy to use the application. 61.4% respondent did not use another similar application whereas 20.5% also use Alodokter, 6.8% also use Go-dok and 4.5% also use Klikdokter. Majority of the respondents use Halodoc for themselves (56.3%), followed by for parents (15.6%) and for friends 12.5%.

The PLS-SEM steps as follows:

1. Determining the algorithm analysis methods, using path algorithm scheme for estimating the model.
2. Determining the resampling method, which is bootstrapping and the number of bootstrap samples is 1000. According to Chin, 200-1000 samples is sufficient to correct the PLS standard error estimation.
3. Drawing path diagrams. The model that has been made at the conceptualization stage of the model is drawn in its path diagram in the SmartPLS 3.0 program.
4. Evaluating the model. This stage consists of two parts, namely the evaluation of the measurement model (outer model) and evaluation of the structural model (inner model). Evaluation of the outer model consists of a convergent validity test, discriminant validity test,

and reliability test. The inner model evaluation was carried out by looking at the R-Squares value and conducting a significance test (two-tailed)

Results

The validity and reliability of the proposed model were evaluated using evaluation of the measurement model or outer model using a convergent validity test, discriminant validity test, and construct reliability test. The results of output outer loading show there are several indicators has factor loading below 0.7 and thus be deleted from the model. The summary of the outer model after the refining indicator is presented in Table 2. As shown in Table 2, the model meets convergent validity where the value of outer loadings are larger than 0.70 and the value of AVE are larger than 0.50, also reliability as the composite reliability value is larger than 0.70.

Table 2. Outer model summary

Variable	Indicator	Outer Loadings	AVE	Composite Reliability
Perceived Usefulness	PU5	0.849	0.757	0,912
	PU7	0.891		
Graphical User	GUI3	0.806	0.630	0.908
Interface	GUI4	0.753		
	GUI5	0.835		
	GUI7	0.757		
	GUI8	0.877		
	GUI9	0.720		
Perceived Ease of Use	PE4	0.871	0.656	0.903
	PE5	0.795		
	PE6	0,826		
	PE7	0.772		
	PE8	0.781		
Reliance of Use	R1	0.861	0.671	0.923
	R2	0.875		
	R3	0.830		
	R4	0.772		
	R7	0.740		
	R8	0.824		
User Satisfaction	US1	0.812	0.736	0.840
	US2	0.908		
Intention to Use	I2	0.925	0.748	0.853
	I3	0.804		

The model also meets discriminant validity where the value of cross-loadings are larger than 0.70 in Table 3 and the value of AVE square root are larger than the value of the correlation between latent construct as shown in Table 4. Henseler et al. (2015) proposed a new criterion for assessing discriminant validity using Heterotrait-monotrait (HTMT) ratio of correlation because of the Fornell-Larcker criterion and the cross-loading not reliable to detect the lack of discriminant validity [15]. This study still used AVE and Fornell-Larcker criterion with the addition of HTMT ratio to assess the discriminant validity. Tabel 5 depicts the HTMT ratio where the results show below the conservative threshold value of 0.85.

Therefore, the model is valid and reliable because it is already met the rule of thumb for the outer model. After evaluation of the outer model, the next step is the evaluation of structural models or inner models. The aim is to predict the relationship between latent variables.

Table 3. Cross Loading results

Indicator	GUI	I	PE	PU	R	US
GUI3	0.806	0.485	0.560	0.430	0.486	0.443
GUI4	0.753	0.459	0.603	0.392	0.519	0.373
GUI6	0.835	0.534	0.570	0.465	0.568	0.519
GUI7	0.757	0.436	0.474	0.310	0.412	0.504
GUI8	0.877	0.438	0.619	0.403	0.601	0.574
GUI9	0.720	0.515	0.693	0.410	0.527	0.494
I2	0.677	0.925	0.593	0.613	0.598	0.697
I3	0.303	0.804	0.292	0.301	0.429	0.491
PE4	0.575	0.532	0.871	0.523	0.596	0.497
PE5	0.576	0.380	0.795	0.290	0.554	0.434
PE6	0.624	0.570	0.826	0.541	0.628	0.510
PE7	0.588	0.276	0.772	0.366	0.540	0.295
PE8	0.647	0.389	0.781	0.481	0.613	0.523
PU5	0.337	0.456	0.463	0.849	0.505	0.318
PU7	0.538	0.515	0.500	0.891	0.478	0.486
R1	0.573	0.515	0.558	0.531	0.861	0.501
R2	0.463	0.535	0.639	0.464	0.875	0.438
R3	0.421	0.489	0.591	0.506	0.830	0.430
R4	0.601	0.467	0.579	0.488	0.772	0.457
R7	0.557	0.425	0.586	0.339	0.740	0.478
R8	0.615	0.535	0.615	0.432	0.824	0.555
US1	0.455	0.529	0.405	0.269	0.361	0.812
US2	0.660	0.667	0.555	0.505	0.612	0.908

Table 4. Fornell-Larcker Criteria Results

Variable	GUI	I	PE	PU	R	US
Graphical User Interface (GUI)	0.793					
Intention to Use (I)	0.605	0.867				
Perceived Ease of Use (PE)	0.744	0.542	0.810			
Perceived Usefulness (PU)	0.511	0.560	0.555	0.870		
Reliance of Use (R)	0.660	0.606	0.727	0.563	0.818	
User Satisfaction (US)	0.662	0.702	0.567	0.468	0.584	0.861

Table 5. Heterotrait-Monotrait (HTMT) Ratio Results

Variable	GUI	I	PE	PU	R	US
Graphical User Interface (GUI)						
Intention to Use (I)	0.724					
Perceived Ease of Use (PE)	0.846	0.643				
Perceived Usefulness (PU)	0.644	0.767	0.706			
Reliance of Use (R)	0.735	0.750	0.820	0.721		
User Satisfaction (US)	0.835	0.839	0.722	0.658	0.729	

Table 6. R-Square results

Latent Variable	R-Square
Intention to Use (I)	0.528
Perceived Ease of Use (PE)	0.542
Perceived Usefulness (PU)	0.293
Reliance of Use (R)	0.553
User Satisfaction (US)	0.425

Discussion

Table 6 shows that latent variables Intention to Use, Perceived Ease of Use, Reliance of use, and User Satisfaction have a moderate R-square value, while the latent Perceived Usefulness has a weak R-square value. Reliance of Use has an R-square value of 0.553 which indicates that Reliance of Use variability is explained by the model by 55.3% while 44.7% is explained by other variables outside the variables studied. Followed by Intention to Use, Perceived Ease of Use, User Satisfaction and Perceived usefulness with 52.8%, 54.2%, 42.5%, and 29.3% respectively.

Table 7. Inner model evaluation results

Hypothesis	Path	Original Sample	Sample Mean	Standard Deviation	T Statistic	P Value	Result
H1a	PU --> I	0.320	0.333	0.164	1.969	0.052	Accept
H1b	PU --> R	0.199	0.201	0.127	1.566	0.118	Reject
H1c	PU --> US	0.151	0.172	0.191	0.788	0.431	Reject
H2a	PE --> I	0.206	0.213	0.174	1.184	0.237	Reject
H2b	PE --> R	0.529	0.529	0.143	3.690	0	Accept
H2c	PE --> PU	0.391	0.414	0.186	2.103	0.036	Accept
H2d	PE --> US	0.168	0.162	0.147	1.140	0.254	Reject
H3a	GUI --> I	0.605	0.616	0.090	6.713	0	Accept
H3b	GUI --> PE	0.744	0.749	0.090	8.231	0	Accept
H3c	GUI --> PU	0.511	0.531	0.119	4.281	0	Accept
H3d	GUI --> R	0.660	0.669	0.093	7.124	0	Accept
H3e	GUI --> US	0.662	0.675	0.085	7.793	0	Accept
H4a	R --> I	0.279	0.299	0.199	1.404	0.161	Reject
H4b	R--> US	0.213	0.257	0.214	0.998	0.319	Reject
H5	US --> I	0.445	0.434	0.205	2.173	0.030	Accept

Table 7 shows the inner model evaluation and from that table, it can be seen that there are 9 hypotheses accepted which have a t-statistic value larger than 1.96. The final model after data processing is depicted in Figure 2. Graphical User Interface affects Perceived Ease of Use, Perceived Usefulness, Reliance of Use, User Satisfaction and Intention to use halodoc application. Perceived Ease of Use affects Perceived Usefulness and Reliance of use halodoc application. It can be seen that Reliance of Use did not have any relation to the Intention to use. Graphical User Interface (GUI) affects all other variables. It seems that the respondent relies on tangible cues on deciding to use halodoc application. It is inline with Silalahi et al research that GUI is one of the most important factors for users of doctors consultation application in Indonesia. However, in Silalahi et al. research, Reliance of Use also one of the most important factors, but in this research, it has no relationship with the intention to use Halodoc application.

There are several fit measures for model fit in PLS-SEM, however, only Standardized Root Mean Square Residual (SRMR) that introduced by Henseler et al (2014) that can be used in PLS-SEM research to avoid model misspecification [16]. SRMR for this model is 0.10 which is a good fit according to the criteria below 0.10 is a good fit.

This research is a preliminary study regarding the use of doctor consultation applications in Indonesia. There may still be other factors that might influence the intention to use Halodoc applications that have not been studied in this study. A study of mediation/indirect effects have not considered in this study and future study should add other factors. Further research should add more variables and respondents.

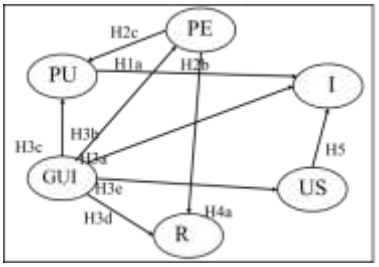


Figure 2. Intention to use Halodoc Application Model results

Conclusion

Finally, from Partial Least Squares-Structural Equation Modeling (PLS-SEM) analysis, it can be concluded that the factors that influence the Intention to Use Halodoc applications are Perceived Usefulness, Perceived Ease of Use, Graphical User Interface, Reliance of Use, User Satisfaction. The model can explain at a moderate level as shown from R-square, and there are 5 of 9 hypotheses accepted in the model as depict in Figure 2. The respondents of this research still new users, so it is interesting to see the difference between new users and frequent users in further research.

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APPENDIX

Questionnaire

Dimension	Question	Code
Perceived usefulness	Halodoc application can be an instrument in providing information on the initial medication and resulting an effective treatment.	PU1
	Halodoc application can provide accurate information on the healthcare as same as professional advice from pharmacists and doctors.	PU2
	Using of Halodoc application can make personal healthcare better.	PU3
	Using of Halodoc application can change behaviors and encourage users to care more about their personal health.	PU4
	Using of Halodoc application will not be seriously harmful to the users' health.	PU5
	Using of Halodoc application can reduce the bill for medication when the users get sick.	PU6
	Using of Halodoc application can facilitate the users in the initial medication.	PU7
GUI (Graphical User Interface)	Buttons on the screen are easy to use.	GUI1
	The screen is clearly distinctive between foreground and background.	GUI2
	Screen colors are appropriate.	GUI3
	Each of the menu images represents understandable functionality	GUI4
	The number of menu is appropriate to use.	GUI5
	Menu list is easy to use.	GUI6
	Text sizes are appropriate.	GUI7
	Contrast of the display is beautifully balanced.	GUI8
	Users like the overall user interface design, the screen.	GUI9
Perceived ease of use	Halodoc application is easy to use and intuitive.	PE1
	Halodoc application provides useful information on the use of non-prescription drugs.	PE2
	Pharmacy Delivery function is useful to find medicines and pharmacies more quickly and easily	PE3
	Contact Doctor function can help users to chat instantly with certified doctors and specialist.	PE4
	Lab Service function can help users to book lab tests from trusted laboratory and view the results in the application.	PE5
	Articles function can help users to receive more information about health issues.	PE6
	Profile function can help users to track medicines order or consultation history.	PE7
	Halodoc application quickly and stably runs on mobile device platform.	PE8
The reliance of the use of application functionality	I have confidence in Halodoc application about the instructions for the initial medication.	R1
	I believe that Halodoc application provides information about drugs with accuracy.	R2
	The information provided on Halodoc application helps users to understand how to use medicines and are able to use that information for immediate treatment.	R3
	I believe that the information given by Halodoc application will do no harm to the users.	R4
	I accept Halodoc application useful as health support	R5
	I would recommend Halodoc application to friends.	R6
	I am sure the doctor at Halodoc is an experienced doctor and gives the right advice	R7
	I am sure that health information in articles in the Halodoc application is correct	R8
User satisfaction	Experience of Halodoc application was very satisfying.	US1
	Halodoc application was a pleasant experience	US2
	Overall, I was satisfied with Halodoc application from every aspect.	US3
Intention to use	I intend to use Halodoc application again in the near future.	I1
	I intend to use Halodoc application again at every opportunity	I2
	When I need health information, I always look for that information in the Halodoc application	I3

The role of ergomomics in suporting supply chain performance in manufacturing companies: a literature review

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Abstract. Nowadays companies are required to work more productive yet maintain good quality. To increase productivity, company needs a conducive effort to optimize the work system. Supply chain management (SCM) is one form of competitive advantages that is applied to every industrial system. There are many factors which can influence the supply chain performance (SCF). Ergonomics is deemed to be one of significant drivers for SCF. This paper proposes and discusses the concepts related to ergonomics which is considered as macro ergonomics in supply chain system. SCM has been seen as macro ergonomics concerning on organization, people, tecgnology, information and resources. This paper shows the importance of ergonomics at the inbound logistics (includes receiving, storing, inventory control and internal distribution management) and outbound logistics (the activites to get the finished product to customer) which are regarded as the critical supply chain activities. A scientific literature review on ergonomics as a critical determinant for SCF is discussed and provided as a theoretical contribution for further research related to the role of ergonomic to support supply chain performance.

1. Introduction

Supply chain management is a form of competitive excellence which is applied in every industrial system. The competitive strength of supply chain is achieved when the operation or act of adding value generates a maximum output. Supply chain is a network of companies that work in harmony to create and deliver product to the hands of end users [6]. In this era, every company is expected not only to work faster, but also to produce more high-quality products; however, there are still a number of businesses that do not consider the affecting factors and their risks. Ergonomics is the affecting factor which maintains the relationship between the company and the environmental aspects [2]. Ergonomics is divided into two sections which are micro- and macroergonomics. The former is the linkage of the workers, machines, methods and materials used, whereas the latter is a top-down sociotechnical system approach which is applied to an overall work system design of various interaction levels of microergonomics, such as human-job, human-machine, and human-software interface. Macroergonomics is something integrated because it covers knowledge, method, and equipment from sociotechnical system, industrial psychology, system design, physical ergonomics, and theoretical ergonomics. The use of macroergonomics in the supply chain performance evaluation

is to analyse the structural work system by evaluating human, environmental, and equipment factors which are the support in production activities. The main purpose of macroergonomics is to harmonize the work system as a whole both in the micro and macro level, increase the work satisfaction which is committed to the health and safety of the workers, and to increase productivity [12]. The company should build a macroergonomics concept that pays attention to the technical aspects (machines equipped with safety), organization/management, good work environment and competent operators/employees [1].

There are several studies done about the important role of ergonomics that could improve supply chain management performance. Pintelon & Azadeh (2016) stated that a systematic framework is by categorizing human factors in maintenance decision making which are human error, reliable calculation, workplace design/macroergonomics, and human resource management. Whereas Hasle & Jensen (2012) found that the ergonomic means and human factor to create international collaboration could affect global supply chain. Identifying five main challenges from global supply chain, especially the ones related to the sustainable social aspects, are the criteria for social sustainability, the role of key performance indicators in supply chain management, the constant changes in the supply chain, the challenges in building participation, and the agency development and mechanism regulations. The research done by Dewa, et al (2016) produces a model to conduct a sensitivity analysis to the implementation of corrective actions that is generated in the corrective models to reduce errors. According to Hartono (2008), ergonomics does not only focus on human and machine, but also on the interaction between culture and its surroundings. Ergonomic evaluation should also be understood and applied in vendors, suppliers, and all value chain components to achieve high level supply chain performance. This analysis uses Porter's value chain model. Supply chain is considered as value chain which covers supplier, the company itself, distribution and buyer. There are two value chains, which are primary activities and support activities. Primary activities include inbound logistic, operations, outbound logistic, marketing and sales, and services.

Based on several research results that have been conducted, it can be temporarily inferred that ergonomic factor in supply chain holds a vital role to the success of supply chain management itself. On previous researches, mostly ergonomics only focuses on operations, which is the product formation process. Due to this fact, this research discusses the importance of ergonomics on inbound and outbound logistics to improve supply chain performance. Inbound logistic is the role of all processes related to the reception storage, and distribution of internal input. Moreover, outbound logistic is the role of providing the products to the customers. Such as inventory control dan transportation.

The purpose of this research is to answer the question of how the role and contribution of ergonomic factor in the context of planning and supply chain operation is to inbound and outbound logistic. With many challenges and issues in operational management in supply chain, there is a need to be an understanding and ergonomic management in planning and operating supply chain, which becomes a fundamental subject to be studied and managed.

2. Literature Review

2.1. Supply chain management

The term supply chain is defined in various ways. Pujawan (2010) stated that supply chain is the network of companies that work hand-in-hand to create and deliver product to the hands of end users. The purpose of every supply chain is to maximize the supply chain profitability, which is the difference between total revenue obtained from the consumers and the total of overall cost spent on a supply chain. According to Ravindran & Warsing (2013) customer is the single source of profit for every supply chain, which is met on a trade-off between responsiveness and efficiency. Supply chain responsiveness includes supply chain that is able to respond to the demand in a broad scope, have a short lead time, handle products with wide variation, and have a high service level.

2.2 Key performance indicator of supply chain

According to Miranda and Amin WT (2005), to develop a balanced performance measurement system, the company should consider financial and non-financial aspects. Even though financial performance measurement is vital to strategic decision-making and making external reports, control towards manufacturing operation and distribution is better handled with non-financial measurement. Supply chain performance measurement has an important role in knowing the company condition, whether it experiences decline or incline, and also the improvement as well as what kind of correction that should be conducted to enhance their performance. The measurement of supply chain performance includes company performance measurement of their internal and external process. The internal process happens within the company starting from the production planning to the product delivery to the customers. On the other hand, external process involves the relationship of the company with outside stages, which are supplier and customer. According to Rakhman (2006), performance measurement is important due to the following reasons performance measurement can control direct and indirect performance, will maintain the company's track to achieve the purpose of increasing supply chain, and it can be used to increase supply chain performance. Faulty measurement method can cause the decrease in supply chain performance. Supply chain can be directed after performance measurement is conducted.

2.3 Macroergonomics

Macroergonomics is a sub discipline of ergonomics which focuses on studying work system design [12]. A work system is comprised of a mutual interaction between personnel with hard and soft wares. A work system includes two or more individuals who cooperate to achieve a general purpose in an organization. Macroergonomics is known as an ergonomics sub discipline related to the correlation between humans, organizations and technology. Macroergonomics is an integrated discipline because it covers knowledge, methods, and equipment from sociotechnical system, industrial psychology, system engineering, physical ergonomics, and theoretical ergonomics. In its application, macroergonomics presents a valuable niche that none of these areas are overlooked. As science, macroergonomics directs to develop an understanding of a work system, behavior, or personnel that interact with hard or soft wares in an internal physical environment, external surroundings, and organizational structure as well as process to improve. Macroergonomics also studies profession, but it examines jobs and work system in a wider scope. Several points that are discussed in macroergonomics are organizational structure, interaction between people in an organization, and workers' motivation aspect. On the other hand, microergonomics only observes from occupational level, but macroergonomics views from both occupational and organizational levels. The table below states the differences between micro- and macroergonomics:

Table 1. Differences micro- and macroergonomics [12]

Characteristics	Microergonomics	Macroergonomics
Level of discussion	Micro	Macro
Work unit	Task, sub task	Work division, group
Purpose	Optimize work	Optimize work system
Focus	Detailing	Extensive review
Measurement tools	Generally measure physically, such as area, i-lumination, decibel, and time	Generally organizational and measure subjectively, such as the number of people, range of control, behavior, and moral.
Expertise application	Anatomy, psychology, psychology of perception	Organizational behavior, industrial psychology and organization

2.4 Porter's Value Chain

Value Chain Analysis is a strategy used to analyze the company's internal activities. It is a process where a company identifies the primary activity and support that increase the value of the product,

then analyze it to reduce cost or increase differentiation. Value Chain Analysis that is extensively used by companies is Porter's Value Chain Model which is introduced by Michael Porter in the year 1985. The said model is pictured below.

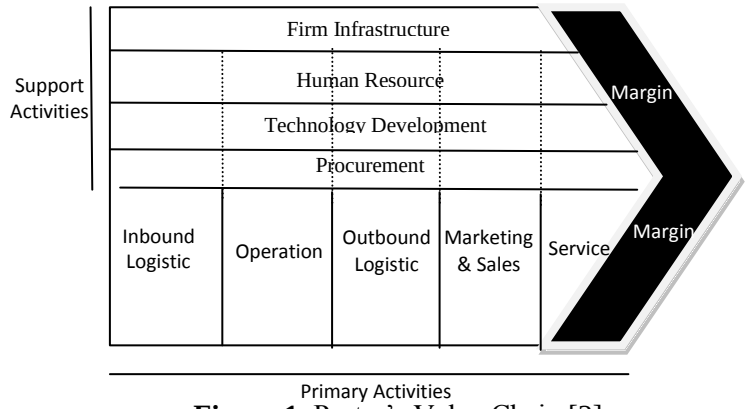


Figure 1. Porter's Value Chain [2]

Porter's Value Chain is divided into two categories, which are primary activities and support activities. The explanation of Porter's Value Chain category is as follows.

- Primary Activities
  The main activity is directly related to physical creation, sales, maintenance, and support from a product or service. Several components that support primary activities are:
  1. Inbound Logistic
     All process related to receiving, storing, and distributing internal input.
  2. Operations
     The action of transformation that changes the input to be the output, which will be sold to the customers.
  3. Outbound Logistic
     Give the customers their product or service. Outboung logistic is the activities to get finished product including warehousing, order fulfillment, transportation and distribution management.
  4. Marketing & Sales
     A process used to persuade the customers to buy the sold products.
  5. Service
     The action related to maintaining product value or services for the customers after the purchase.

2.5 The relation between supply chain performance and ergonomics

Not only does ergonomics focus on humans and machines, it also focuses on the interaction between culture and its surroundings. If a company is not supported by good ergonomics, supply chain performance will not run well. Ergonomics affects the accuracy and rate of a production process tremendously. The initial step to establish the right ergonomics to supply chain is by recognizing the ergonomic standard used. For instance, the product and design process standard that should be ergonomic and safe. Macroergonomics is a concerned with a broad view of ergonomics which is called technical system. Since supply chain management us regarded asa system of organization, there will be a closer relantionship between macroergonomics and supply chain management. The concern of how to maintain comfortable work station, flow of material, safety, team work and other. In today's competitive business world, employees are expected to work faster with more qualified result to meet

customer needs. The biggest issue of ergonomic is how to maintain the employees or operators in appropriate way when they are working. All the workstation available should fit to the body dimension of operators, so they can work safety, comfortably and more productive [2]. Ergonomic can also be viewed in inbound and outbound logistic. Inbound logistic is from the suppliers to pointa of storage or use. The engineering ergonomist may have to work with supplier, providing specifications related to the material management. Other objectives for the procurement, transportation, warehousing must also be included in the ergonomics process. If the inbound logistic are not going well, it will hinder the production process such as inventory can not meet the demand. Outbound logistic is the activity to get finished product including distribution. If the distribution are not going well, it will make a late delivery product and also unable to meet customer satisfaction.

3. Research Methodology

This research is theoretical; hence, the output produced is a study of literature, and data collection is yet to be done. This research focuses on the role of ergonomics in supply chain performance. The first step is collect some journals which have a similar topic to this research. Material collection is an important stage. The database selection are taken through Emerald, Science Direct and Scholar.google.com. with keywords "macroergonomics", "supply chain". Criteria for journal selection is published from 2008-2018 (the last ten years). In this stage conducted by entering on the title, abstract and conclusion which is similar to this research.

4. Analysis

The study related to the role of ergonomics in supply chain performance has been conducted by Hartono (2008). This research used Porter's Value Chain model with several additional variables to create the current complex field of ergonomics. Hartono (2008) stated that it is important to highlight ergonomics determinants such as employees' physical capability, safety, task requirements, equipment requirements, and policy or procedure in work system. These should be accounted for in every part of the company's supply chain. This research has not discussed further about the involvement of ergonomics in primary activities and support activities as one of the supporters for supply chain performance. Another study is by Hasle & Jensen (2012) which found the ergonomic means and human factor to create an international collaboration which could affect the global supply chain. Hasle & Jensen (2012) identify five main challenges of global supply chain, especially the ones related to the sustainable social aspects, which are the criteria for social sustainability, the role of key performance indicators in supply chain management, the constant changes in the supply chain, the challenges in building participation, and the agency development and mechanism regulations. The research done by Dewa, et al (2016) produces a model to conduct a sensitivity analysis to the implementation of corrective actions that is generated in the corrective models to reduce errors. Sensitivity analysis model is built by using Monte Carlo simulation. This model is equipped with human aspect that tends to be unclear, which uses the fuzzy concept. This model is capable of recommending cost effective corrective actions. However, this study has yet to consider the mental and inherent behavior aspects that are attached to human individuals. The summary of this study's differences with the previous one and the research position is as follows.

Table 2. Research position table

Characteristics	Hartono (2008)	Hasle & Jensen (2012)	Dewa, et al (2016)	This research (2019)
The scope of research	-	Operations (machine, assembly)	Operations (machine, assembly)	Inbound logistic (Inventory control & transportation) and outbound logistic distribution

Characteristics	Hartono (2008)	Hasle & Jensen (2012)	Dewa, et al (2016)	This research (2019)
Method	Porter's Value Chain	General ergonomics	Monte Carlo simulation	Porter's Value Chain
Performance measurement used	Did not measure performance	Occupational accident levels and attendance	Human error in carrying out the production process	Delivery time, number of complaints

Based on the table, this research focused on inbound and outbound logistic with the Porter's value chain method. Key performance indicator of this researh is delivery time and number of complainys. This research is expected to be a literature review for further reseacrh related to the role of ergonomics in supply chain performance.

5. Conclusion

After conducting reviews of several journals related, it can be concluded that macroergonomics has a vital role in a company's internal and external process. This will provide a considerable impact towards every process, supply chain included. Research results show that there are not many journals that discuss the effects of macroergonomics in supply chain on inbound and outbound logistics. To date, most of the discussions focus mainly on management from the company, and non-value-added activity on the production floor in the form of defects found. This becomes one of the considerations that could be used to conduct further research.

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Green dynamic capability for enhancing green innovations performance in a manufacturing company: a conceptual framework

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Abstract. Green innovation has become a necessity for companies in line with the demands of environmental requirements. Green innovation is the activity of developing a product or process that is carried out by considering environmental aspects (such as energy savings, pollution prevention, waste recycling, reduction of resource consumption) to reduce the impact of industrial activities on the environment. One of the factors associated with green innovation performance is the company's dynamic capabilities. This paper proposes a conceptual framework that illustrates the role of companies' dynamic green capabilities on the performance of green innovation in manufacturing companies in Indonesia.

1. Introduction

The industrialization has become a major driver of economic growth and increased the welfare of countries in the world. On the other hand, industrial activities also contribute to the reduction of natural resources, destruction of ecosystems, and the threat of climate change. Limited natural resources, global warming, waste management, and other environmental issues are challenges for industrial growth. In addition, international environmental regulations, various environmental protection conventions, and increasing environmental awareness of consumers have an impact on the pattern of business competition and how industrial companies conduct their business [1, 2]. This encourages industries throughout the world to increase attention and awareness of environmental issues. Therefore, the company's environmental management plays an important role in business today.

Environmental management and green practices are related to firm innovativeness [3]. Therefore, green innovation is one way to achieve sustainable development in the manufacturing industry that is in line with increasing environmental awareness among consumers. Green innovation is innovation that is carried out related to environmental aspects (energy-saving, pollution prevention, waste recycling, reduction of resource consumption) to reduce the impact of industrial activities on the environment. Green innovation is a topic that has been widely studied by researchers in recent years. If examined from various literature on innovation, research on green innovation can be broadly grouped into several groups. The first group is the literature that discusses green design, such as the influence

of environmental problems in the R&D process [4]; the influence of market performance on green innovation and the development of new products [5]; influences from consumers and environmental regulations on green product innovation [6]. The second group consists of literature that discusses drivers and barriers to green innovation. This group includes those who discuss internal and external barriers [7] and challenges for green innovation [8]. Third, is a literature group that discusses the impact of green innovation on performance. Included in this group are the literature on how green innovation impacts on the company's competitive advantage [1] and the influence of green innovation on company performance [9, 10, 11, 12]. The last group is the literature that discusses the performance of green innovation, which is related to dynamic capabilities [13]; absorptive capacity [14]; regulatory pressure and customers [15]; and estimation and evaluation of green innovations [16, 17].

Green innovation performance depends not only on existing capabilities but also on how to change these capabilities to build new capabilities. The dynamic capability perspective is one concept that provides a theoretical view to examine the practices of innovation management at the organizational level. Dynamic capabilities allow companies to combine and rearrange resources to respond to environmental challenges. The dynamic capability perspective also explains that dynamic capabilities help companies to sense and capture opportunities and to reconfigure important knowledge at various levels of the organization [18, 19]. In addition, a key factor for achieving sustainable innovation is knowledge [20]. Innovations are often associated with high levels of variation and exploration. This requires new knowledge that is different from existing knowledge and specific combinations of new knowledge [21]. When companies innovate, they not only process information but also create information and knowledge to re-create a new corporate environment. The creation of the company's knowledge becomes important if the company will innovate [22]. Therefore, knowledge management is an important activity for companies especially to be able to innovate and adapt to environmental changes. According to [23], knowledge management also has relevance to dynamic capabilities. This is supported by [24] and [25] which shows that the achievement of dynamic capabilities is influenced by knowledge-based resources. The availability of company knowledge is a requirement for the occurrence of new knowledge flows in the learning process to create dynamic capabilities [26].

Based on the literature, it can be seen that the dynamic capability and ability of the company to absorb knowledge are related to green innovation performance. However, none of the literature has comprehensively discussed how dynamic capabilities and knowledge play a role in green innovation performance. Therefore, this paper will explain a conceptual framework that illustrates how the relationship between a company's ability to acquire and create knowledge, green dynamic capabilities, and green innovation performance.

2. Literature Review

2.1. Green Innovation

Green innovation is also known as eco-innovation or environmental innovation. Eco-innovation, in general, can be defined as innovation for reducing negative impacts on the environment. According to [27], eco-innovation activities can be analyzed based on three dimensions, namely 1) targets, are areas of focus on eco-innovation: products, processes, marketing methods, organizations, and institutions; 2) mechanism, is the way in which changes are made in the target: modification, redesign, alternatives, and creations); and 3) impacts (the impact of eco-innovation on the environment. Green innovation is generally defined as activities related to the development of new products and processes that can reduce negative impacts on the environment [1]. Green innovation is categorized into technology, management functions, product design, and production processes. Green innovations carried out during product life cycle assessments include the process of modifying existing product designs to produce environmentally friendly products. Whereas green innovation in the process is done by

modifying production methods so as to reduce consumption of natural resources, water, and energy, and reduce waste and pollution.

2.2. Green dynamic capability

Dynamic capabilities are needed by companies to adapt to changes in the environment. Dynamic capability is different from organizational capabilities. Dynamic capabilities allow companies to innovate beyond their current routines, while organizational capabilities provide the means to configure organizational resources for company routines [18]. This capability consists of high-level organizational practices that transform organizational and member expertise into products and services. [19] explains that dynamic capability is the ability of companies to reconfigure their competencies both internal and external competencies to deal with environmental changes. In this definition, organizational competence shows managerial and organizational processes or "current patterns of practice and learning". In line with [18], [21] then redefining dynamic capabilities as a corporate process that uses resources to match and even make market changes. This definition describes dynamic capabilities as processes within organizations to integrate and reconfigure resources. Dynamic capabilities are widely regarded as combining processes that enable organizations to maintain superior performance over time [28].

The term green dynamic capability used in this study adapted from [29]. In this case, green dynamic capabilities are defined as the ability of companies to use existing resources and knowledge to renew and create green organizational capabilities. With this capability, the company can change its products and processes to meet the requirements of environmental conditions and adapt to dynamic environmental changes. Dynamic capability consists of sensing capability, seizing capability, and reconfiguring capability.

- Sensing capability is the company's ability to see, interpret, and pursue opportunities related to "green" aspects [13, 19, 28, 30, 31]. Sensing capability describes the intensity of company activities for scanning, search, exploration, and observing green best practices in the same industry.
- Seizing capability is the company's ability to respond to "green" opportunities through new products, processes, or services [19, 28].
- Reconfiguring capability is the ability of companies to carry out sustainable alignment, reorganize, and protect assets (tangible and intangible) to adapt to environmental changes [19, 28].

2.3. Absorptive Capacity

Based on [32], absorptive capacity is defined as the ability of a company that is indicated by a series of routines and processes in the company to acquire, assimilate, transform, and exploit knowledge. Absorptive capacity consists of potential absorptive capacity and realized absorptive capacity [32, 33].

- Potential absorptive capacity is the company's ability to acquire and assimilate knowledge from the external environment. Knowledge acquisition describes the company's ability to carry out activities to identify and obtain external knowledge that is considered important for the company. Assimilation is the company's ability to analyze, process, interpret, and understand the knowledge that has been acquired.
- Realized absorptive capacity describes the ability of companies to utilize external knowledge that has been absorbed. This capability illustrates how companies combine existing knowledge with newly acquired and assimilated knowledge, and how companies develop and improve their competencies by incorporating modified knowledge.

3. Conceptual Framework

The conceptual framework that will be discussed in this paper refers to [13], [14], [34], and [35]. Green innovation is used to improve environmental management performance in terms of meeting environmental protection requirements [1]. Green innovation performance is company's performance derived from innovation in processes and products that pay attention to environmental aspects (energy savings, pollution prevention, waste recycling, green product design, or environmental management) so as to reduce negative impacts on the environment [1, 13, 14, 35]. Green innovation performance consists of green product innovation performance and green process innovation performance [1, 13, 17, 35].

Based on the perspective of dynamic capabilities, companies need dynamic capabilities to adapt to change. The company's dynamic capability is something that can transform resources into performance [24, 36]. Green innovation performance does not only depend on existing capabilities but also the ability to change these capabilities so that the company can build new capabilities. Dynamic capability helps companies to perceive and capture opportunities and to reconfigure important knowledge at various levels of the organization [18, 19]. Dynamic capability is an important mechanism for changing the ability to manage knowledge into performance at the company level. Dynamic capability is the company's ability to create and utilize resources in the company to achieve sustainable competitive advantage [31]. In this case, the company combines individual skills and knowledge, physical and technical resources, structure and culture to stimulate the dynamism of knowledge within the company.

Knowledge is a source of dynamic capability through various activities in the company such as technical training provided to partners, informal information exchange, identification of market information through direct communication between individuals, and systematic collection of information from central companies. The ability to recognize opportunities depends on individual abilities and existing knowledge. Various forms of knowledge, especially when transmitted through social interaction, can act as a source of dynamic capabilities. However, the relationship between organizational knowledge and dynamic capabilities is not always positive and is very dependent on the broader organizational context [23]. The ability to absorb knowledge is also needed for knowledge creation in companies which also influences the company's dynamic capabilities [34]. Referring to [32], absorptive capacity is divided into two namely potential absorptive capacity and realized absorptive capacity. Potential absorptive capacity is the ability of companies to assess and obtain knowledge originating from outside the company (acquisition and assimilation of knowledge), while the realized absorptive capacity is the ability of companies to utilize the knowledge that has been absorbed (transformation and exploitation of knowledge). Potential absorptive capacity and realized absorptive capacity both affect the company's dynamic capabilities. According to [14], the ability to absorb knowledge has a positive effect on the performance of innovation performance both green product innovation and green process innovation.

Based on the literature review described in the previous section, a conceptual framework is developed that illustrates how manufacturing companies can improve their green innovation performance through the company's green dynamic capability. The conceptual framework is illustrated in Figure 1.

4. Methodology

The conceptual framework described in this paper is part of the ongoing research on green innovation performance. The conceptual framework was built based on the literature review and preliminary observations in several manufacturing companies. The next step is to develop the conceptual framework into a conceptual model by identifying research variables and relationships between research variables. Furthermore, the conceptual model will be empirically tested. Data collection will

be carried out by distributing questionnaires to manufacturing companies in Indonesia that have implemented environmental management (such as companies that have obtained ISO 14000 certificates, have followed the PROPER standard assessment). Empirical data testing will be carried out using PLS-SEM. The analysis and validation phase of the research model will be carried out with multi-case studies to obtain a complete and in-depth analysis of how green innovation can be achieved through a green dynamic capability.

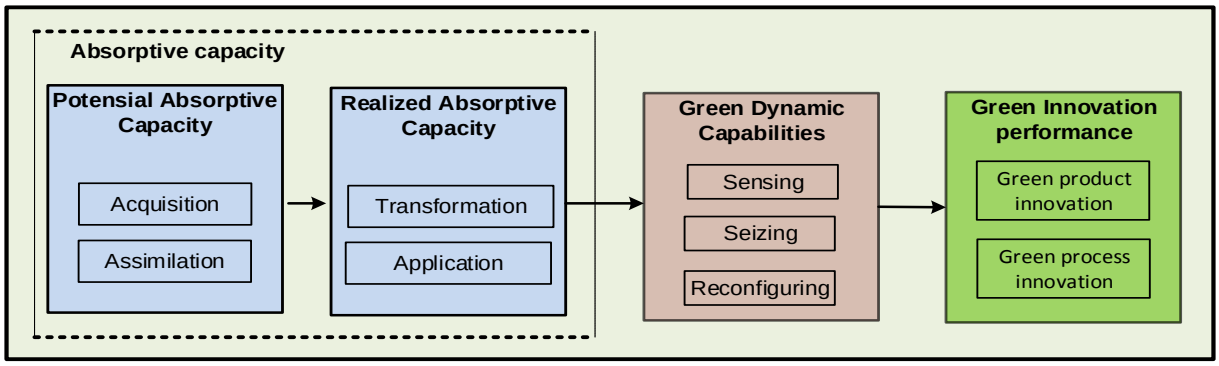


Figure 1. Conceptual framework

5. Conclusion and further study

Based on the conceptual framework that has been built, there are three important aspects that are considered interrelated to achieve green innovation performance, namely the ability to absorb knowledge, the company's dynamic capabilities, and green innovation. This conceptual framework will be developed into a conceptual model by determining research variables and relationships between variables. Data collection with surveys will be conducted to test the model empirically. For this purpose, the development of measurement instruments, data collection and analysis will be carried out. Measuring instruments will be designed by adopting and modifying measurement items from the relevant literature that already exists.

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Green dynamic capability for enhancing green innovations performance in a manufacturing company: a conceptual framework

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Abstract. Green innovation has become a necessity for companies in line with the demands of environmental requirements. Green innovation is the activity of developing a product or process that is carried out by considering environmental aspects (such as energy savings, pollution prevention, waste recycling, reduction of resource consumption) to reduce the impact of industrial activities on the environment. One of the factors associated with green innovation performance is the company's dynamic capabilities. This paper proposes a conceptual framework that illustrates the role of companies' dynamic green capabilities on the performance of green innovation in manufacturing companies in Indonesia.

1. Introduction

The industrialization has become a major driver of economic growth and increased the welfare of countries in the world. On the other hand, industrial activities also contribute to the reduction of natural resources, destruction of ecosystems, and the threat of climate change. Limited natural resources, global warming, waste management, and other environmental issues are challenges for industrial growth. In addition, international environmental regulations, various environmental protection conventions, and increasing environmental awareness of consumers have an impact on the pattern of business competition and how industrial companies conduct their business [1, 2]. This encourages industries throughout the world to increase attention and awareness of environmental issues. Therefore, the company's environmental management plays an important role in business today.

Environmental management and green practices are related to firm innovativeness [3]. Therefore, green innovation is one way to achieve sustainable development in the manufacturing industry that is in line with increasing environmental awareness among consumers. Green innovation is innovation that is carried out related to environmental aspects (energy-saving, pollution prevention, waste recycling, reduction of resource consumption) to reduce the impact of industrial activities on the environment. Green innovation is a topic that has been widely studied by researchers in recent years. If examined from various literature on innovation, research on green innovation can be broadly grouped into several groups. The first group is the literature that discusses green design, such as the influence

of environmental problems in the R&D process [4]; the influence of market performance on green innovation and the development of new products [5]; influences from consumers and environmental regulations on green product innovation [6]. The second group consists of literature that discusses drivers and barriers to green innovation. This group includes those who discuss internal and external barriers [7] and challenges for green innovation [8]. Third, is a literature group that discusses the impact of green innovation on performance. Included in this group are the literature on how green innovation impacts on the company's competitive advantage [1] and the influence of green innovation on company performance [9, 10, 11, 12]. The last group is the literature that discusses the performance of green innovation, which is related to dynamic capabilities [13]; absorptive capacity [14]; regulatory pressure and customers [15]; and estimation and evaluation of green innovations [16, 17].

Green innovation performance depends not only on existing capabilities but also on how to change these capabilities to build new capabilities. The dynamic capability perspective is one concept that provides a theoretical view to examine the practices of innovation management at the organizational level. Dynamic capabilities allow companies to combine and rearrange resources to respond to environmental challenges. The dynamic capability perspective also explains that dynamic capabilities help companies to sense and capture opportunities and to reconfigure important knowledge at various levels of the organization [18, 19]. In addition, a key factor for achieving sustainable innovation is knowledge [20]. Innovations are often associated with high levels of variation and exploration. This requires new knowledge that is different from existing knowledge and specific combinations of new knowledge [21]. When companies innovate, they not only process information but also create information and knowledge to re-create a new corporate environment. The creation of the company's knowledge becomes important if the company will innovate [22]. Therefore, knowledge management is an important activity for companies especially to be able to innovate and adapt to environmental changes. According to [23], knowledge management also has relevance to dynamic capabilities. This is supported by [24] and [25] which shows that the achievement of dynamic capabilities is influenced by knowledge-based resources. The availability of company knowledge is a requirement for the occurrence of new knowledge flows in the learning process to create dynamic capabilities [26].

Based on the literature, it can be seen that the dynamic capability and ability of the company to absorb knowledge are related to green innovation performance. However, none of the literature has comprehensively discussed how dynamic capabilities and knowledge play a role in green innovation performance. Therefore, this paper will explain a conceptual framework that illustrates how the relationship between a company's ability to acquire and create knowledge, green dynamic capabilities, and green innovation performance.

2. Literature Review

2.1. Green Innovation

Green innovation is also known as eco-innovation or environmental innovation. Eco-innovation, in general, can be defined as innovation for reducing negative impacts on the environment. According to [27], eco-innovation activities can be analyzed based on three dimensions, namely 1) targets, are areas of focus on eco-innovation: products, processes, marketing methods, organizations, and institutions; 2) mechanism, is the way in which changes are made in the target: modification, redesign, alternatives, and creations); and 3) impacts (the impact of eco-innovation on the environment. Green innovation is generally defined as activities related to the development of new products and processes that can reduce negative impacts on the environment [1]. Green innovation is categorized into technology, management functions, product design, and production processes. Green innovations carried out during product life cycle assessments include the process of modifying existing product designs to produce environmentally friendly products. Whereas green innovation in the process is done by

modifying production methods so as to reduce consumption of natural resources, water, and energy, and reduce waste and pollution.

2.2. Green dynamic capability

Dynamic capabilities are needed by companies to adapt to changes in the environment. Dynamic capability is different from organizational capabilities. Dynamic capabilities allow companies to innovate beyond their current routines, while organizational capabilities provide the means to configure organizational resources for company routines [18]. This capability consists of high-level organizational practices that transform organizational and member expertise into products and services. [19] explains that dynamic capability is the ability of companies to reconfigure their competencies both internal and external competencies to deal with environmental changes. In this definition, organizational competence shows managerial and organizational processes or "current patterns of practice and learning". In line with [18], [21] then redefining dynamic capabilities as a corporate process that uses resources to match and even make market changes. This definition describes dynamic capabilities as processes within organizations to integrate and reconfigure resources. Dynamic capabilities are widely regarded as combining processes that enable organizations to maintain superior performance over time [28].

The term green dynamic capability used in this study adapted from [29]. In this case, green dynamic capabilities are defined as the ability of companies to use existing resources and knowledge to renew and create green organizational capabilities. With this capability, the company can change its products and processes to meet the requirements of environmental conditions and adapt to dynamic environmental changes. Dynamic capability consists of sensing capability, seizing capability, and reconfiguring capability.

- Sensing capability is the company's ability to see, interpret, and pursue opportunities related to "green" aspects [13, 19, 28, 30, 31]. Sensing capability describes the intensity of company activities for scanning, search, exploration, and observing green best practices in the same industry.
- Seizing capability is the company's ability to respond to "green" opportunities through new products, processes, or services [19, 28].
- Reconfiguring capability is the ability of companies to carry out sustainable alignment, reorganize, and protect assets (tangible and intangible) to adapt to environmental changes [19, 28].

2.3. Absorptive Capacity

Based on [32], absorptive capacity is defined as the ability of a company that is indicated by a series of routines and processes in the company to acquire, assimilate, transform, and exploit knowledge. Absorptive capacity consists of potential absorptive capacity and realized absorptive capacity [32, 33].

- Potential absorptive capacity is the company's ability to acquire and assimilate knowledge from the external environment. Knowledge acquisition describes the company's ability to carry out activities to identify and obtain external knowledge that is considered important for the company. Assimilation is the company's ability to analyze, process, interpret, and understand the knowledge that has been acquired.
- Realized absorptive capacity describes the ability of companies to utilize external knowledge that has been absorbed. This capability illustrates how companies combine existing knowledge with newly acquired and assimilated knowledge, and how companies develop and improve their competencies by incorporating modified knowledge.

3. Conceptual Framework

The conceptual framework that will be discussed in this paper refers to [13], [14], [34], and [35]. Green innovation is used to improve environmental management performance in terms of meeting environmental protection requirements [1]. Green innovation performance is company's performance derived from innovation in processes and products that pay attention to environmental aspects (energy savings, pollution prevention, waste recycling, green product design, or environmental management) so as to reduce negative impacts on the environment [1, 13, 14, 35]. Green innovation performance consists of green product innovation performance and green process innovation performance [1, 13, 17, 35].

Based on the perspective of dynamic capabilities, companies need dynamic capabilities to adapt to change. The company's dynamic capability is something that can transform resources into performance [24, 36]. Green innovation performance does not only depend on existing capabilities but also the ability to change these capabilities so that the company can build new capabilities. Dynamic capability helps companies to perceive and capture opportunities and to reconfigure important knowledge at various levels of the organization [18, 19]. Dynamic capability is an important mechanism for changing the ability to manage knowledge into performance at the company level. Dynamic capability is the company's ability to create and utilize resources in the company to achieve sustainable competitive advantage [31]. In this case, the company combines individual skills and knowledge, physical and technical resources, structure and culture to stimulate the dynamism of knowledge within the company.

Knowledge is a source of dynamic capability through various activities in the company such as technical training provided to partners, informal information exchange, identification of market information through direct communication between individuals, and systematic collection of information from central companies. The ability to recognize opportunities depends on individual abilities and existing knowledge. Various forms of knowledge, especially when transmitted through social interaction, can act as a source of dynamic capabilities. However, the relationship between organizational knowledge and dynamic capabilities is not always positive and is very dependent on the broader organizational context [23]. The ability to absorb knowledge is also needed for knowledge creation in companies which also influences the company's dynamic capabilities [34]. Referring to [32], absorptive capacity is divided into two namely potential absorptive capacity and realized absorptive capacity. Potential absorptive capacity is the ability of companies to assess and obtain knowledge originating from outside the company (acquisition and assimilation of knowledge), while the realized absorptive capacity is the ability of companies to utilize the knowledge that has been absorbed (transformation and exploitation of knowledge). Potential absorptive capacity and realized absorptive capacity both affect the company's dynamic capabilities. According to [14], the ability to absorb knowledge has a positive effect on the performance of innovation performance both green product innovation and green process innovation.

Based on the literature review described in the previous section, a conceptual framework is developed that illustrates how manufacturing companies can improve their green innovation performance through the company's green dynamic capability. The conceptual framework is illustrated in Figure 1.

4. Methodology

The conceptual framework described in this paper is part of the ongoing research on green innovation performance. The conceptual framework was built based on the literature review and preliminary observations in several manufacturing companies. The next step is to develop the conceptual framework into a conceptual model by identifying research variables and relationships between research variables. Furthermore, the conceptual model will be empirically tested. Data collection will

be carried out by distributing questionnaires to manufacturing companies in Indonesia that have implemented environmental management (such as companies that have obtained ISO 14000 certificates, have followed the PROPER standard assessment). Empirical data testing will be carried out using PLS-SEM. The analysis and validation phase of the research model will be carried out with multi-case studies to obtain a complete and in-depth analysis of how green innovation can be achieved through a green dynamic capability.

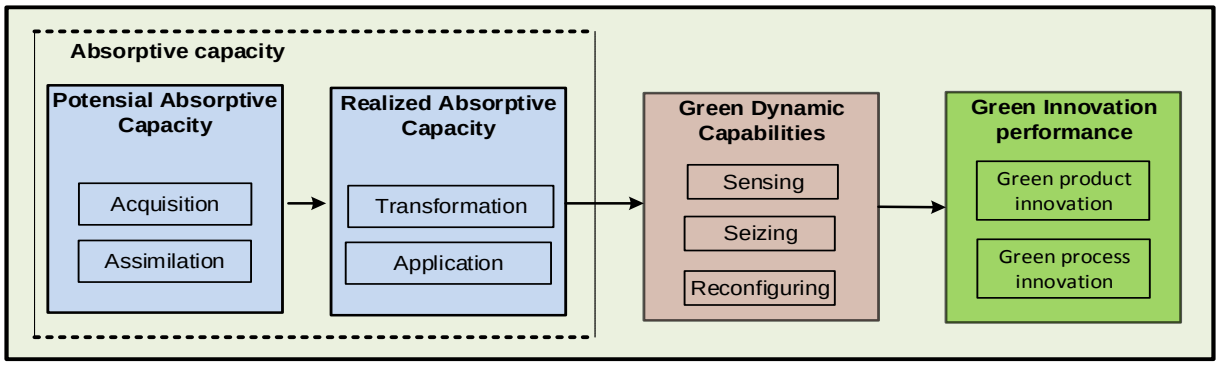


Figure 1. Conceptual framework

5. Conclusion and further study

Based on the conceptual framework that has been built, there are three important aspects that are considered interrelated to achieve green innovation performance, namely the ability to absorb knowledge, the company's dynamic capabilities, and green innovation. This conceptual framework will be developed into a conceptual model by determining research variables and relationships between variables. Data collection with surveys will be conducted to test the model empirically. For this purpose, the development of measurement instruments, data collection and analysis will be carried out. Measuring instruments will be designed by adopting and modifying measurement items from the relevant literature that already exists.

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Kansei engineering application in redesigning Carica packaging to support local-small industry in Central Java

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Abstract Packaging is one of the important elements in product sales. Packaging is one form of branding business of a business party. This study was conducted to apply the principles of Kansei Engineering to packaging products of Carica, one of the MSMEs in Wonosobo. This research was conducted to find out what kind of design desired by consumers of Carica products so as to encourage them to make purchases of these products. The method used is the Kansei Engineering method which will then be collaborated with the Kano model method and conjoint analysis. Kansei Engineering will help this research in determining what aspects consumers want to feel when they buy a Carica product. After that, using the Kano model principle, will be determined categories from each aspect that consumers feel into several parts, namely basic attributes, linear attributes, attractive attributes, and non-significant attributes. Aspects included in the non-significant attribute category are considered not suitable to be used as a new design concept of carica packaging. Finally, the packaging aspects that consumers want to feel when buying these products will be linked to the new design using conjoint analysis. This research concludes that the new packaging will be square and made of glass and has a label that has a fruit picture and has an orange theme.

1. Introduction

Carica sweets are one of the most famous from Wonosobo, Central Java, Indonesia. The fruit *Vasconcellea Cundinamarcencis* generally grows around the hills which have a fairly cold climate. Nowadays, carica sweets are even sold online, showing that the businesses are in the promising development phase. MSME Embun Pagi is one of more than 200 carica sweets confectionery industries in Wonosobo, which has been producing since 2016. To compete with other similar businesses, MSME Embun Pagi requires a good and distinctive image of the product. Currently, Embun Pagi packages carica sweets in a 7.5 cm diameter and 4 cm height plastic cup. It is also equipped with yellow color label, which was designed around two years ago. The packaging costs IDR1,750 today. **Figure 1** shows the existing packaging.



Figure 1. Existing packaging of Carica sweets of MSME Embun Pagi

Packaging means the results of packaging to protect the merchandise. It is a science, art and technology that aims to protect a product when it will be sent, stored or sold or it can also be a production process that aims to package. In the past people said, "packaging protects what is sold", but now it turns into "packaging selling what is protected" (Kertajaya, 1996). Based on this, it can be understood that packaging, nowadays, must also have an attraction so that consumers are interested in buying products (Kotler, 2003). Also packaging functions as the first communication medium between products produced by producers and consumers to display the image of the product itself. The current packaging of carica sweets in MSME Embun Pagi does not yet represent the company's identity and urgently need new packaging so that it looks more attractive. Therefore, attractive packaging design is needed in accordance with consumer affective and can protect the product itself.

Kansei Engineering has a goal of getting consumers' desires through feelings felt by consumers. When a consumer wants a product or service, the consumer's sensory needs will appear like elegant, cheap, unique, etc. That sensory need is a Kansei. From this, Kansei can be interpreted as a psychological and physiological sense of consumers of the desired product or service (Nagamachi & Lokman, 2008). Through Kansei words obtained from various sources, the Kansei concept collects consumer feelings and turns them into product design specifications. Concerning customer satisfaction, Kano Model can also help product designers to get products that are in accordance with the customer's desires.

Therefore, this study aims to design carica sweets packaging that is able to show the identity of the product, increase consumer buying interest in the product, and protect the product so that the quality reaches consumers. The packaging design was carried out based on the assessment of the aspects needed by a consumer. As well, this research combined Kansei engineering with Kano model concept in order to produce aspects that are truly important and needed by packaging.

2. Methodology

Research was conducted in observatory method using two types of questionnaire, each of them for container and label of the packaging. A number of 104 people were voluntarily involved as participants. Data were collected via online questionnaires.

The preliminary stage was an open question to gain the Kansei words. Related Kansei words were also determined from previous studies in product design. Then the first questionnaire was distributed to assess any aspects that participants want when interacting with carica sweets products. Participants were asked to rate packaging design according to each Kansei words by selecting one of five points of Likert-like scale. This scale was applied to quantify their impressions and feelings towards the design of carica packaging in general. This process was used as input to the second questionnaire.

In the second questionnaire, the packaging was divided into two parts, namely the container section and the label section. In the container section, the idea of packaging design elements was divided into ideas of shape, size, and material. While in the label section, it was divided into colors and illustrated images. Furthermore, Kansei words mapping was conducted with the Kano model diagram. At this stage each aspect of packaging will be obtained using the Kano concept so that it divides the packaging aspects

into four categories, i.e. basic attributes, linear attribute, attractive attributes, and non-significant attributes. The non-significant category was discarded because it was considered to have no effect on the changes of the packaging. The final step was to design a packaging design proposal. It was carried out using analysis to determine the relationship between Kansei words and packaging design elements, so that the combination of packaging design elements desired by consumers were well explained.

3. Result and Discussion

3.1 Consumer Identification

In conducting product design research, it is necessary to know who the users of the product are so that they can know the user needs of the product. After conducting interviews with MSME owners, there was no focus on the market for the sweet carica products of the MSMEs or users specifically for the sweet carica products of these MSMEs. However, by knowing carica sweets products are a typical souvenir product, it can be assumed that the product will be purchased by consumers who are likely not domiciled in the area.

Travelers from outside Wonosobo are the main target of the carica sweets market. For consumers who are new to the product, carica sweet products are expected to have something interesting and can convince consumers to make purchases. Consumers can only buy products directly in stores in Wonosobo or buy them from outside the area. Thus, the product is expected to have simple, easy to carry, easy to store, practical and lightweight.

3.2 Kansei Words Collection

The first step in this research is data collection in the form of Kansei words. At this stage, the data collected comes from two sources. The first source was taken from references on packaging product development and the second source was taken through a questionnaire distributed to participants regarding their feelings about carica packaging products. Twenty-eight Kansei Words had been collected as follows: unique, portable, easy to store, have product image, reusable, luxurious, single-use, interesting, easy to remember, easy to open, informative, convincing, tight, tough, transparent, simple, safe, limited edition, ecofriendly, hygienic, ergonomic, practical, durable, up-to-date, brightly colored, plain, lightweight, and economic.

3.3 First Questionnaire

After collecting the data of each Kansei words in Likert-like scale, validity tests were conducted. With 4 times repetitions, 15 Kansei words were passed the validity tests. In reliability test with Cronbach's Alpha, all data were concluded as reliable and can be further analyzed.

3.4 Generate Design Idea

By paying attention to consumer needs for products that have been described before such as interesting, portable, easy to store, practical, simple, lightweight and convincing, this research will choose products that can translate the needs of these consumers. By benchmarking to the similar products on the market, the design elements of container were divided into three parts, namely material, shape, and size. In the materials section, the sample design elements were divided into glass and plastic, with regard to consumer needs for safe packaging, plastic materials are chosen rather than glass-based packaging. Aside from being an alternative container material, the selection of glass materials also refers to consumer needs for unique packaging. In the shape section, the sample design elements were divided into balls, boxes, and tubes. The selection of tubes and boxes was based on consumer needs for portable and easily stored packaging, that makes it easier for producers and consumers in the process of moving products from one place to another. The shape of the tubes and boxes can also be used so that the products stored in containers or shipping boxes use space as much as possible. Apart from being an alternative, the ball shape can fill consumers' needs for uniqueness. The size section is divided into small and large. The size used in this study is

relatively small, so it is lightweight, simple, easy to store, and portable. Figure 1 shows the container samples.

In the label section, the design element was divided into two parts, which were color and image. In the color section, the sample design elements were divided into yellow and orange, which will generalize the selection of products from male and female consumers of color. These colors can also symbolize the color of the carica fruit itself as the basic ingredient of carica sweets product. In the form section, the sample design elements were divided into fruit, mountain, and plain. The selection of three alternative images in this study was considered very simple because the images selected as samples were directly related to the product. Examples of choosing images of carica and mountain fruits symbolize the fruit shape and origin of carica itself, while the selection of a plain image as an alternative image was based on plain Kansei word. Figure 2 comprises the samples of label.

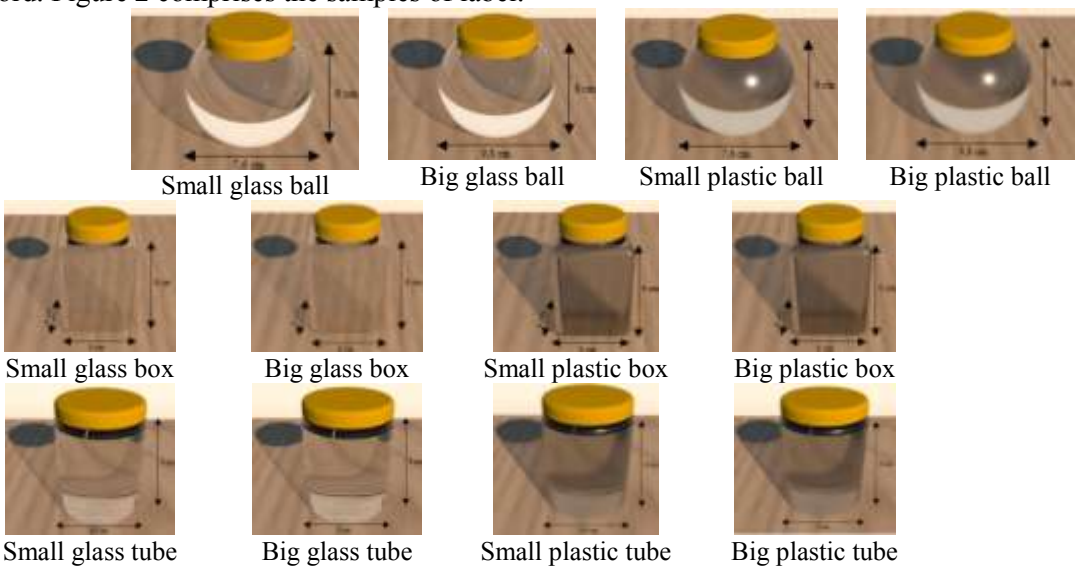


Figure 1. Research samples of container

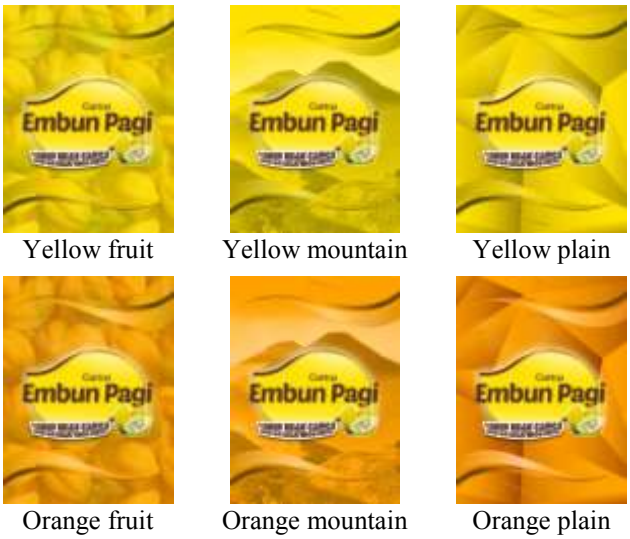


Figure 2. Research samples of label

3.5 Second Questionnaire

In the container there are eleven Kansei words, i.e. unique, portable, easy to store, easy to open, single-use, safe, practical, durable, easy to remember, tight and lightweight. For the label section, there were six Kansei words, i.e. unique, have product images, easy to remember, informative, bright and plain colors. In addition, there are additional questions in this second questionnaire, whether the participants saw the container or label as good or not.

3.6 Kano Model Mapping

The data needed in mapping the Kano model in both the container section and label section are, among others, the average value of each Kansei Words in the first questionnaire, and the second questionnaire data. As for this stage, there are also two categories that indicate the tendency of an attribute to appear according to the participants called the positive category. Vice versa, the negative category was the category that shows the tendency of an attribute to be eliminated according to the participants.

To find out the Kansei words section of the container, the average Kansei words section of the container was obtained by summing all the values given by participants to Kansei words and dividing by the number of participants. This value will determine which data from the second questionnaire was included in the positive or negative category. After the previous stage was complete, then the next step is to find the correlation value of each Kansei words to its global evaluation. Each correlation value for all Kansei words either positive or negative will be the source of making the Kano model in the cartesian graph in the final stage. The ordinate was derived from the Kansei words correlation value for the positive global evaluation, and the abscissa was derived from the Kansei words correlation value for evaluation the global category was negative, and the center of the graph was sourced from both averages. Finally, Kano display models can be made in the form of diagrams for parts of containers and labels that can be seen in figure 2 and figure 3. The results of mapping Kano Model were Kansei words which were categorized as insignificant attributes, that were portable and easy to remember for the container, and easy to remember for the label. For Kansei words that are not included in the category of attributes that are not significant, they will still be used at the next stage in this research because Kansei words was stated to have a value that consumers consider in choosing this product.

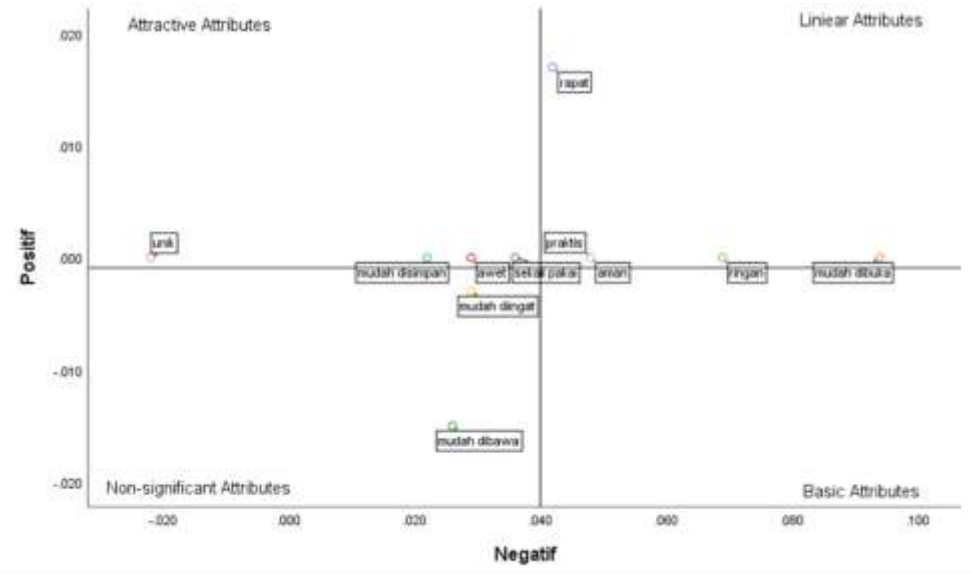


Figure 3. Kano diagram of container

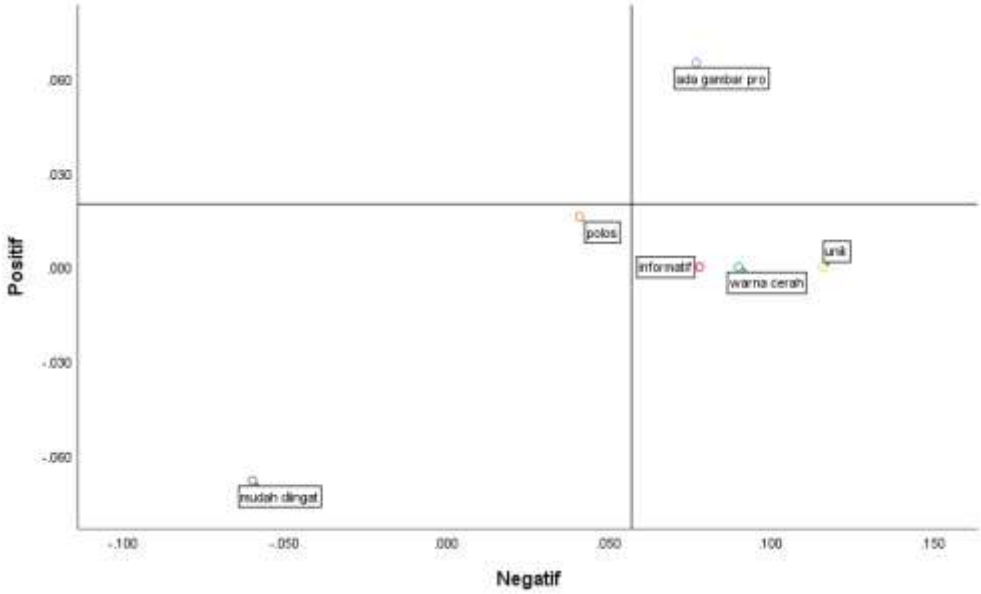


Figure 4. Kano diagram of label

3.7 Conjoint Analysis

Conjoint analysis was used to determine the relationship between design elements and Kansei word according to the results of the second questionnaire. The input data used to carry out this conjoint analysis was the average Kansei word data in each design in the second questionnaire. Later on, from the utility of container and label, we can choose the largest utility value of each item for each Kansei words. The overall selected packaging design elements were then determined by the category mode chosen in Kansei words. In other words, the category that appears most often will be the category in the overall selected

item. Based on that process, container design elements and selected labels have the following characteristics: a small glass box container and orange fruit label, as shown in figure 5.



Figure 5. Selected design combination

MSME Embun Pagi was then recommended to change the packaging of the product into a small glass box and labeled with an image of carica fruit in it with an orange theme color. Additional costs were needed to change the product packaging now. However, MSMEs should make this research recommendation as their business investment through engineering their products in the packaging field. This is supported by various studies listed in the book on consumer behavior by Dickson and Sawyer (1986), where it is said that packaging is an important aspect that is directly felt by consumers when interacting with a product, not to mention carica products in these MSMEs.

4. Conclusion

A new design of carica sweets packaging was proposed to involve the emotion aspects of consumer: a small glass box container and orange label with pictures of carica fruits on it. As the packaging is an important aspect of a product, the new design was hoping to gain more attention of the prospective customers, as it is easy to open, safe, practical, tight, lightweight, unique, easy to store, single-use, durable, and have product pictures on it.

Acknowledgement

Authors thank to MSME Embun Pagi as the study object. This research was financially supported by The Faculty of Engineering, Diponegoro University, Indonesia through Strategic Research Grant 2019.

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Organic-inorganic nanocomposite membranes for molecular separation and bioapplications

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Abstract. Novel porous materials like metal organic frameworks have shown good promise in catalysis, separation, sensing and adsorption. Compared with the conventional polymeric membranes, metal organic framework membranes usually exhibit higher separation efficiency. However, there are still many challenges need to be addressed, like the interfacial compatibility within the mixed matrix membrane, defective engineering and stability of the framework stability. We will discuss our strategies to solve these problems towards better membranes. On top of the conventional separation membranes, metal organic framework materials can be applied to construct the artificial cellular membranes for bioentities and even living cells. The porous crystal provides exoskeleton to protect the soft biomolecules and their combination can enable a series bioapplications like catalysis, drug delivery and drug release.

1. Introduction

Metal organic framework materials have been recognized as one of the most promising candidates for separation and energy applications. It has a large surface area, controllable porous structure and chemical properties, and surface functionalization capability. Currently, the total structure of metal organic framework materials has reached over 60,000 of different types. However, its application, especially as a separation device, is still limited due to its difficulty in assembly into practical devices without introducing extra defects, which is extremely important for the membrane separation process as the presence of any defects can impose significant negative effect on the separation efficiency. The selectivity can be compromised by the microdefects on the membrane. In this contribution, we would like to introduce some of our recent contribution in this line of research, by regulating the interfacial compatibility between metal organic frameworks and polymeric, continuous supports, to fabricate better membrane devices toward their potential application in water treatment, gas separation, and energy-related applications.[1,2]

2. Compositing Zeolite Imidazolate Framework-8 with polymeric supports

Zeolite imidazolate framework is usually constructed by the Zn, Co metal ions, interconnected by imidazolate ligands. The framework structure is very similar to that of the inorganic silica-based porous zeolite material. The pore size of the zeolite imidazolate framework can be regulated at the size range of gas molecules, e.g. CO_2 and N_2, thus it has been regarded as a promising candidate for molecular separation for gaseous mixtures. One of the early attempts from us, is to blend one type of zeolite imidazolate framework (ZIF-8) with the polymeric support (Figure 1),[3,4] and the resultant membranes were tested for CO_2 and N_2 separation. Though the loss of selectivity was observed after

the incorporation of ZIF-8 (i.e. the membrane has the lower capability to separate CO_2 from N_2), the membrane exhibited a significantly improved permeance (gas flow rate). In addition, one of the common problems for the polymeric membrane is its instability under the industrial-related operational conditions, like high temperature and elevated pressure. The inherent flexible, porous polymeric chain can experience compaction and rigidification, leading to the loss of separation efficiency. What we discovered through our research is that due to the satisfactory interfacial compatibility between ZIF-8 nanocrystals and their surrounding polymeric matrix, the formed hydrogen and pi-pi interaction can help stabilize the polymeric membrane structure, even at challenging operational conditions.

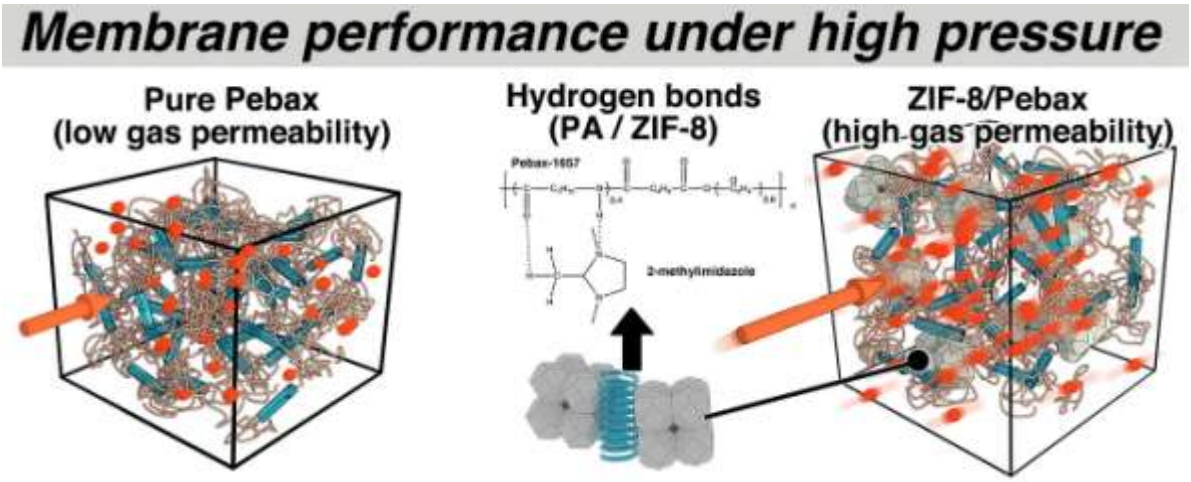


Figure 1. Schematic diagram of the ZIF-8/polymer mixed matrix membrane, and the mechanism of their improved operational stability under an elevated pressure condition.[3]

Since the presence of high porosity of the ZIF-8 nanocrystals, it is ideal to assembly the nanocrystal to form a coherent, continuous film to realize efficient separation. However, the as-synthesized ZIF-8 materials are usually in the form of discrete powder form, and it is difficult to assemble it into practical devices: the processability of the nanocrystal is low, as it does not dissolve in solvents without compromising its porous structure. Recent advance in metal organic framework hot pressing can be inapplicable for membrane fabrication as well due to the difficult to form a thin layer for separation. Ideally, a coherent film can be formed via *in-situ* heterogeneous crystallization and crystal growth of ZIF-8 of top of polymeric support. However, due to the limited compatibility between the crystal phase and polymeric phase, the heterogeneous nucleation efficiency can be limited, restricting the formation of a high-quality film. We proposed a concept to solve this problem, by introducing an interfacial mediate layer, composed of TiO_2 nanoparticles, to promote the growth and formation of ZIF-8 on a polymeric support. The polymeric porous support was firstly coated with a layer of nano-sized TiO_2 nanoparticles, followed by surface functionalization of amine groups to promote the heterogeneous nucleation of ZIF-8. The fabricated composite membrane has a thickness of 400 nm for the ZIF-8 layer, with its good alignment of the crystal structure with the pristine ZIF-8 powder (as suggested by the powder XRD results). Then the coherent, macroscope defect-free ZIF-8 layer showed satisfactory molecular sieving behaviour, exhibiting highly efficient H_2 and CO_2 separation efficiency. The practical membrane performance has good agreement with the theoretical estimations of the pure ZIF-8 layer, suggesting the separation is achieved via the ZIF-8 layer.[5]

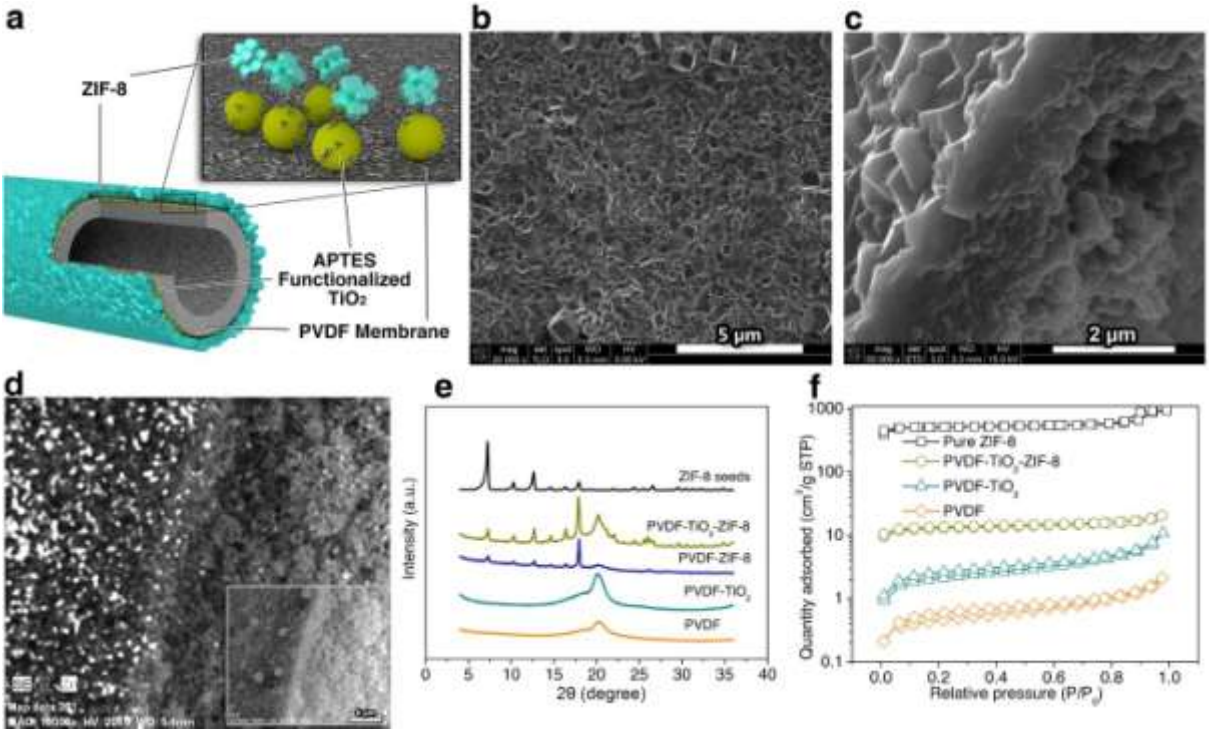


Figure 2. Formation of the coherent ZIF-8 coating layer on polymeric membrane surface. (a) Structure of the composite membrane, composed of polymeric PVDF support, surface coated TiO_2 layer and ZIF-8 top coating layer. (b-c) Surface and cross-sectional SEM image for the ZIF-8 membranes. (d) Elemental mapping results of the composite membranes, showing the presence of Zn elements on the ZIF-8 layer. (e-f) Crystal structure analysis and gas adsorption profiles of the membranes subject to different treatment.[5]

3. Interfacial engineering to improve the membrane performance

As stated above, the presence of micro defects for membrane can lead to the loss of separation efficiency. However, the defect engineering for metal organic frameworks has been attracting increasing attention as it can induce extra functions for the materials. For example, the loss of metal ion or organic ligands can generate under-coordinated metal clusters, which further promote the catalytic efficiency and adsorptive capacity. In order to incorporate the defective yet functional metal organic framework materials into the membrane, we specifically engineered a type of topologically engineered metal organic framework material, with the presence of surface mesoporous structures, on top of the inherent microporous framework (Figure 3). The resultant materials exhibited a significantly improved water uptake from brine, showing good potential as pervaporation desalination membranes. After subsequent blending of the engineered crystal into substrates, we managed to fabricate a series of composite membranes, showing an improved brine desalination performance: compared with benchmark counterparts, the composite pervaporation membrane exhibits a nearly 100 % improvement in terms of the water productivity, and it maintained nearly 100 % rejection of the salts. This membrane technology has been considered one of the most promising candidates for challenging brine (e.g. 300 g/L NaCl solution) treatment (Figure 4).

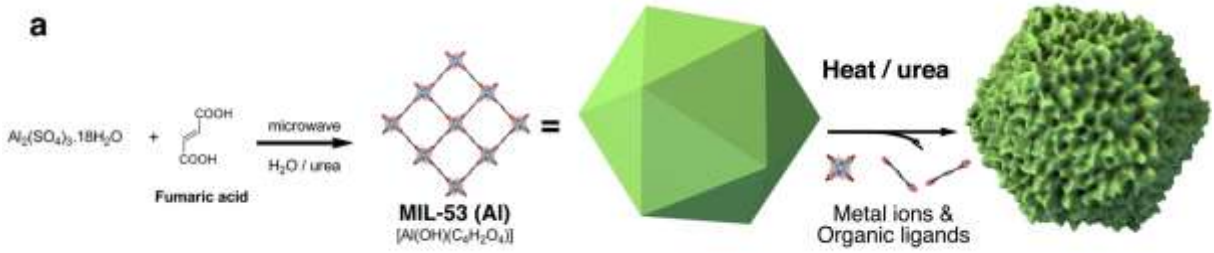


Figure 3. The fabrication of surface engineered metal organic framework materials with mesoporous structure.[6]

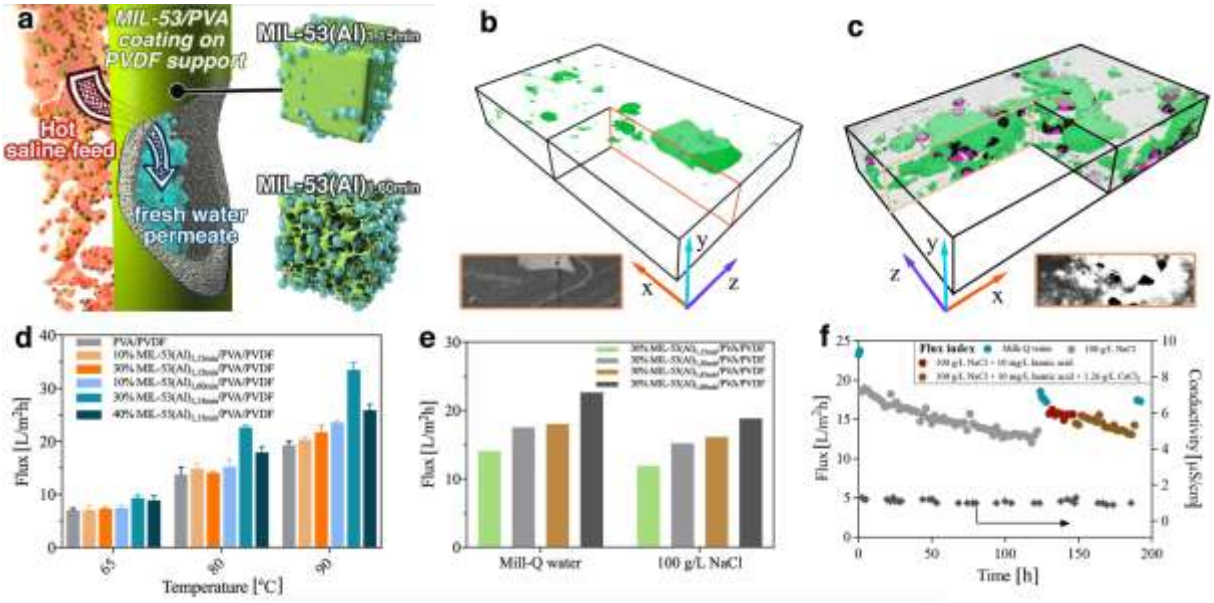


Figure 4. Nanocomposite membrane with surface engineered defective crystals for pervaporation desalination. (a) Schematic diagram of the composite membrane containing defective crystals. (b-c) FIB-SEM image of the composite membrane containing original and defective crystal materials. (d) Water productivity for the pervaporation membrane flux. (e) Membrane operational flux with milli-Q water and salty water. (f) Membrane long term operational flux with challenging brine as feed.[6]

4. Conclusion

The development of material science provides numerous opportunities enabling the development of nanocomposite materials to realize advanced functions. This contribution summarizes the recent progress in this line of research in our group, through which we hope to shed light on the future development of a metal organic framework based nanocomposite membranes, and the development of the crystal materials at the same time.

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Fluazinam potential as a fungicide in liquid culture system for the growth of *Haematococcus pluvialis* microalgae

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Abstract. Across all biological system, fungal infection in freshwater systems are well known to obstruct the aquatic biomass population such as microalgae. However, there is a lack of extensive information on the suitable technique to control them. The aim of this research is to assess the effects of the fungicide fluazinam as a single dose treatment on the *Haematococcus pluvialis* growth rate and the presence of chytrids fungus in liquid culture system. The variables used in this experiment were the concentration of fluazinam given to the culture (i.e. 0.25; 0.5; 0.75; 1; 1.25 ppm) as a single dose treatment. The growth performance of *H. pluvialis* was observed in 6 days consecutively based on cell density by a single direct absorbance measurement and cell counting by haemocytometer. The best growth was achieved in a culture system which was given fluazinam at a concentration of 0.5 ppm (started from 1.0 x 10^5 cells/mL to 5.5 x 10^5 cells mL^{-1} at the 5th day). And no chytrids fungus are found in the culture system either. So, in conclusion, the use of fluazinam is a promising treatment for removing contaminants that inhibit *H. pluvialis* growth.

1. Introduction

More than 7000 species of green microalgae are found growing in a variety of habitats. One of them is *Haematococcus pluvialis* which becomes a commercial interest due to its ability to produce the highest level among all known astaxanthin producing organisms. It may reach up to 5 % dry weight in the encysted aplanospore state [1] and can reach 95% of the total carotenoids [2].

Astaxanthin (3,3′-dihydroxy-ß-carotene-4,4′-dione) is a bright red secondary carotenoid from the same family as lycopene, lutein, and ß-carotene, synthesized by some microalgae, plants, yeast [3]. Astaxanthin has a wide range of applications in the food, feed, cosmetic, aquaculture, nutraceutical, and pharmaceutical industries because of its free radical scavenging capacity [4]. The natural astaxanthin exhibited higher bioactivity as compared to the synthesized astaxanthin [5, 6]. In general, astaxanthin is produced by Haematococcusis through a two-stage culture: vegetative (green) and aplanospore (red) stages [7, 8]. At first stage cultivation, *H. pluvialis* cells are green and vegetative under favourable environmental conditions (i.e. nitrogen sources, light intensities, aeration rates, temperature and

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nutrients), and once subjected to stress conditions like high light, cells begin to synthesize and accumulate astaxanthin, transforming green vegetative stage to red aplanospores [9].

Due to complex life-cycle of *H.pluvialis* it is important to maximise cell densities of alga at "green stage" of cultivation by maximizing cell growth to obtain a high biomass with high astaxanthin yield from the "red stage" [10]. However, vegetative cultivation of Haematococcus is the most problematic part due to the susceptibility to contamination which results in slow growth rate or low cell concentration. Fungal contamination by chytrids has been recognized as one of the most serious hurdles for producing astaxanthin from the green algae *H. pluvialis* [11]. Moreover, the process of culturing a small volume *H. pluvialis* culture through the green swimmer stage to a large volume in the red cyst stage may take weeks due to the cultivation of Haematococcus involves growing, dividing, and accumulating carotenoids [12]. During this time period the *H. pluvialis* cells are vulnerable to weakening of the physical integrity of the cells (e.g., lysis) and to attacks by contamination which reduce the chances of *H. pluvialis* survival in both the green swimmer and red cyst stages [13].

Fluazinam is known as a fungicide with broad spectrum activities which was commercialized since early 1990's. The good characteristics of this fungicide are control every stage of fungal life cycle, multi-site action and no cross-resistance to other fungicides, besides safe to beneficial. Its chemical structure can be seen in figure 1 and its IUPAC name is 3-Chloro-N-(3-chloro-5-tri fluoromethyl-2-pyridyl)-α,α,α-tri fluoro-2,6-dinitro-p-toluidine.

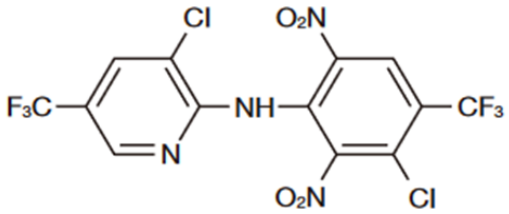


Figure 1. Fluazinam – phenil pyridinamin

The species sensitivity of freshwater organisms such as invertebrates and algae to fluazinam has been assessed by van Wijngaarden et al. [14] and showed a good result. It has been tested as well in liquid culture systems for the growth of microalgae [15] combined with other fungicide. But until now it is hardly to found research on the application of fluazinam as a single dose treatment. Therefore, the goal of this research is to study the application of fluazinam as a single dose treatment on the *Haematococcus pluvialis* growth rate and the presence of chytrids fungus in liquid culture system.

2. Materials and Method

2.1. Materials and Culture Conditions

Haematococcus pluvialis UTEX Collection Strain 2505 was obtained from Algae Analytics, US, and has been cultivated for 1 (one year) in our laboratory. During that time, the inoculum was contaminated. Whereas fluazinam (Nando 500 SC) with active ingredient 500g/L was purchased from Nufarm, Indonesia. The stock cultures were grown photoautotrophically in Modified Bolds 1N-3P medium without soilwater, vitamin B12, and biotin (only thiamine 0.1 mg/L). The culture cell concentration was 1 x 10^5 cells/mL when 200mL *H.pluvialis* starter cultures was carried out into 250 mL erlenmeyer flask. The cultures were illuminated with white-blue LED lamps at light intensity of 3200 lux with dark: light cycle was 10:14 hours. The cells were grown in batch cultures and aerated at 0.2 L/min. under the temperature of environment at 25.7±1^{0}C without any additional CO_2 (see figure 2 below).

2.2. Investigating the Effect of Fluazinam

Five different concentration of fluazinam (i.e. 0.25; 0.5; 0.75; 1; and 1.25 ppm) were given to the contaminated culture (initial cell numbers of 1 x 10^5 cells/mL) as a single dose. The contaminated culture

grown in the absence of fluazinam was used as a comparison. Culture density and cells number were monitored in 6 days consecutively.

2.3. The Growth Rate Measurement



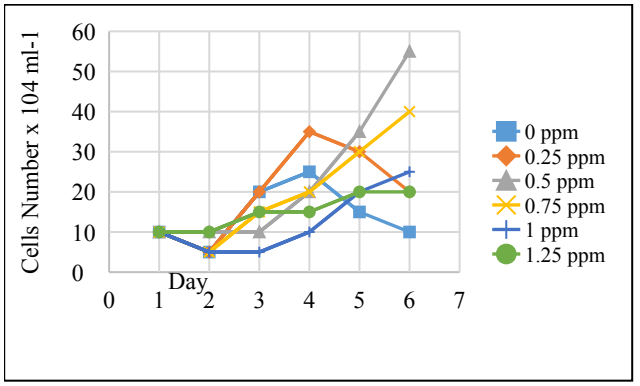
Figure 2. Set up of the experiments

The optical density was measured using spectrophotometer UV-6100PC Double Beam (Mapada, Shanghai, China). The absorption peak of green *H. pluvialis* cells was obtained at 680 nm. Cells number was quantified using an improved Neubauer haemocytometer (Marienfeld Superior, Lauda-Königshofen, Germany) at 400x magnification with binocular microscope (Olympus, Tokyo, Japan).

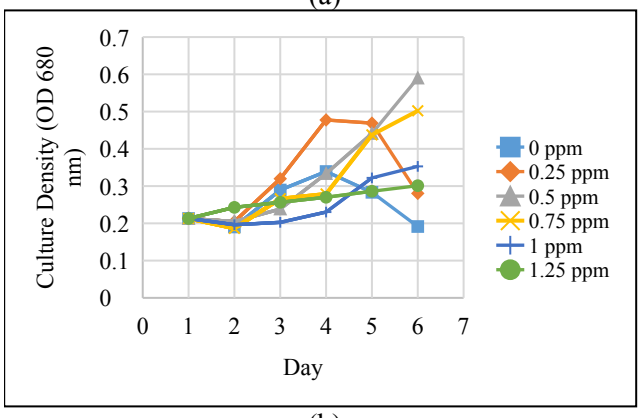
The mean growth rate (μ) was calculated on cell number basis according to the equation 1:

, where X_1 and X_2 in the equation represent the cell number at the times t_1 and t_2, respectively.

3. Results and Discussion



(a)



(b)

Figure 3. The Growth of *H. pluvialis* during treated by various concentrations of fluazinam (a) based on cell number (b) based on culture density

The presence of fungus in liquid culture medium is not just a significant biological problem but furthermore is an economic challenge to the commercial cultivation of algae in industrial scale [16]. Han et.al [3] indicated that the fungal contamination by chytrids has been recognized as one of the most serious hurdles for producing astaxanthin from the green algae *Haematococcus pluvialis*. By applying fluazinam into the medium it was expected that the presence of fungus would be reduced. But as fungicide action has a side effects on nonfungal microorganisms as well, therefore, it might affect the *H. pluvialis* growth rate [17]. It can be seen from figure 3, although the cell density (≈ optical density of the cell) represents the absorbance of both living and dead cells, whereas the cell number only measures the living cells, both of the graphs illustrate a same pattern.

3.1. The Effect of Fluazinam on the Growth Rate of H. pluvialis

From figure 3 can be seen that *H. pluvialis* in all culture after being treated by fluazinam at the first day, did not grow, even some of the cell died especially at the culture

with high concentration of fluazinam. The cells number of *H. pluvialis* in a contaminated culture in the absence of fluazinam and in the presence of 0.25 ppm fluazinam just really collapsed at the 4th day. These were mostly likely due to the lack of nutrients source for the de novo protein biosynthesis of microalgae as filamentous fungus wrapped and bound from one to another alga. Whereas, for the contaminated culture in the presence of 0.5 ppm or higher concentrations of fluazinam the cells number were still increasing at the 4th day and so forth.

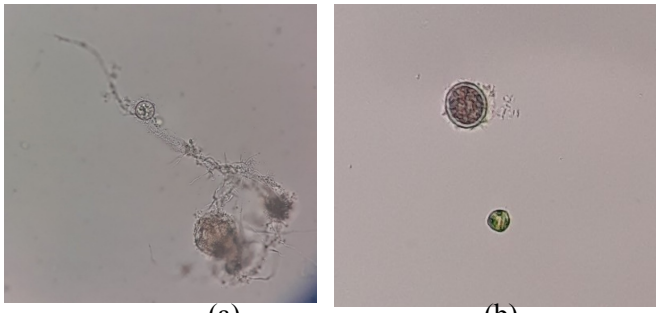
At the 6th day, the culture in the presence of 0.5 ppm of fluazinam resulted the highest cells number (5.5 x10^{5} cells mL^{-1}), it was about 5 times from the initial number. The cell number in the culture with 0.75 and 1 ppm of fluazinam resulted 4 x10^{5} cells mL^{-1} and 2.5 x10^{5} cells mL^{-1} respectively. They had similar trend when viewed from the culture density side. The culture with fluazinam at a concentration of 0.5 ppm resulted microalgae density at 0.59 ODU which was about 3 times the density of microalgae grown in the absence of fluazinam. It was also observed that the culture with fluazinam at concentration 0.5ppm, 0.75 ppm and 1 ppm were still growing at the 6th day.

The culture grown in 1.25 ppm of fluazinam had the same number of cells (2x10^{5} cells mL^{-1}) on 4th and 5th day. However, there was a slight increase in culture density between 4 and 5 days of the culture grown in 1.25 ppm of fluazinam. That might happen because the cell density represents both living and dead cells as explained above. It means the rate of cell reproduced and collapsed were almost similar at that time.

This shows that the higher concentration of fluazinam might cause a decrease in microalgae growth. However, an effective concentration of fungicide may cause a decrease in microalgae growth but causes a greater reduction in the growth of a chytrid as well. Many of the fungicides used in agriculture inhibit respiration, and many are effective against a wide range of plant-pathogenic fungi. Fluazinam belongs to the secondary amine group, is cited as an uncoupler of oxidative phosphorylation, this compound inhibits reactions most likely on some proton-coupled uptake process necessary for fermentative growth within the cell [18]. Whereas some fungicides affect fungal respiration at the level of the enzyme complex system, other fungicides may impact respiration through other targets. Fluazinam sparks very unusual uncoupling activity in target cells. The metabolic state of their mitochondria was found to be inhibited after exposure to fluazinam. Consequently, ATP production is inhibited and downstream cellular metabolisms is interrupted [17]. Low concentrations of the uncoupler fluazinam inhibited conidial germination and germ tube elongation in fungus [19].

The culture with 0.5 ppm fluazinam gave the maximum growth rate (on cell basis) of *H. pluvialis* with the value 0.568 day^{-1} starting at the 4th day. Whereas before the 4th day, the culture without fluazinam and treated by 0.25 ppm of fluazinam supported the high growth rate of *H. pluvialis* (i.e. 0.805 day^{-1} and 0.973 day^{-1}). This condition is in line with the observation by some researchers, instead of killing fungi, fluazinam also inhibits the growth rate of H. pluvialis by weakening cell walls [17].

After the 4th day, the cell number of *H. pluvialis* in the system with 0.25 ppm fluazinam and without fluazinam collapsed. This showed that the development of contaminants are more dominant than the cell resistance.



(a) (b)

Figure 4. *H. pluvialis* cells that collapsed because of fungus (a) in the absence of fluazinam and (b) in culture with 0.25 ppm of fluazinam at the 5th day

3.2. The Effect of Fluazinam on the Fungus

Figure 4 (a) shows H. pluvialis cells that collapsed because of fungus in the absence of fluazinam at the 5th day whereas figure 4 (b) shows the dead and living cells of H. pluvialis in 0.25 ppm of fluazinam at the 5th day.Different microalgae may have different ranges of toxicity that be determined by the growth of a microalga in the presence of a certain concentrations of a fungicide. An effective concentration of a fungicide should be not toxic to the microalgae being cultured in the liquid system.

Figure 5 display a macrozooid cell, green palmella cells, a sporocyst that was infected with chytrids, respectively (before the culture treated with fluazinam). As shown in figure 3, the growth of *H. pluvialis* treated by 0.5 ppm or higher concentration of fluazinam continued to increase from the first day being given fungicide. This indicated that 0.5 ppm or higher of fluazinam in culture can inhibit the growth of chytrids (showed by no visible filament), even though the greater concentration of fluazinam has a different effect on the growth of microalgae. Figure 5 (b) display healthy green motile cells, green palmella cell and a healthy cyst and sporocyst, respectively.

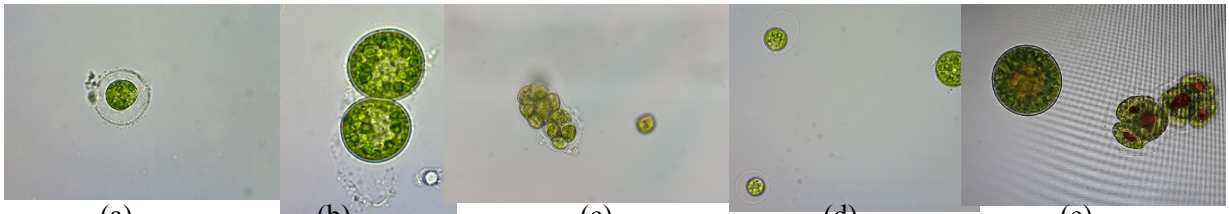


Figure 5. A macrozooid cell (a), green palmella cells (b), sporocyst of *H. pluvialis* before treating with fluazinam and after treating with fluazinam (d, e)

4. Conclusion

Fluazinam as a single dose fungicide at a certain concentration (0.5 ppm) in the culture of the *H. pluvialis* can be an effective toxic to the growth of chytrids but do not turn off the growth of microalgae. It can be concluded that fluazinam at a certain concentration has a potential as a fungicide even as a single dose treatment.

Acknowledgement

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Tensile properties of kenaf fiber by alkalinization treatment: effect of variations in concentration

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Abstract. The main problem when natural fibers are used as reinforcement in the matrix of synthetic polymers (hydrophobics) is that they are hydrophilic (easily absorb water) in nature, as a result of the compatibility between natural fibers and polymeric matrices to be weak. Chemical treatment is one of method that is currently widely used for modifying the surface properties of fibers. In this study, alkali treatment with variations in NaOH concentration was used to modify the surface of kenaf fibers. The effect of alkalinization treatment on the tensile properties of kenaf fibers has been carried out. The fiber is soaked in sodium hydroxide solution with variations in concentrations of 4, 6, 10 and 15% by weight for 3 hours at room temperature and continued with the washing and drying process. Samples were then tested by tensile testing and characterized by using FTIR and FE-SEM instruments. Tensile testing of untreated and treated fiber is carried out 5 times for each variable. Based on the results of these experiments showed an increase in tensile strength of all treated fibers compared to untreated fibers and the highest maximum tensile strength was obtained from the treatment of alkalinization of fibers at a concentration of 10%. This result was also confirmed by the results of FTIR and FE-SEM characterization which have shown a decrease in amorphous content in kenaf fibers and fibrillated bundle fibers into fiber elements.

1. Introduction

At present, natural fiber is the center of attention as a substitute for reinforcing materials in polymer matrices, replacing synthetic fibers such as glass fiber, because it has several advantages, namely light, abundant, recyclable and environmentally friendly. In addition, natural fiber is also safe for process equipment and health and cheap [1,2]. Industry that considers the use of natural fiber as a reinforcing material replacing glass fiber and carbon is the transportation industry [2]. Among various types of natural fiber, Kenaf fiber (Hibiscus connabicus, L family malvacea) is one of the natural fibers that is a concern because of its rapid growth over a wide range of climatic conditions [3] and low cost [2].

The main disadvantage of natural fiber is that it is naturally hydrophilic (easily absorbs water), causing weak interface ties with synthetic (hydrophobic) polymeric matrices. For this reason, natural fibers cannot be applied to heavy loads, replacing synthetic fibers. The use of natural fibers as reinforcing materials on synthetic polymer matrices has been applied to the automotive industry, but the application is still limited to the interior [4]. Because of its great potential in the industrial world,

modification of natural fibers with the aim of increasing compatibility is important to study. Several options, including chemical treatment of natural fibers and the use of compatible substances, have been suggested to improve the compatibility of surface energy between natural fibers and synthetic polymer matrices [4,5].

Alkali treatment, also known as mercerization, is one of the most widely used chemical treatments, to modify the surface of natural fibers because the process is simple and inexpensive. M. Suhairil Meon et al. Reported that the tensile strength of kenaf fiber tensile strength increases with increasing concentration of the NaOH solution [6]. B. Ahmed Amel et al. also conducted research on kenaf fibers and reported that the tensile strength of kenaf fibers treated by 5wt% NaOH was higher than that of untreated fibers [7]. While Y Cao et al. shows the tensile strength of kenaf fibers with an alkaline treatment, 5% higher than without treatment and decreases at 10% and 15% [8].

This study is aimed at exploring the effect of the concentration of alkaline solutions on the tensile properties of kenaf fibers. FT-IR and FE-SEM were used to investigate changes in compound composition and morphology of kenaf fibers from alkali and untreated treatments. This result is expected to be used as a direction in developing the process of natural fiber surface modification for composite applications.

2. Materials and experimental work

2.1. Materials

Kenaf fiber comes from plant stem parts, cleaned, washed and dried. After drying, kenaf fibers are cut to a size of about 70 mm and followed by alkali treatment.

2.2. Chemical treatment of kenaf fibers

The kenaf fiber, which was prepared previously, was made in three different aqueous NaOH solutions (4, 6, 10 and 15 wt%) for 3 hours at ambient temperature. After being alkalized, kenaf fibers were washed several times until neutral with distilled water and dried using solar heat.

2.3. FT-IR measurement

Changes in the composition of compounds from treated fibers are compared with Fourier transform infrared spectra (Perkin-Elmer FTIR spectrometer)

2.4. Tensile strength of kenaf fibers.

The tensile testing of the alkaline alkali treatment with different aqueous NaOH fibers was performed using UTM (Universal Tensile Machine) tensile testing machine by ASTM D1708-02 standard with a withdrawal speed of 100 mm / minute.

2.5. Morphology examination

The surface of kenaf fiber without treatment and alkali treatment results were examined by field scanning electron microscope (FE-SEM - FEI Inspect F50). All characterizations and testing were carried out in Metallurgy and Materials Engineering department, Universias Indonesia.

3. Results and discussion

3.1. Chemical composition

Fourier Transform Infrared spectroscopy was used to investigate changes in the composition of compounds in kenaf fibers after undergoing alkali treatment with different NaOH concentrations. FTIR spectra of untreated kenaf fibers and alkali treatment results are shown in Figure 1. From figure 1 (KV), it can be observed that untreated kenaf fibers show peaks at around 3335, 2894, 1731, 1594, 1423, 1160, dan 897 cm^{-1} . Peaks at 3335 cm^{-1} and 2894 cm^{-1} indicated O – H stretching vibrations and the hydrogen bond of the hydroxyl groups and C–H stretching of cellulose, hemicelluloses, and lignin, respectively [9,10]. The peak on 1731 cm^{-1} berasal dari C=O stretching vibration of the acetyl

groups in the hemicelluloses and lignin [8]. Puncak pada 1594 dan 1423 cm^{-1} mewaklli C=C stretching of the benzene ring of the lignin [10,11]. Anathor peak at 1160 cm^{-1} is a characteristic band for C – O stretching modes and C – O – C stretching vibration of cellulose, hemicelluloses, and lignin [10]. The final peak at 897 cm^{-1} is associated with the C – H of β-glycosidic linkages between the monosaccharides of Cellulose [9].

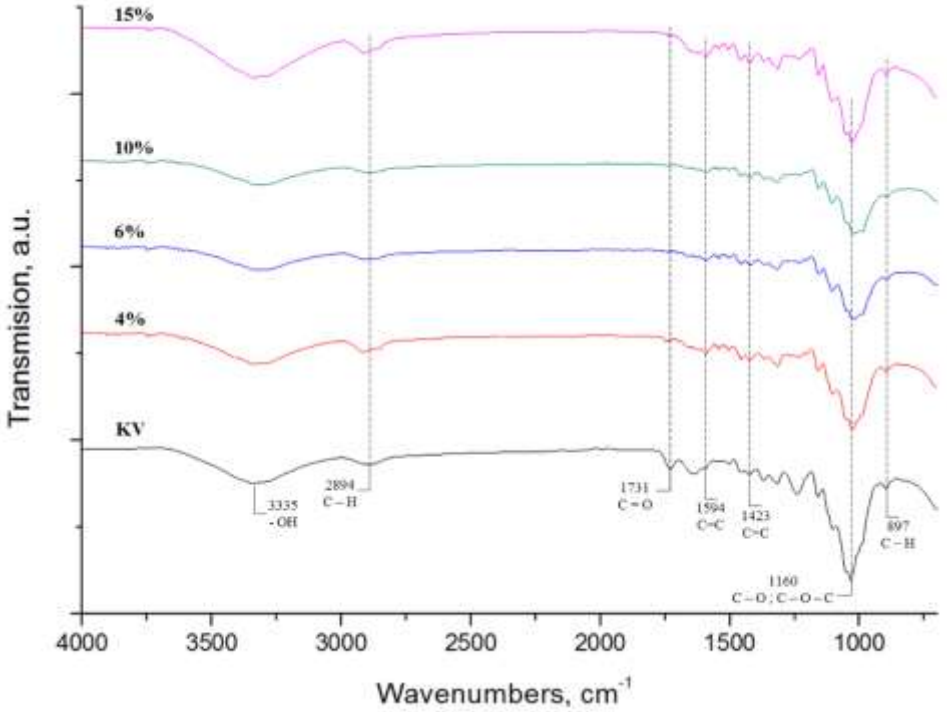


Figure 1. Perbandingan Spektra IR Serat Kenaf Tanpa Perlakuan dan Alkalinisasi dengan vaiasi konsentrasi.

Compared with the peak of kenaf fiber the result of the treatment of alkalinization at 10 wt.% NaOH, the peak at 1731 cm^{-1} is no longer visible. This indicates that part of lignin was removed from kenaf fibers after alkali treatment. While the peaks at 1594, 1423, 1160, and 897 cm^{-1} increase in transmission values which indicate a reduction in the molecules at the peak decreases. From these results it can be concluded that alkaline treatment, causes loss of binding materials, such as hemicellulose, lignin and amorphous cellulose. The loss of lignin content in kenaf fibers due to the influence of the concentration of NaOH solution can be seen in Fig. 2.

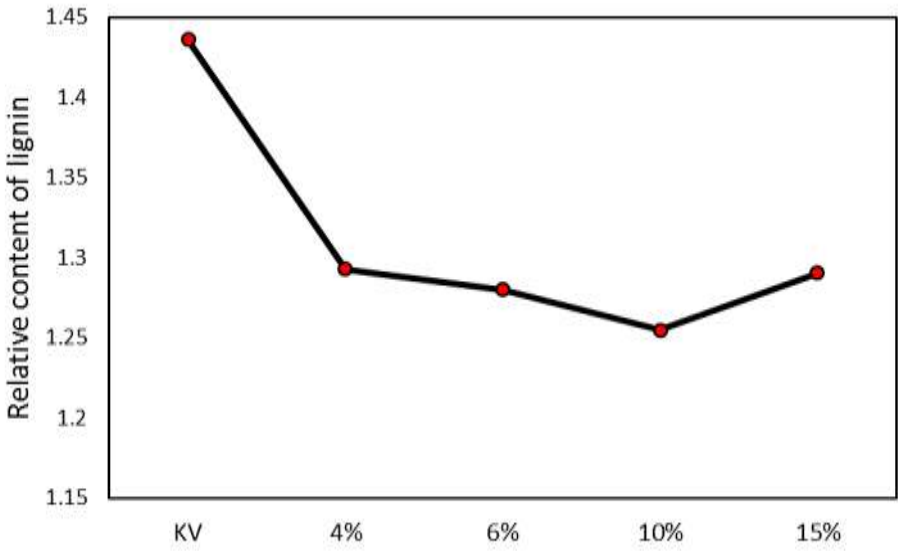


Figure 2. Pengaruh konsentrasi perlakuan alkali terhadap kandungan reakktif lignin

3.2. Tensille strength

One of the factors that influence the mechanical properties of natural fibers is the content of cellulose contained in and natural because cellulose has a semicrystalline structure while lignin and hemicellulose have an amorphous structure. The effect of the alkali treatment concentration is shown in Figure 3. From the figure it is shown that overall the alkali treatment can increase the tensile strength of kenaf fibers when compared to untreated kenaf fibers. These phenomena occur because during the alkali treatment the amorphous content in kenaf fibers is reduced so that the cellulose content in the fiber increases and this is in accordance with the data obtained from FTIR testing. The maximum value of tensile strength of kenaf fibers was obtained in alkali treatment with a concentration of 10 wt.%.

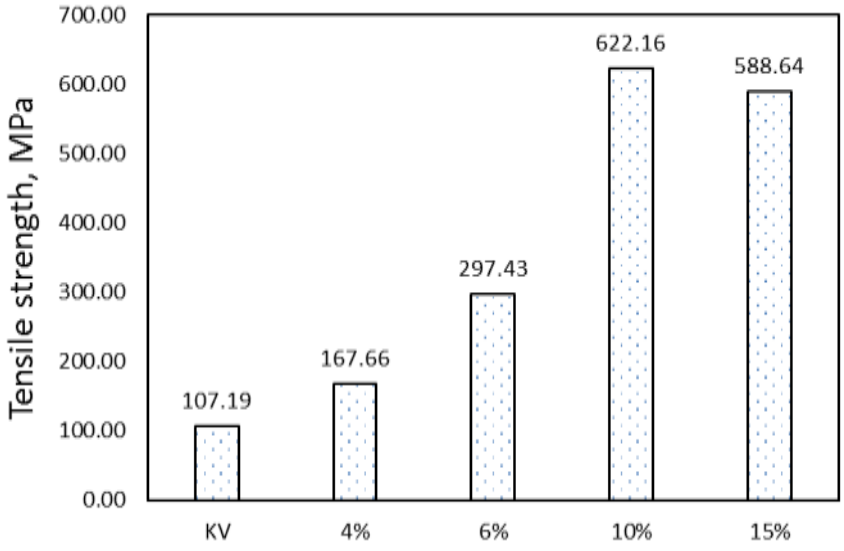


Figure 3. Pengaruh konsentrasi perlakuan alkali terhadap kandungan reakktif lignin

3.3. Morphologhy

SEM images in Fig. 4 & Fig 5 shows the untreated kenaf fiber and treated fiber through alkali treatment with 10 wt.% NaOH. From Fig. 4 it can be seen that kenaf fibers are still in bundle or fused state and there are many impurities. While the fiber results in an alkalinization treatment (Fig. 5) fibrous kenaf fibers with a clean surface appearance. The fibrillated of kenaf fibers shows binding materials such as lignin and hemicellulose are removed after alkali treatment and bundle fibers break down into separate fiber elements. This result is in accordance with the results obtained from FTIR testing.

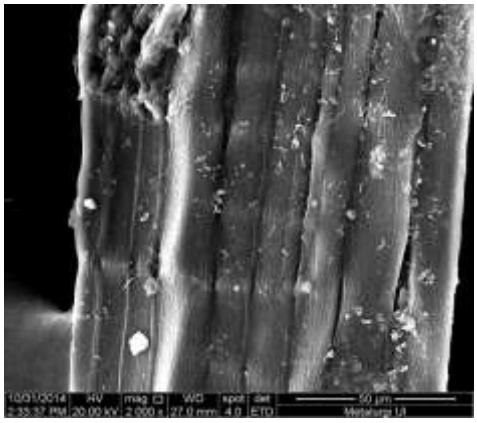


Figure 4. SEM imange of untreated kenaf fiber (kenaf virgin;KV)

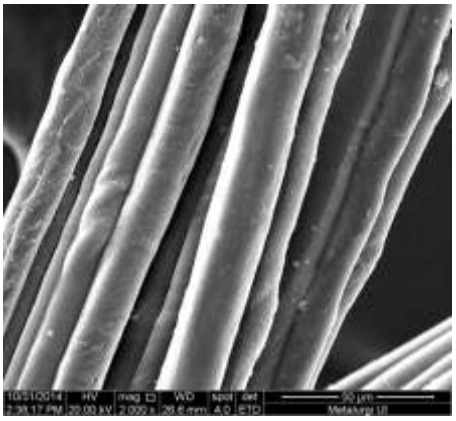


Figure 5. SEM imange of alkali treated kenaf fiber with 10 wt.% NaOH

4. Conclusion

The effect of alkali concentration on the mechanical properties of kenaf fibers was discussed in this study. Alkali treatment, causes the kenaf fibers to become fibrillated and the amount of cellulose increases with the loss of amorphous content such as lignin and hemicellulose. Increasing cellulose content in fiber caused the tensile properties of kenaf fiamabers to increase and the maximum yield was obtained in alkali treatment with a concentration of 10 wt.% NaOH.

Acknowledgments

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Regulatory performance of two different tuning method for milk cooling control system

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Abstract. Temperature is one of the essential factors for bacterial growth in milk. The higher the temperature, the faster bacteria will grow. It is empirically proven that the bacteria will stop to grow at temperature of about 4˚C. In this research, continuous milk cooling process would be simulated and then controlled by using Proportional - Integral (PI) feedback control system. The regulatory performance of the two different tuning method would then be analyzed (i.e Tyreus - Luybean and Hagglund – Astorm). Their SSE (sum squared of errors) would be compared. It was found that Tyreus – Luyben method gave better regulatory performance than Hagglund – Astorm.

1. Introduction

Milk is collected, transported and delivered to milk cooling centres in a number of ways, as shown in figure 1.

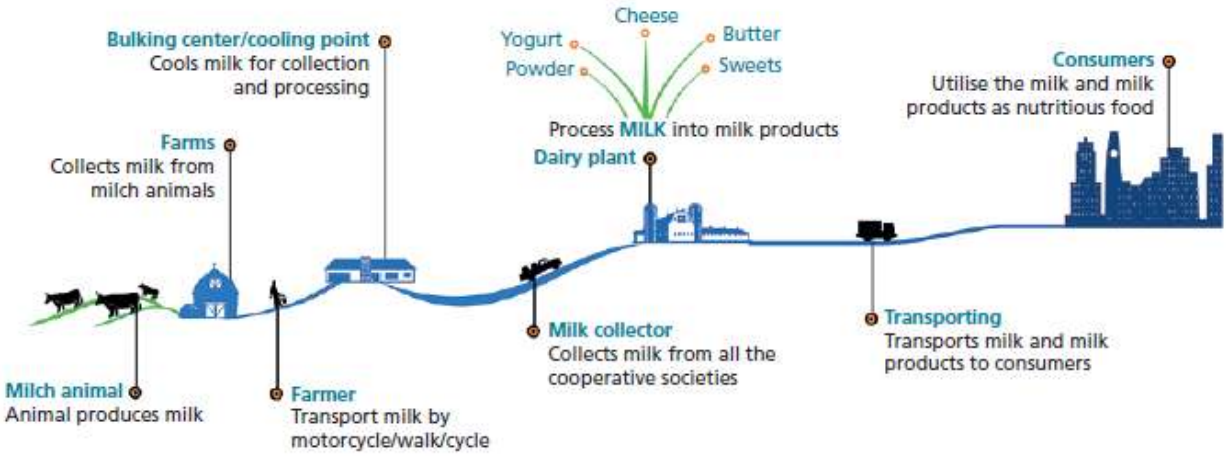


Figure 1. Rural dairy collection [1].

Warm fresh milk should be cooled immediately after milking to preserve quality and prevent spoilage. Cooling to 4˚C within 3 to 4 hours is essential but more rapid cooling is much preferred [1].

Normally, milk arrives at the milk cooling centres in the morning and late afternoon or early evening. Therefore batch milk cooling are performed as such in cooperatives (i.e Koperasi Unit Desa

SAE in Pujon, KUD Batu and elsewhere). However, in this study continuous milk cooling process would be simulated as it is more applicable for larger capacity and it gives more rapid cooling.

Proportional Integral (PI) controllers are the most commonly used form of Proportional Integral Derivative (PID) controllers, accounting for over 90% of industrial PID applications. Tuning a PI controller involves setting the controller gain (k_c) and the reset time (τ_I) [7]. There is strong evidence that PI and PID controllers remain poorly understood and, in particular, poorly tuned in many applications [9].

The aim of this research is to compare regulatory performance of two different tuning method (i.e Tyreus - Luyben and Hagglund – Astorm) for controller parameter determination while servo performance for this application had been published elsewhere [2].

2. Simulation

The system being studied is the milk cooling system at Koperasi Unit Desa SAE Pujon [2] as shown figure 2 and figure 3.

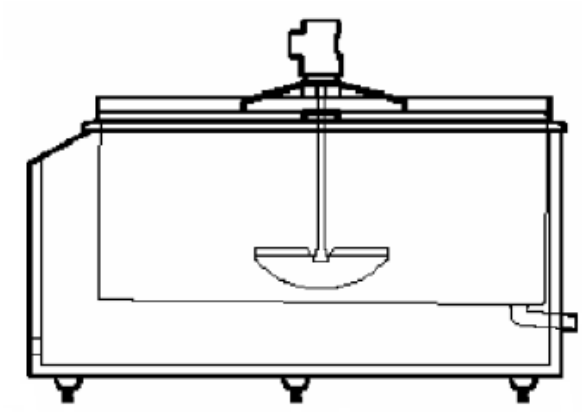


Figure 2. Milk cooling system seen from side.

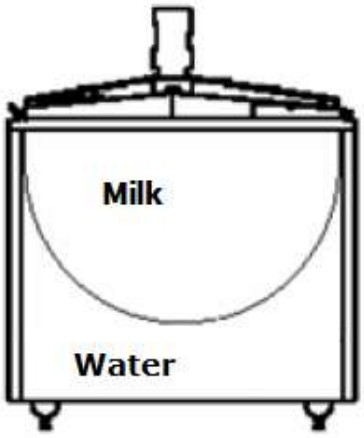


Figure 3. Milk cooling system seen from the front.

For continuous system with Proportional – Integral (PI) controller installed as shown in figure 4, its mathematical model can be derived based on energy balance. The final model in Laplace Transform is shown below [2]:

$$T_0(s) = \frac{T_i(s)}{\left(\frac{m}{w_s}s+1\right)} - \frac{\frac{Q(s)}{w_s C_p}}{\left(\frac{m}{w_s}s+1\right)} - \frac{\frac{(T_{0,s}-T_{i,s})W_s}{w_s}}{\left(\frac{m}{w_s}s+1\right)} \quad (1)$$

Where:

W_s = milk flowrate (kg/min)

$T_{0,s}$ = steady state temperature of inlet milk (˚C)

$T_{i,s}$ = steady state temperature of outlet milk (˚C)

m = mass of inlet milk(kg)

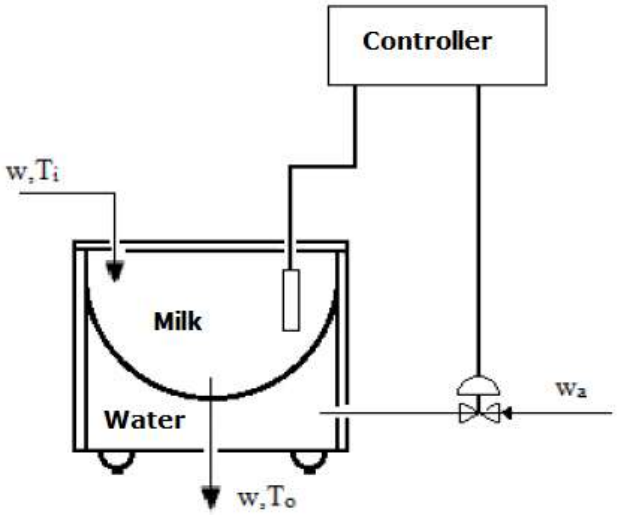


Figure 4. Continuous milk cooling system.

The data for milk is as follows:

C_p = heat capacity of milk = 3.93 $\frac{kJ}{kg.K}$ (2)

ρ = density of milk = 1027 $\frac{kg}{m^3}$ (3)

Table 1 shows data at steady state.

Table 1. Steady state data.

Parameter	Value	Unit
V_{milk}	2500	L
T_i	36	˚C
T_0	4	˚C
T_1	2	˚C
T_2	15	˚C

Tyreus – Luybean Tuning Method

PI or PID parameters can be determined by using equation as shown in table 2 [3,4], where:

k_{cu} = ultimate gain

P_u = ultimate period

P_u and k_{cu} are similar to those in Ziegler – Nichol method and detail can be read elsewhere [5,6,7].

Table 2. Tyreus – Luyben settings [3,4].

Controller	k_c	τ_I	τ_D
PI	$\frac{k_{cu}}{3.2}$	$2.2P_u$	-
PID	$\frac{k_{cu}}{2.2}$	$2.2P_u$	$\frac{P_u}{6.3}$

Hagglund – Astorm Tuning Method
Setting PI controller for Hagglund – Astorm is using equation below [8]:

$$k_c = \frac{1}{K}\left(0.14 + 0.28\frac{\tau}{\theta}\right) \quad (4)$$

$$\tau_I = \theta\left(0.33 + \frac{6.8\tau}{10\theta + \tau}\right) \quad (5)$$

Where:

K = process gain
θ = process time delay
τ = process time constant

3. Results and Discussion

Tyreus-Luyben is quite similar to Ziegler Nichols method. There are two method in obtaining k_{cu} (ultimate gain) and P_u (ultimate periode). For simplicity, we choose plotting Bode diagram of open loop system (which is depend on parameters of the process). Therefore, both Tyreus-Luyben and Hagglund-Astorm are basically model based control method. The values for time delay were assumed ranging from 1 to 5 min so that both tuning methods can be applied. Table 3 shows the values for controller parameters obtained.

Table 3. Controller parameters.

Time Delay	Controller Parameters	Tyreus - Luyben	Hagglund - Astorm
1	k_c	-10209	-2834
	τ_I	4.2	5.4
2	k_c	-6200	-1441
	τ_I	6.9	8.7
3	k_c	-4894	-977
	τ_I	8.8	10.9
4	k_c	-3674	-745
	τ_I	11.7	12.6
5	k_c	-2954	-606
	τ_I	5.5	14.0

At certain times, the temperature of inlet milk (T_i) was disturbed in the form of step function of -2˚C (form its steady state value) at t = 35 min and at 3˚C at t = 60 minutes. When interference was given, the output will move away from its setpoint but will be back immediately. These disturbances may affect the output milk temperature and the amount of heat released (Q).

Figure 5 shows profile of output milk temperature (T_0) and its setpoint when such disturbances of inlet milk temperature (T_i) occurred. Profile of heat released (Q) is also shown. This figure is for one min time delay assumption and using Tyreus-Luyben. Profile for T_0 and Q under similar disturbances are shown in figure 6 for Hagglund–Astorm tuning method. Again, one minute time delay assumption was applied. Simulation were then continued for other time delay values (i.e time delay = 2 to 5 minutes). The figures similar to figure 5 and figure 6 could also be generated. The sum squared of errors (SSE) values for both method and all time delay assumptions are listed in table 4. Both method are successful in term of disturbance rejection, but Tyreus – Luyben give smaller values of SSE.

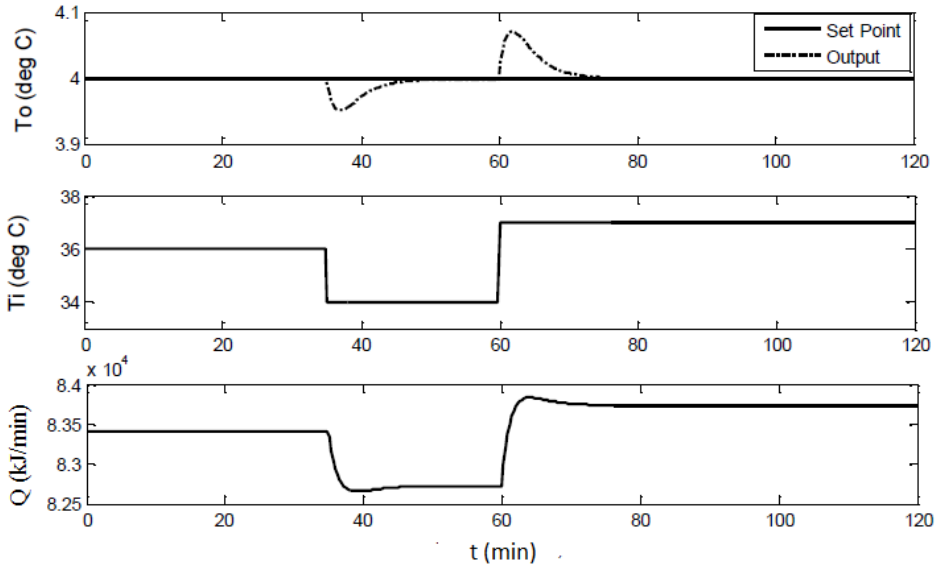


Figure 5. Profile of outlet milk temperature (T_0) and heat released (Q) for 1 min time delay assumption using Tyreus - Luyben tuning method.

Table 4 also shows that small value of time delay assumption were preferred since the higher the value, the higher their SSE values.

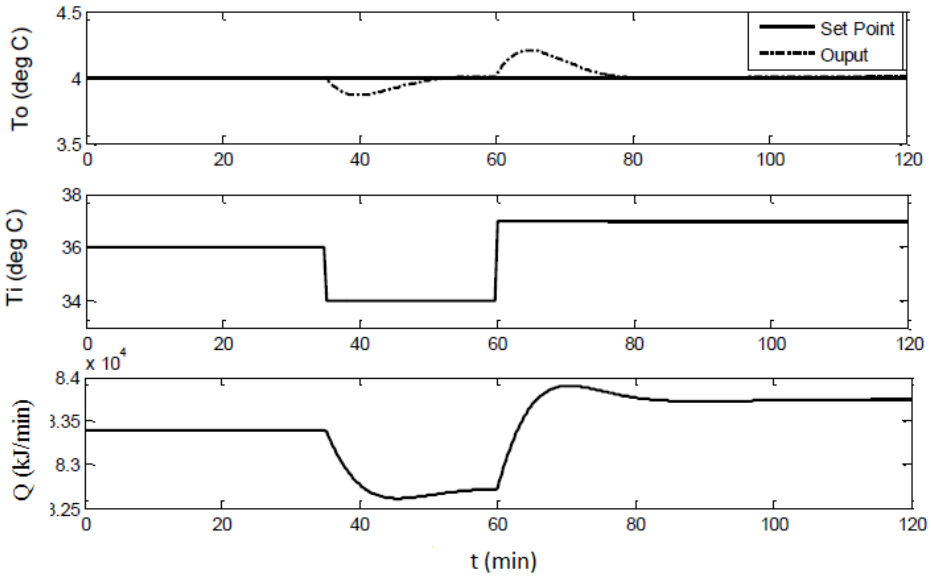


Figure 6. Profile of outlet milk temperature (T_0) and heat released (Q) for 1 min time delay assumption using Hagglund – Astorm tuning method.

Table 4. SSE (sum squared of errors) values of outlet milk temperature.

Time Delay (min)	SSE	
	Tyreus - Luyben	Hagglund - Astorm
1	0.0953	1.4872
2	0.4117	8.1972
3	0.8057	17.5491
4	1.7406	27.2457
5	3.0064	36.5148

4. Conclusions

Feedback control system using PI controller has been applied for continuous milk cooling process. Two method of tuning has been investigated (i.e. Tyreus – Luyben and Hagglund – Astorm) and both give satisfactory results for regulatory performance. However, it seems that Tyreus- Luyben is slightly better because it gives smaller SSE values than Hagglund Astorm. It is also recommended that small time delay assumption were used instead of higher values.

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A review of a machine design of chocolate extrusion based co-rotating twin screw extruder

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Abstract. Based on innovation and competitive market for food industry, there are several food products, have been designed to attract customer. Since there is US 39,431 millions of chocolate sales in 2018, USA [1], chocolate product shape has been developed based on manufacturing process. This paper presents a review process of a machine design of chocolate extrusion based co-rotating twin screw extruder. A property of suitable chocolate for extruder were established. The pros and cons of machine extruder for food processing including, a screw extruder design were exposed. Since there are problem in chocolate extruder, the process parameters such as barrel temperatures, feed rate, screw speed, motor load and melt pressure were established. These parameters would be applied to design screw extruder for chocolate processing.

1. Introduction

Several new technologies or innovations have be introduced in order to increase high productivity while reduce production cost. There are several areas in food industry that has highly competition. Such as, the chocolate market has market price US 39,431 millions of chocolate sales in 2018, USA with consumers ranging from children to adults [1]. Therefore, many technologies has been applied to increase productivity of chocolate production while enrage favor and various shape. Since the properties of chocolate are melted in normal temperature, flowed in a container and changed viscosity depend up on temperature, chocolate is processed via many production processes such as extrusion, printing, etc.

However, there are several problems during extrusion process such as low productivity rate, product waste and improper extrusion temperature affect to increased production costs. Therefore, the chocolate extrusion with the screw extruder in order to reduce those problems, the screw extruder has been apply to control various factors including high flexibility. This paper presents a review process of a machine design of chocolate extrusion based co-rotating twin screw extruder.

2. Chocolate

Chocolate is composed of nonfat particles (sugar and cocoa solids and, eventually, milk powder particles) dispersed in cocoa butter as a continuous phase [2]. The flow properties to control the quality of chocolate product a chocolate flow is an important parameters. Since, too low viscosity, the weight of the chocolate over the enrobed candy will also be too low. However, If it too high, then bubbles may be formed and put chocolate. Moreover, the different chocolate viscosity provide distinguished

flavor, that can be detected by consumer. The perceived taste relates to viscosity and rate of melt. Therefore, the favor of chocolate is different between stored in the refrigerator or room. [3]. Therefore, the designs of machine to process chocolate are important to control the parameters that affect to flow and viscosity of chocolate. Those factors affects the chocolate extrusion process because it is involved in melting, as well as extrusion through the die.

3. Extrusion processing in food industrial

The extrusion processing for the food industry has been wildly used in production process since it provides a variety food shape. The products are vary depending on the ingredients and the condition of the control. Machine, called Extruder, has be incorporated with various processes. The extruder mechanism is to blending of raw materials and ingredients (feed or transport section) under pressure and heat conditions, to shaping or metering section from compression, and to pushing the product out to die. Extrusion technology has be introduced to shape a variety of food productions because there are many advantages such as save energy, reduce labor and production costs, flexibility for several raw materials, ability for mixing ingredient, and save space for tool installation. Those properties can also improve the quality of products as needed. [4]

4. Screw extruder design

Hot-melt extrusion equipment consists of an extruder, auxiliary equipment for the extruder, down stream processing equipment, and other monitoring tools used for performance and product quality evaluation [5]. The extruder is typically composed of a feeding hopper, barrels, single or twin screws, and the die and screw–driving unit (figure 1). The auxiliary equipment for the extruder mainly consists of a heating/cooling device for the barrels, a conveyer belt to cool down the product and a solvent delivery pump. The monitoring devices on the equipment include temperature gauges, a screw-speed controller, an extrusion torque monitor and pressure gauges.

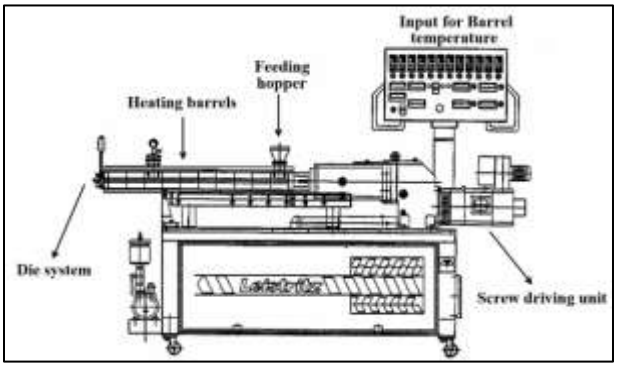


Figure 1. Micro-18 Twin screw co-rotating Leistritz extruder [6].

The theoretical approach to understanding the melt extrusion process is generally presented by dividing process flow into four sections, as followed. [7] 1) Feeding of the extruder, 2) Conveying of mass (mixing and reduction of particle size), 3) Flow through the die, 4) Exit from the die and down-stream processing. Generally, the extruder consists of one or two rotating screw inside a stationary cylindrical barrel. The barrel is often manufactured in sections, which are bolted or clamped together. An end-plate die, connected to the end of the barrel, determines the shape of the extruded product shown in figure 1 and figure 2.

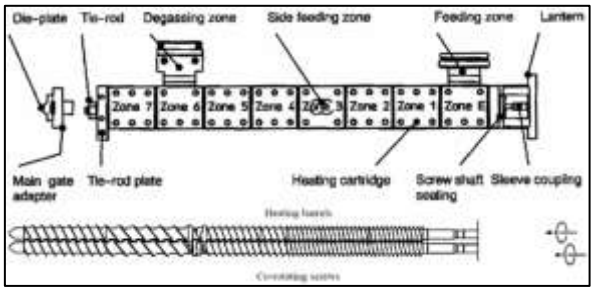


Figure 2. Heating barrels and co-rotating screws [6].

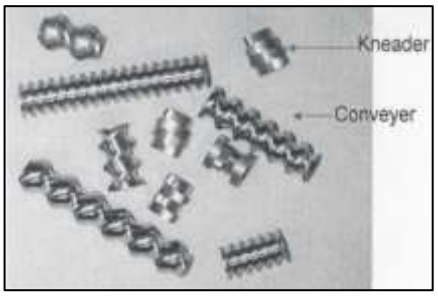


Figure 3. Screw and kneading elements for hot-melt extruder [6].

The heat that is generated from friction force, required to melt or fuse the material. This force is shear force occurring between the rotating screws and the wall of the barrel that is mounted with electric or liquid heaters [8]. Most commercial extruders have a modular design, providing a choice of screws or interchangeable sections which modifidy the configuration of the feed, transition, and metering zones. The modular design has been introduced to meet special process requirements, such as, increase high shear extrusion, addition more solvent and enlarge evaporate solvent from raw material. Modifying screw designs also allow the extruder to perform a mixing and reduction of particle size in addition to extrusion, so that material can be blended into the extrudate or even dissolved, as shown in figure 3.

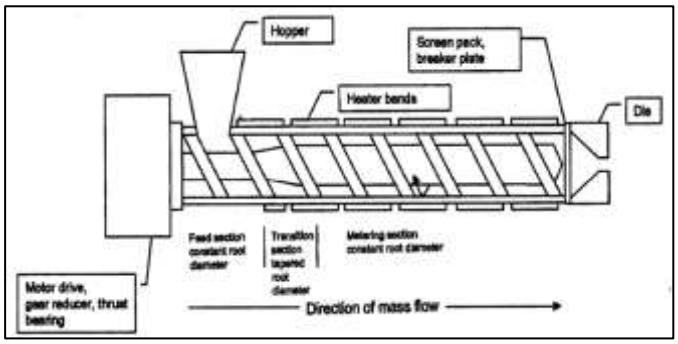


Figure 4. Component parts of single – screw extruder [6].

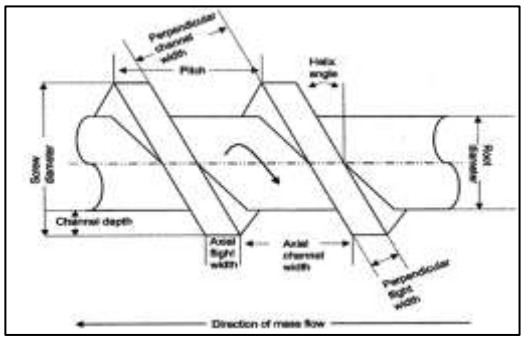


Figure 5. Extrusion screw geometry [6].

The screw and die design available, and a practical considerations of thermoplastic extrusion were reviewed by Whelan and Dunning [9]. The extrusion channel is conventionally divided into three sections: feed zone, transition zone, and metering zone, as shown in figure 4. The starting material is fed from a hopper directly in to the feed section, which has deeper flights or flights of greater pitch, as shown in Figure 5. This geometry enables the feed material to fall easily into the screw for conveying along the barrel. The pitch and helix angle determine the throughput at a constant rotation speed of the screws. The material is transported as a solid plug to the transition zone where it is mixed, compressed, melted and plasticized. Compression was developed into two types: (1) decreasing the thread pitch while keeping a constant flight depth, and (2) decreasing flight depth but keeping a constant thread pitch [10]. Both types resulted increase pressure as the material moves along the barrel. The melt conveys by circulation in a helical path by means of transverse flow, drag flow, pressure flow and leakage; the latter two mechanisms reverse the flow of material along the barrel. The space between screw diameter and width of the barrel is normally in the range of 0.1-0.2 mm [8]. The material reaches

the metering zone in the form of a homogeneous plastic melt suitable for extrusion. To extrude a uniform part thickness, flow must be consistent without stagnant zones right up to the die entrance. The function of the metering zone is to eliminate pulsating flow and ensure a uniform delivery rate through the die cavity [7].

5. Twin screw extrusion

The twin-screw extruder has two agitator assemblies mounted on parallel shafts These shafts are driven through a splitter/reducer gear box and rotate together with the same direction of rotation (co-rotating) or in the opposite direction (counter rotating) and are often fully intermeshing. In such case, the agitator element wipes both the surface of the corresponding element on the adjacent shaft, and the internal surfaces of the mixing chamber and ensures a narrow and well-defined residence time distribution. In general, co-rotating shafts have better mixing capabilities as the surfaces of the screws move towards each other. This leads to a sharp change in mass flow between the screw surfaces [7]. As the screws rotate, the flight of one screw element wipes the flank of the adjacent screw, causing material to transfer from one screw to the other. In this manner the material is transported along the extruder barrel. The twin-screw extruder was characterized by the following descriptive features [8]:1) Short residence time: The residence time in the twin-screw extruder in a typical extrusion processes ranges from 5-10 minutes depending on the feed rate and screw speed, 2) Self wiping screw profile: The self wiping screw profile is the flight of the one screw wipes the root of the screw on the shaft next to it, ensures near complete emptying of the equipment and minimizes product wastage on shutdown, 3) Minimum inventory: Continuous operation of the equipment coupled with the continuous feeding of the material helps in reducing inventories of work in progress. This is important when processing valuable or potentially hazardous materials, 4) Versatility: Operating parameters can be changed easily and continuously to change extrusion rate or mixing action. The segmented screw elements allow agitator designs to be easily optimized to suit a particular application. Die plates can also be easily exchanged to alter the extrudate diameter. This allows processing of many different formulations on a single machine, leading to good equipment utilization. Polymers with a wide range of viscoelastic and melt viscosities may be processed and even fine powders may be directly fed into the system, 5) Superior mixing: The screws have various mixing elements which impart two types of mixing, distributive mixing and dispersive mixing. The distributive mixing ideally maximizes the division and recombining of the material while minimizing energy. The dispersive mixing ideally breaks droplet or solid domains to fine morphologies using energy at or slightly above the threshold level needed. This mixing aids in efficient compounding of two or more materials in the twin-screw extruder.

Typical twin-screw laboratory scale machines have a diameter of 16-18 mm and length of four to ten times the diameter. A typical throughput for this type of equipment is 0.5- 5 gm/min. As the residence time in the extruder is rather short and the temperature of all the barrels are independent and can be accurately controlled from low temperatures (30°C) to high temperatures (300°C) degradation by heat can be minimized [8]. Extrusion processing requires close monitoring and understanding the various parameters: viscosity and variation of viscosity with shear rate and temperature, elasticity and extensional flow over hot metal surfaces. Today, extruders allow in-process monitoring and control of parameters, such as the temperature in the extruder, head and die as well as pressure in extruder and die [11].

6. Extrusion parameters

The main monitoring and controlling parameters are barrel temperatures, feed rate, screw speed, motor load and melt pressure. Barrel temperature, feed rate and screw speed are controlling parameters and motor load and melt pressure are monitoring parameters. 1) Barrel temperatures: The glass transition or melting temperatures of polymers and drug usually determines the barrel temperature, 2) Feed rate and screw speed:. The constant feeding rate and screw speed throughout the process is important as the combination of these two factors establishes the level of fill in extruder. This is critical to the process, because it governs the balance between the weak and strong mass transfer mode [8]. Due to constant feed rate and screw speed, there will be a constant amount of material in the extruder and thus the shear stress and residence time applied to material remains constant, 3) The motor load and melt pressure: These parameters depend on feed rate and screw speed. With constant feed rate and screw speed these parameters depend upon the molecular weight of polymer and drug as well as polymer miscibility in binary mixtures [7].

7. Co-rotating and counter rotating twin screw

Since there are variety of raw materials to mix into chocolates, the co-rotating twin screw extruders has be interesting to investigate in order to improve chocolate extruder machine. The twin screw extruder has been classified into two types as following [12]:1. Based on screw rotation direction: co-rotating and counter-rotating, as shown in figure 6, 2. Based on degree of meshing: non overlap (non-intermeshing) and overlaps which are a partially intermeshing and a fully intermeshing, as shown in figure 7.

The rang of twin screw extruder operation is during low speed (10-40 rpm) to high speed (200-500 rpm). In most industries, counter-rotating twin screw extruders are preferred because they have better conveying performance than co-rotating twin screw extruders as well as counter-rotating twin screw extruders and the heat generated by the shear is less. [12]

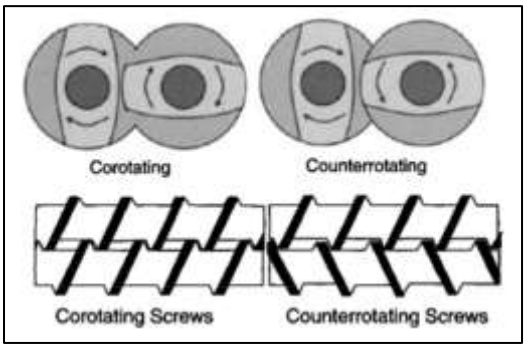


Figure 6. Screw rotation direction, co-rotating screw and counter rotating [6].

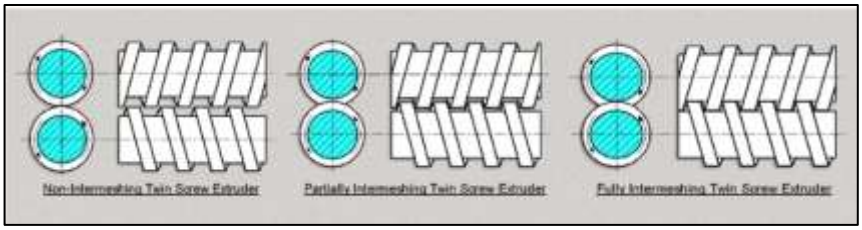


Figure 7. The amount of overlap between the screws in the twin screw extruder [6].

Twin screw extruder offers advantages over single screw extruder in that it does not require a drag force to push the material. Less shear results in less shear heat, more efficient mixing and less flexibility for low speed applications [6]. A comparison of screw parameters was concluded as table 1.

Table 1. A review of investigating screw parameters.

Researchers	Year	Screw parameters					
		Single screw extruder	Twin screw extruder	Ram extruder	Screw speed	Material temperature	Viscocity
Milivoje M. Kostic [14]	2006	/					
Vivar-Vera [15]	2008				/	/	/
Hesam Anvari Ardakani [16]	2014			/		/	
Chris Rauwendaal [1]	2015	/				/	

8. Screw extrusion problems

Although, there are several benefits of screw extrusion e.g. available for many chocolate formulas, flexible for process parameters and suitable for continuous process. There are many extrusion problems such as shape accuracy, appearance problems, functional product properties, high melt temperature, high motor load, wear of screw and/or barrel. Moreover, process problems had been mentioned [1] such as low yield productivity, and products defected, as shown in figure 8. A non-appropriate extrusion temperature affects to product surface that increases production cost, as shown in figure 8(a), and to chocolate state that constructs un-uniform chocolate line, as shown in figure 8(b).

Figure 8. Defective product [13]

(a) The cracks surface. **(b)** Un-uniform chocolate line.



(a) **(b)**

9. Conclusion

Screw extrusion is widely used in the food industry e.g. pasta and dessert. One of the desserts with high market value is chocolate, in which chocolate also capable of melting and extrusion. The extruder also has many problems in the manufacturing process, such as low productivity and defective products. As a result, the extruder design has been investigated to improve process efficiency and reduce the production problems that was occurred during extrusion process. The co-rotating twin-screw extruder has been redesigned in order to reduce product flaws while increase productivity. Since co-rotating twin-screw composes of feeder element, transition element and metering element, the advantages of co-rotating twin-screw are well mix chocolate paste and good conveying performance of paste products. However, the process parameters of co-rotating twin-screw chocolate extrusion should be investigated in order to minimize screw extrusion problems as a future work.

Acknowledgments
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An empirical study of how the deployment of lean sigma can reduce its enemies: waste, overburden and defect

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Abstract. Lean thinking focuses on shortening cycle time by eliminating non-value added activities in every process so that the production can flow efficiently. Six sigma focuses on increasing process capability by eliminating variation so that the defected product can be reduced. Both concepts are integrated into Lean Sigma methodology and offered to companies in a form of DMAIC framework to achieve twofold benefits: quality and speed. In terms of lean implementation, several empirical studies have used the DMAIC framework to emphasis on defining and analysing MUDA (waste), measuring the level of process cycle efficiency and making the improvement initiatives to remove waste. This research proposed an additional analysis to the existing DMAIC framework on identifying and evaluating MURI (overburden), measuring the MURI score and formulating the improvement plans by identifying non-ergonomics work conditions that create overburden activities. The proposed DMAIC framework has been deployed in an Indonesian-footwear manufacturer; the implementation indicated that MURI analysis can be aligned with MUDA analysis and boosted the design of improvement. At the end, the research showed that the proposed framework was able to give significant impacts on reducing two enemies of Lean (MUDA and MURI). The implementation of the framework can prove the efficiency advantages of implementing the framework i.e. to improve more ergonomic working method, increase the sigma level as well as reduce process cycle time.

1. Introduction

Lean Sigma is a methodology that can be used to maximize shareholder value by achieving the fastest rate of customer satisfaction, price, and quality, process speed, and capital turn over. It is a combination of the ability of lean manufacturing to accelerate the process and the ability of six sigma to improve the quality of output [1]. Integration the concepts between lean and six sigma offers a complete and holistic approach to bring business to gain the efficiency advantages; the principles and strategies of both methods will produce a business solution for a better, faster, and more economical business process. For manufacturing industry, Lean Sigma can be used to fasten the process cycle time, increase the capability of sigma level and business flexibility and operate at the lower cost [2].

The concept of lean thinking makes 3M as the main concept, they are three kinds of lean's enemies namely MUDA, MURI and MURA [3]. MUDA is defined as non-value added activities that occur in business process and commonly are categorized into seven waste [4] covering excessive transportation, unnecessary inventory, waiting, unnecessary motion, overproduction, defects, and overprocessing. MURI is referring to overloading facilities or human resources that can be caused by untidy workstation, lack of standardization of work, and fluctuated output volume [3]. MURA is unevenness or unbalanced working load among workers [3]. Six sigma creates a five-phase

improvement process i.e. Define, Measure, Analyze, Improve, Control; it is known as DMAIC methodology [5].

Several empirical studies which adopted Lean Sigma methodology focus on analyzing waste (MUDA), because MUDA is something that company can identify with. The integration of Lean and Six Sigma methodology was used to identify non-value added activities and seven type of waste during the processes, to measure efficiency and defect level and formulate action plans to eliminate MUDA [5, 6]. However, two other enemies (MURA and MURI) are usually fail to be identified although they are often the main causes of MUDA. In this research, MURI analysis is supplementary applied because there is a linkage between MUDA, defects and MURI. As an illustration, waste over processing and defectives product can cause extra work and fatigue to operators, and vice versa, overburden can cause a decrease in worker's performances and an increase either in operation time or more defective products. MURI analysis can be aligned with MUDA analysis and boosted the design of improvement. This research was an empirical study which aimed to deploy the framework of DMAIC in an Indonesian-footwear manufacturer; it starts from identifying the problems, measuring the current condition, analyzing root causes, formulating the improvements, until designing control mechanism to prevent the potential errors or waste that might occur in the future. MURA analysis was not included because this particular footwear production process is a continuous flow that carried out by a group of workers and either the imbalances process or inconsistent output were found.

2. Research Methodology

Data-driven life-cycle approach called as DMAIC methodology is being used for problem exploration, data collection and analysis, problem solving and designing solutions. Lean activities are integrated into the steps of Six Sigma's DMAIC and the framework of DMAIC methodology (figure 1) was described concisely below.

Define. The main points of this first stage are problem identification and determine the goals. In identifying problems and goals, several ways can be done such as knowing the needs of customers as well as process owner by exploring Voice of Customer (VoC) and Voice of Business (VoB). VoC and VoB are then interpreted into Critical to Quality (CtQ) and defect criteria. CtQ should be measured so that it can be controlled. Another primary output from defining stage is to identify MUDA and MURI through the observation on overall production process and the interview with process owners.

Measure. This stage is about collecting necessary data; there were two types of collected data: (i) primary data which can be collected through direct observation and exploration, such as production processes, production activities, time for each activity, defect types, and number of defects, and (ii) secondary data which can be collected from company historical data, such as company profile and history, business process, products and materials list, and production capacity. The output of this phase are: (i) the value of Defect per Million Opportunities (DPMO) and current sigma level for each process that can describe the capability of each production process, (ii) Process Activity Mapping (PAM) that maps the distribution of value-added, non-value-added, and necessary-non-value-added activity, and the level of Process Cycle Efficiency (PCE), (iii) *MURI* score, which can be obtained from direct observation in every process using an industrial template of MURI analysis [6].

Analyze. At this phase, Failure Mode and Effects Analysis (FMEA) and 5 WHYs are being used as tools to find the potential causes of the problems. The analysis of FMEA provides the value of Risk Priority Number (RPN) of each failure which can be used to set the improvement priority.

Improve & Control. After doing further analysis to find the root cause of the problem, one of the most important things should be done is how the potential solutions can be formulated and implemented. Control phases is highly needed in order to standardize the current improvements so that the same errors in the future can be prevented, one of the control initiatives is designing new work procedure guideline to accommodate the implemented improvements. However, the result of implementation and control design has not been discussed here, since the focal issue of the article is proposing additional MURI analyze and the benefit for the manufacturer is it can boost the design of improvement plans.

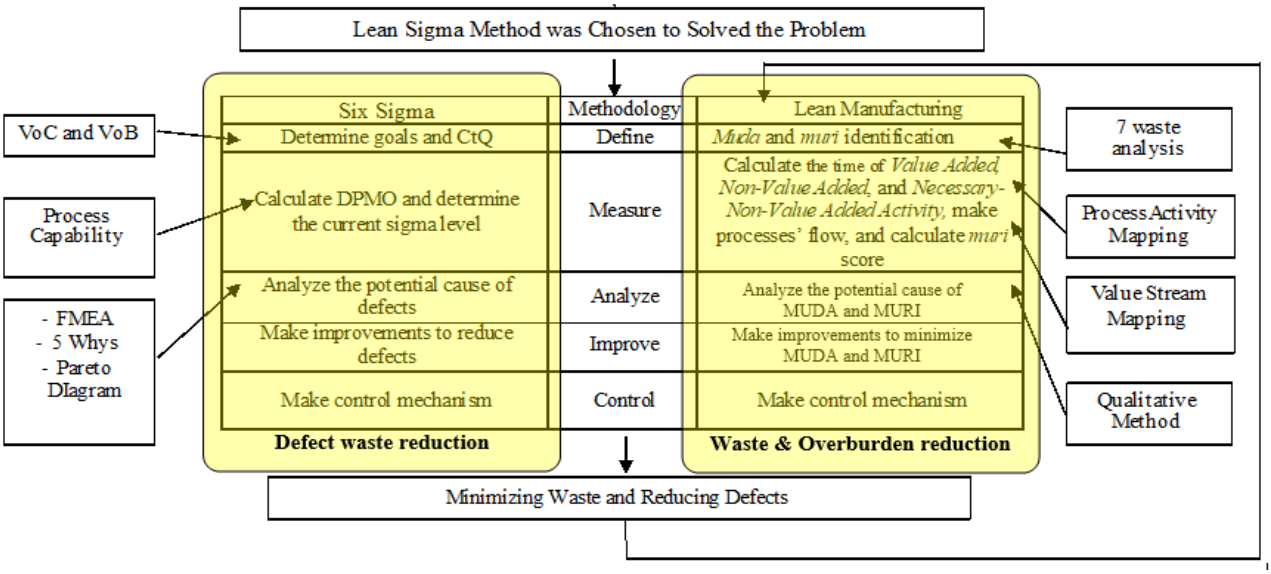


Figure 1. Framework of DMAIC approach.

3. Result and Discussion

3.1 Define

In define stage, the footwear manufacturer decided to deploy the DMAIC framework on a product namely SAN CARBONE slipper. There are seven main processes for making slipper, the production starts from raw materials processing to finished goods packaging, as shown in figure 2 below. Although the study was done to all of the seven production processes, but the process of pressing and sewing were selected for the issues of discussion in this article. Pressing is a process of strap/motif making to the slippery component in which the raw material sheets are passing to the oven conveyor previously and the material is taken by the operator to be pressed by the pressing machine and using a cold-temperature mattress. Stitching is a process to combine two components of sandals using threads including the process of adding stitching line for the slipper model.

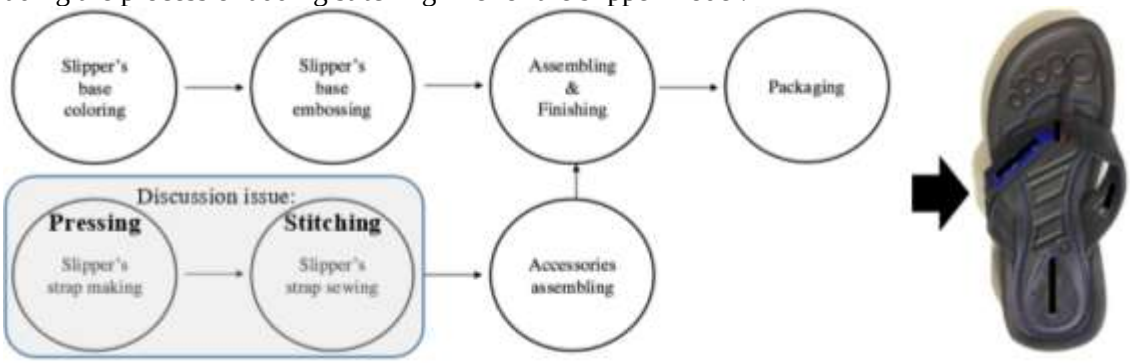


Figure 2. Production process flow (product type: SAN CARBONE slipper).

Table 1. Critical to Quality (CtQ) and Defect Criteria (examples are for pressing process).

VoC / VoB	CtQ	Criteria for Defect
"Good quality" "Good design" "Comfortable" "Neat stitching" "Strap sandals do not make pain" "Durability of slippers" "Packaging is in good condition"	For pressing process: - The maturity level of pressing output - The conformity of the strap making (the strap result is not outside of material size	- Raw or burnt component - Oblique/cut off component

After doing some interviews with customers and business owner, the result had been translated into Critical to Quality (CtQ) and defect criteria (see table 1). Furthermore, the identification of MUDA and MURI was done by observing pressing and stitching processes in advance and the result was shown in table 2 and table 3. The next stage will provide the quantitative result of both analyses.

Table 2. MUDA Analyse: identification of seven waste.

Process	Type of Waste	Description of Waste	Impact
Pressing	Inappropriate Processing	Oven and cooler are not stable	Process time becomes longer
		The material is not neat when placed on the floor so it must tidy up again	
	Transportation	Too much mobilization of operators and materials	Fatigue worker
Stitching	Inappropriate Processing	The process is not continuous; the product must be put in the sack before moving into the next process	Process time becomes longer

Table 3. MURI Analyze.

Process	Activity	Description	Visual proof
Pressing	Placing and taking material from the floor.	The body position of workers must frequently bend when sorting the material (left).	
	Writing the code on the material	Workers sometimes face difficulty in taking material that located too high (right)	
Stitching	Inspection.	Inspection is done on the floor, so sometimes the operator has to squat for a long time (left).	
	Transfer the material	The operator's body position must bent to take material that is located on the floor (right).	

3.2 Measure & Analyze

After the defect data was collected according to defect criteria, the sigma level can be measured. In general, sigma capability for all processes are above 3.9, with the lowest one is in pressing process with score of 3.929 (current sigma level). Table 4 showed the calculation of the current sigma level for pressing process. FMEA was then used to calculate risk priority number (RPN = Severity x Occurrence x Detection) and the result (see table 5) showed that raw component and cut off defect/failure in pressing process with the caution of material problems and human errors should be prioritized because it had the highest RPN.

Table 4. Current sigma level for pressing process.

Date	Production Quantity	Defect		
		Cut off	Burnt	Raw
17/9/2018	7585	31	77	39
18/9/2018	7752	41	65	69
19/9/2018	7737	42	98	70
20/9/2018	7332	22	83	79
21/9/2018	7777	24	62	64
Total	***38183***	***160***	***385***	***321***
Sigma Level		**3.929**		

SIGMA LEVEL CALCULATOR DISCRETE DATA

Enter Number of Defects:	866
Enter Number of Units:	38,183
Enter Number of Opportunities Per Unit:	3
Defects Per Million Opportunities:	7,560
Sigma Level	3.9

To find out the level of Process Cycle Efficiency (PCE), a tool called as Process Activity Mapping (PAM) was used to measure time and distance for every activity in a certain process; it was then

categorized into Value-Added Activity (VA) and Non-Value-Added Activity (NVA). PCE can be calculated by dividing amount of time for VA and total cycle time, PCE for stitching process is 95.12%. The result of PAM and the calculation of PCE for stitching process were shown in table 6.

Table 5. FMEA and RPN for pressing process.

No	Mode of Failure	Effect of Failure	SEV	Causes of Failure	OCC	Current Process Control	DET	RPN
1	Burnt component	Scrap	8	Material too soft	6	*Visual check*	1	48
			8	Temperature of oven too high	5	*Visual check*	1	40
2	**Raw component**	**Scrap**	**8**	**Material too hard**	**5**	***Visual check***	**2**	**80**
			8	Air con not cool enough	4	*Visual check*	2	64
3	**Cut off**	**Scrap**	**8**	**Human error**	**5**	***Visual check***	**2**	**80**

Table 6. Process Activity Mapping for Stitching Process.

No.	Activities	Machine / Distance	Activity time (sec)	VA	NVA
1	Take the materials from the storage	Distance: 10 m	169.97		169.97
2	Untie the knots		45.36		45.36
3	Prepare the machine		235.72		235.72
4	Stitch the material into component	Machine: Stitching	46350	46350	
5	Change threads if they runs out		11.72		11.72
6	Pile up, inspect, and count		2144.46		2144.46
7	Bind the materials		257.26		257.26
8	Put materials in storage	Distance: 10 m	173.57		173.57
9	Take the materials from the storage	Distance: 2 m	68.03		68.03
10	Untie the knots		90.72		90.72
11	Prepare the machine		235.72		235.72
12	Stitch the material into another component	Machine: Stitching	77250	77250	
13	Change threads if they runs out		11.72		11.72
14	Pile up, inspect, and count		2465.51		2465.51
15	Bind the materials		257.26		257.26
16	Put materials in storage	Distance: 10 m	173.57		173.57
Total			**129940.59**	**123600**	**6340.59**

For MURI identification, the results are obtained from quantitative analysis using MURI analysis [7]; in which every activity for each process is analyzed based on 9 categories (category A to I). The range of scores is 1 to 3, where 1 is for the lightest (good), 2 is for average, and 3 is for the heaviest (bad). Those categories, as shown in figure 3, are: (A) flexion angle of the waist, (B) rotation angle of the waist, (C) height of the working arm, (D) flexion and stretching angle of the knee, (E) rotation angle of the wrist, (F) pick up parts and materials, (G) working range, (H) walk, (I) transport. If an activity has score 1 for all those categories, with total MURI score is 9, the activity contributes low risk of working condition. If MURI score is more than 12, the activity should be improved because it contributes a high risk one. From MURI analysis, the causes of overburden were caused by: (i) the position of materials was too low or too high because of space limitation in production area, (ii) materials must be cooled on the floor in pressing process that caused operators have to move frequently, (iii) the inspections were done on the floor and there were no small seats for operators, (iv) some activities required operators to bend because the materials are on the floor.

4. Conclusion

This research proposed briefly a framework of DMAIC to deploy Lean Sigma. Two processes of footwear production i.e. pressing and stitching processes were selected to explain how the tools could be used and how the research activities were done. As the focal issue, the result presented how the

alignment between MUDA and MURI analysis can develop better improvement plans. For instance, the improvement plans in pressing process which were generated from MUDA analysis included: (i) proposing regular maintenance in order to solve the air con problem, (ii) reviewing the supplier performance in order to solve raw material problem. MURI analysis enhanced the improvement plans by suggesting to: (iii) add extra trolleys, (iv) provide small seats, and (v) use a cooling conveyor.

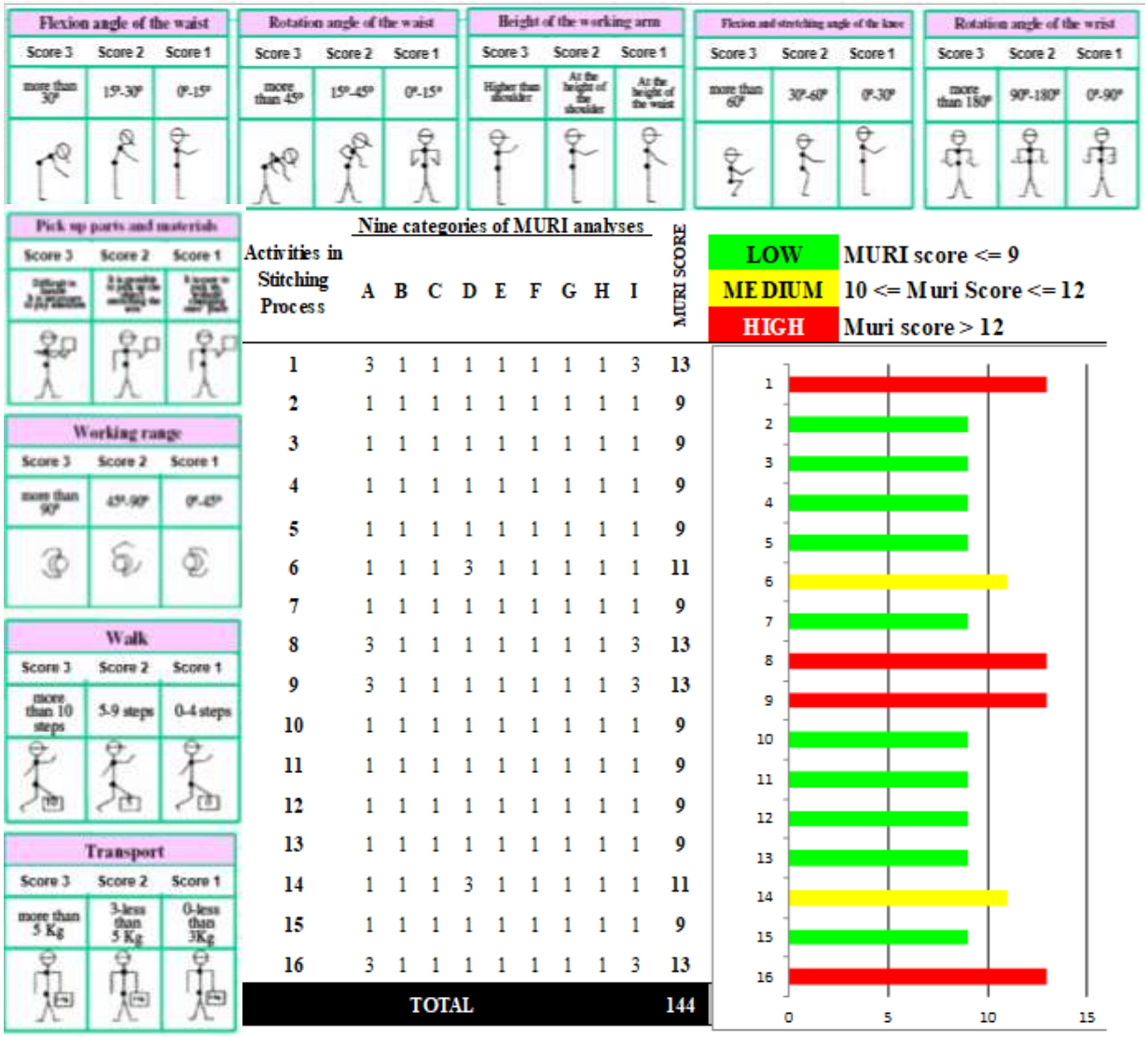


Figure 3. MURI analysis (for stitching process).

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Controlled release fertilizer based on starch chitosan encapsulation

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Abstract. Phosphor is a main component in a triple super phosphate (TSP) fertilizer which needed by plants. But, phosphor is very soluble in the water and makes it easily to be removed out of the soil, flows into the river, and causes algae bloom problem. The solution for the problem is by using the coating fertilizer with starch-chitosan based material. The coated hydrogel bead fertilizer is expected to have a phosphor controlled-released behaviour and retains the phosphor to be able stay for a longer time in the soil. The research deals with studying phosphorus releasing behaviour of starch-chitosan based fertilizer, water uptaking characteristic (swelling), and the morphology of material. The commercial granular fertilizer TSP was coated using starch-chitosan suspension. The coatings were conducted by spraying technique. The chitosan-starch mass ratio used were 100:0, 30:70, and 70:30, otherwise the starch percentages was made of 1%, 2%, and 3%. After coated by starch-chitosan suspension, the fertilizers were dried and used on the soil media. The soil which contained coated fertilizer was regularly watered and the phosphorus content was analyzed. The study showed that the water uptaking of the coated fertilizer was higher than the conventional uncoated fertilizer.The optimum condition of the chitosan-starch based coating is 30:70 and 2% of starch percentage. Furthermore, the higher chitosan content yields the higher water uptaking capacity. This phenomenon is supported by the Scanning Electron Microscope (SEM) result. The coating fertilizer with higher chitosan content (ratio of 70:30, 2% starch) has more pores than that of lower chitosan content (ratio of 30:70, 1% starch).

1. Introduction

Phosphorus is the important component in triple super phosphate (TSP) fertilizer. The component is easily dissolved and carried away by water which causes eutrophication problems [1]. According to [2], the phosphorus absorbed by plants is only 10-15%, the rest is released into the waters. This means that fertilizer efficiency is low because a lot of phosphorus is wasted.

Fertilizer can be modified to produce the fertilizer which has slower release behaviour than that of the conventional fertilizer. The purposes of modification are to control releasing process of nutrients into soil and to prolong the avaibility of the nutrients in the soil [3].

The modification can be conducted by coating the fertilizer using polymer such as chitosan and starch. Chitosan is a biopolymer which has an amine group produced from deacetylation of chitin and can be extracted from shrimp waste [4]. Besides it has controlled release behaviour, both of chitosan and starch have the ability to swell (save water). Those characteristics make them have dual function on fertilizer, as a controlled release system and also as water storage system that helps the availability of water in the soil especially in the dry season.

This study has purposes to synthesize and characterize chitosan-starch-coated fertilizers. The characterization includes the morphology and swelling properties of coated fertilizers. Then, the performance of coated TSP fertilizers is tested by analyzing the release rate of the component. The effect of the chitosan : starch mass ratio as coating material is also analyzed.

2. Experimental

The research is carried out in three steps of processes. The steps consist of the synthesis of chitosan-starch coated fertilizers, the characterization of the coated fertilizer and the analysis and modelling of phosphorus release rate.

2.1. Synthesis of hydrogel bead fertilizer

Chitosan solution 1% (w/w) was prepared by dissolving chitosan powder in 1% (v/v) acetic acid solution. The starch gel was made by heating 1, 2, and 3% (w/v) of tapioca flour in distilled water at 76 ºC. Chitosan solution and starch gel which had mass ratio (100:0, 70:30, 30:70) were stirred for 30 minutes. Then, the mixture was added 0.8 %w/w citric acid solution as a crosslinking agent and stirred for 2 hours. The coating process was conducted by spraying the coating mixture onto the entire surface of the fertilizer. After that the coated fertilizer was dried at 60 ºC for 12 hours. The fertilizer coating process was repeated for 5 layers.

2.2. Characterization of hydrogel bead fertilizer

The characterization of coated fertilizers was analysed by studying morphology and swelling behaviour of coating system. Morphological analysis was carried out using Scanning Electron Microscope (SEM). The morphology of the coated fertilizer surfaces were observed using an SEM FEI INSPECT S-50, Netherlands. The surface of the fracture was attached onto double-sided carbon tape and subsequently placed in a sample holder.

The swelling analysis was carried out by immersing a sample of dry-coated fertilizer in water for definite time and then weighing it. The procedure was repeated until the hydrogel beads fertilizer achieved the equilibrium. It was assigned by constant weight. Furthermore, the swelling parameters were analysed by comparing the changes in the coated fertilizer mass at a certain time to the dry hydrogel mass of coated fertilizer.

2.3. Controlled release of hydrogel bead fertilizer

A certain amount of coated fertilizer and topsoil were placed in a polybag that has been perforated. The arrangement on polybag was placed of soil-coated fertilizer-soil in series. Water reservoir was placed below the polybag to keep the water drain. Furthermore, the analysis was conducted by watering each system with an amount of water for 7 days. After watering process, the soil sample was analysed using spectrophotometer to find out how much phosphorus was released in the soil. The phosphorus in the sample was quantitatively determined via colorimetry by reacting orthophosphate with ammonium molibdovanadat to form a yellow complex molibdovanadat phosphoric acid compound. Yellow liquid containing phosphorus was analysed by spectrophotometer.

3. Results and Discussions

The commercial TSP fertilizer which has 36 %w/w phosphorus content was increased in its efficiency by modifying the fertilizer. Modification was conducted by coating the fertilizer surface with chitosan-starch mixture. The variation systems consist of 1% chitosan : starch with ratio 100: 0 (A), 70:30 (B), 30:70 (C) - 1% starch and 1% chitosan : starch 70 : 30 with 1% starch (D), 2% starch (E), 3% starch (F) and non-coating fertilizer (G). The phosphorus released in the soil was analysed on the same treatments for each variations. The optimum results of the variations was analysed on morphology, swelling ability, and the release rate of phosphorus content.

3.1. Morphology of chitosan-starch coating surface

The morphology of chitosan-starch coating on samples C and E were analyzed by Scanning Electron Microscope (SEM). The samples C and E have the optimum performance on phosphorus release. The C sample was coated fertilizer which has chitosan: starch ratio 30:70 ratio and 1% starch concentration, while sample E was coated fertilizer which has chitosan : starch ratio 70:30 and 2% starch concentration.

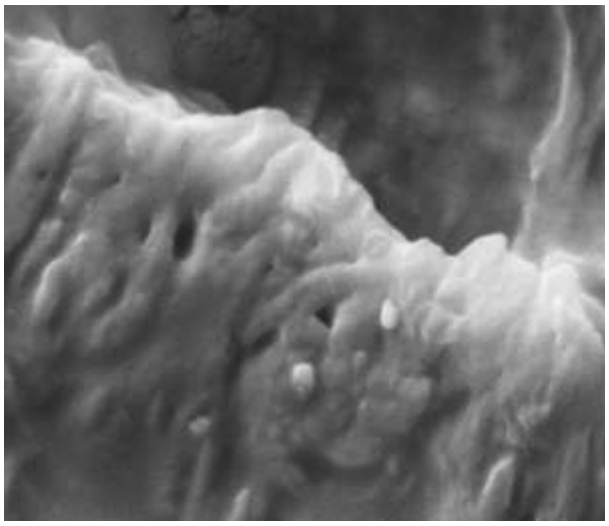


Figure 1. The morphology of coated fertilizer for chitosan : starch ratio 30 : 70 and 1 % starch solution (sample C).

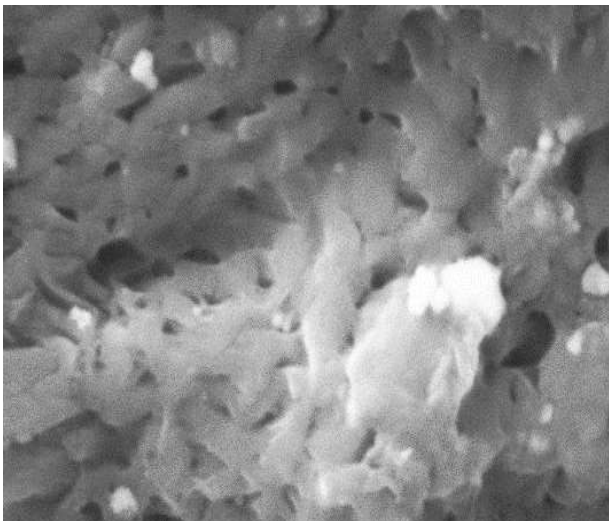


Figure 2. The morphology of coated fertilizer for chitosan : starch ratio 70 : 30 and 2 % starch solution (sample E).

Figure 1 and figure 2 show that the coating film consist of fiber matrix and some granulars distribute on the matrix. The fiber matrix is chitosan structure, otherwise the granular is starch component. The arrangement of chitosan fiber make pore on the film structure. The starch granular is attached on the chitosan matrix by crosslink linkage. The crosslink linkage occurs because the hydroxyl (OH) group in starch is replaced by an amine group (NH_2) from chitosan [5]. The matrix structure with granular become the surface to barrier the phosphorus content of TSP fertilizer release. The sample C (figure 1) is more dense than the sample E (figure 2). Sample C has more starch content, whereas the sample E has more chitosan content. An increase in starch content causes the coating pores to become denser than that of higher chitosan content. The pore size in sample C is 200-300 nm while in sample E is 200-600 nm.

Besides the size of pores on the matrix coating, there are differences number of pores for both of the samples. The sample E shows more number of pores than that of sample C. It indicates that sample E is easier to pass phosphorus content than that of sample C. This is proved by the amount of phosphorus on the soil for period of release as shown in figure 3.

From figure 3, it can be seen that on the first three days both sample C and E have the same phosphorus release behaviour, but on the next day the amount of phosphorus in the soil in sample E is lower than that of sample C. Sample C is able to maintain more amount of phosphorus in the soil than that of sample E. According to the results , it can be stated that the slow release behaviour of coated fertilizer can be obtained by creating the dense surface with less pore on the matrix structure.

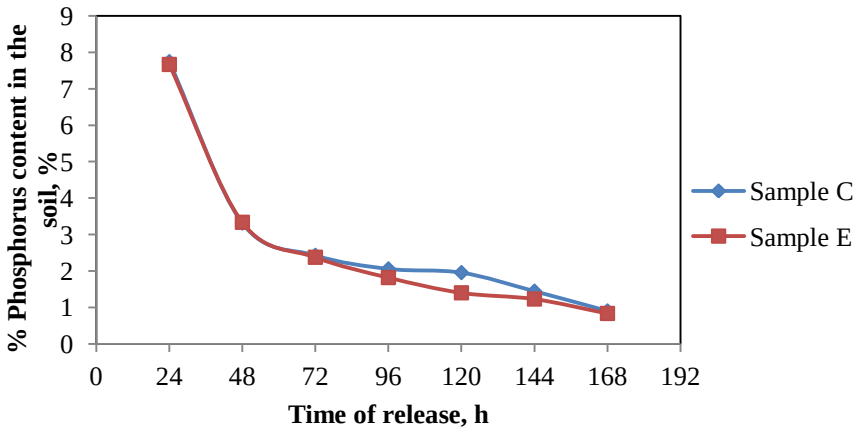


Figure 3. The percentage of phosphorus content on the soil after period of release because of watering.

3.2. Swelling Analysis

Swelling analysis is done to determine the water absorption capacity of the coating system. Table 1 shows the results of swelling analysis for each variation of fertilizer coating.

Table 1. The swelling behaviour for different coating systems on fertilizer.

Type of fertilizer	Starch content (%)	Chitosan : Starch ratio	Swelling (%)
A	1	100 : 0	24.658
B	1	70 : 30	24.735
C	1	30 : 70	18.422
D	1	70 : 30	25.099
E	2	70 : 30	18.917
F	3	70 : 30	20.282
G	-	-	7.828

When compared with non-coating fertilizer (sample G), it can be seen that the presence of coatings (sample A - F) increase the percentage of swelling. Increasing the swelling percentage indicates that the amount of water that can be absorbed by the coating is also increase. Table 1 shows that the presence of chitosan in coating system increase the percentage of swelling, where in samples A, B and D there is relatively more chitosan than starch. During the starch gelatinization process, the hydrophobic hydroxyl groups in the starch chain will lead to the outer side [6]. As a result of the condition, the more amount of starch content in the coating systems, the coating systems tend to be more hydrophobic and make the swelling percentage get smaller.

The presence of starch in the coating systems is proved to have an effect on the reduction on swelling, but the physical strength of the coating is improved by increasing the chitosan content. The result is supported by the research of Xu, et al. [7], that films made from chitosan have poor water vapor barrier characteristics or high Water Vapor Transmission Rate (WVTR) compared to films that have been modified with starch. Water vapor barrier or Water Vapor Transmission Rate (WVTR) is a parameter that indicates whether or not a layer is penetrated by water. A high WVTR or poor water vapor barrier indicates that chitosan films are easily passed by water vapor. On conclusion that the addition of starch will slow the release of phosphorus content because of reducing the ability of the coating to absorb water.

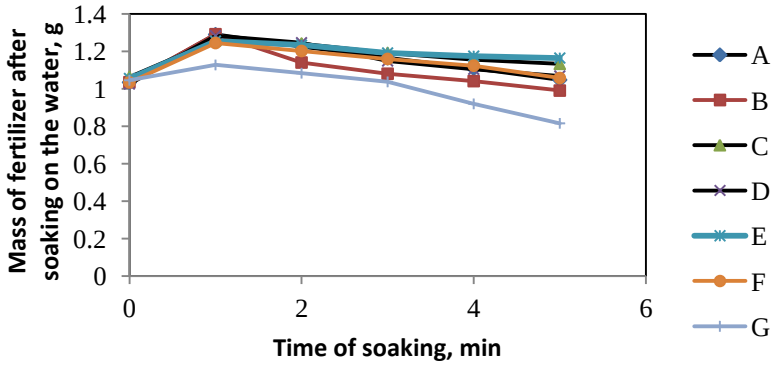


Figure 4. Mass of fertilizer after soaking on the water for period of time.

Figure 4 shows that the increase in fertilizer mass after soaking on the water has the maximum value in the first minute. It can be stated that the process of water absorption or swelling process of coated fertilizers occurs quickly. The phenomenon can be related that the phosphorus diffusion process out of fertilizer occurs slower and the phosphorus release process follows a diffusion controlled transport mechanism. If the swelling rate is much faster than that of the diffusion rate, the controlling mass transfer is the diffusion rate.

3.3. The Performance of Phosphorus Released by Coated Fertilizers

The release behaviour performance of coated fertilizer can be conducted by measuring the amount of phosphorus release in to the soil with a spectrophotometer.

Table 2 shows that the coated fertilizers have slower release behavior than that of non-coated fertilizers. The increasing amount of chitosan can produce the strong matrix of layer but give more pores, otherwise the increasing amount of starch can enhance the hydrophobicity of coating system. The sample C give the best performence as slow release fertilizer because it has the best physical properties as surface barrier to retain the phosphorus on the fertilizer. It can also be stated that the effect of the chitosan : starch ratio is greater to release behaviour than that of the starch content on coating system.

Table 2. The Amount of Phosphorus Release on to soil at different sample for period of release.

Type of Fertilizer	Percentage of Phosphorus Content (%)						
	24 h	48 h	72 h	96 h	120 h	144 h	168 h
A	7.775	3.537	1.611	1.617	1.174	1.131	0.499
B	7.651	3.334	2.236	1.669	1.062	1.104	0.499
C	7.745	3.316	2.430	2.059	1.956	1.448	0.904
D	7.671	3.448	2.317	1.422	1.230	1.091	0.585
E	7.668	3.337	2.377	1.820	1.402	1.231	0.835
F	8.378	3.613	2.156	1.712	0.954	0.734	0.838
G	8.449	3.043	2.236	1.679	1.173	0.987	0.582

The results of this study can be compared with the research Perez, J. and Francois, N. [8] who examined the behavior of nitrogen release in chitosan-starch coated fertilizers. The results of the study indicated that the higher amount of chitosan in the coating system, the more nitrogen can be released from fertilizer. At various chitosan : starch ratio 100:0; 30:70; and 20:80 nitrogen releases reached 95%, 73% and 80%, respectively. From this study it can be stated that the starch content for optimum performance is in the coating system which has composition chitosan : starch ratio as high as 30:70. The optimum coating is a coating which has the best physical properties so that the release of phosphorus is minimum.

4. Conclusions

The presence of chitosan on the coating system is responsible to produce a porous matrix surface otherwise, the availability of starch tends to reduce the number of pores in the surface. The swelling analysis shows that the presence of chitosan-starch coatings increases the water absorption ability. The greater the content of chitosan, the higher the percentage of swelling. The release behaviour analysis shows that the optimum of coated fertilizer is the fertilizer which has mass ratio of chitosan : starch by 30:70, and starch concentration of 1%.

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Assessing materials from hoarded mobile phones: hidden e-waste subject for reverse logistics

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Abstract. The advancement of communication technology is shortening the lifetime of mobile phones (MP), resulting in a phenomenal increase in mobile phones waste (MPW). However, instead of recycling their obsolete devices, customers shelved MPW for personal data stored inside. This study aims to estimate secondary minerals contained in MPW stockpiled by Indonesians. "Consumption and used" method is employed to assess the quantity of MPW generated in this country based on data of mobile subscribers. Considering that MP life span is around 3 years, and about 38% of obsolete MP are hoarded by their owners, this study reveals that about 339.69 million units of MPW are waiting to enter the reversed logistics. This volume of MPW may generate economic intrinsic at approximately USD 508 million from valuable metals such as 80,949 Kg of silver, 8,873 Kg of gold, and 2,547 Kg of palladium. It implies that hoarding MPW impedes the noble goal of recycling; that is to promote sustainable materials management (SMM) since mining precious metals from e-waste will reduce the demand of virgin minerals directly extracted from nature and reduce environmental impact. This paper highlights that it is imperative to develop a sustainable system to support the mineral supply chain.

1. Introduction

When mobile phones (MP) were firstly introduced in Indonesia market, not many residents could afford to buy this particular technology. However, purchasing power in this country has improved along with its economic growth. As a result, the demand of these equipments escalates persistently. In facts, the penetration of medium brands with affordable price has made smartphones popularity increases among lower-medium income residents. They are attracted to multiple functions embedded in these devices. Having diverse features, smartphones can assist people in many ways. For example, maintaining social relationship, reading news and doing many other activities.

The number of cellular customers in this country experienced enormous growth, since it is the third biggest market of MP in Asia. In 2001, there were only 3.6 million subscribers then it multiplied almost a hundred times within 15 years (see figure 1); at a point that outnumbered its population. In 2015, this country was populated by 255 million inhabitants [1] but mobile cellular subscriptions reached more than 338 million [2]. This mobidensity (mobile connections per 100 citizens) of 132% is clear evidence that some residents posses more than one active MP. It is supported by a survey conducted by Maheswari et al. [3] that there were 47.9% of Indonesians who have 2 or 3 active phones.

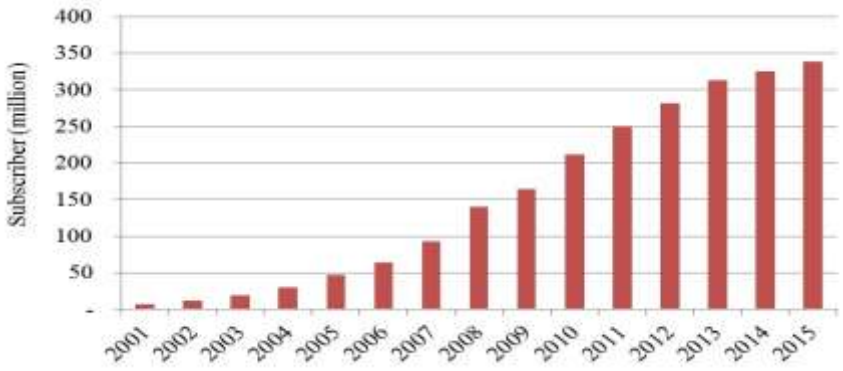


Figure 1. Mobile cellular subscriptions in Indonesia [2].

The increasing amount of MP ownership along with significant improvement in communication infrastructure explains how this country is in the period of a digital revolution [4]. It raises concern because this proliferating number of MP demand has a positive correlation to the enormous amount of MPW. The MPW quantity will continue to rise driven by technology enhancement that provokes people to replace their gadgets. Due to its short lifespan, literature shows that MPW dominated the number of e-waste in this country [5,6]. Recently, Santoso et al. [6] applied population balance method and estimated that in 2028, the amount of e-waste generated in Indonesia will be about 49.62 million units, including MPW of 40.78 million units or 82%. This number is alarming since management of obsolete telecommunication devices in the country shows minimum progress. Besides, it is portraying that developing sustainable e-waste management is urgent.

Sustainable e-waste management needs a legal framework, collection mechanism, transportation scheme and processing infrastructure [7]. In this system, collection plays as a front gate and it influences the whole process. The collection rate will be affected by consumer's willingness to recycle their old devices. However, for many reasons users prefer to retain their end of used MP. Some people replace their old MP since they have malfunctioned and it is cheaper to buy a new one rather than bringing the broken handheld to service centres [8]. Others who are addicted to gadgets, change their MP merely because they are fascinated by the innovative features in the latest models [8, 9]. Moreover, people hesitate to recycle their MPW since their personal data were loaded inside. They are afraid of privacy disclosure [3]. As this type of e-waste is small enough, keeping them does not need much space in a room. Consequently, a large proportion of MPW buried deep inside one's drawers; stockpiled by their owners. This has become a barrier to mineral resources sustainability as shown in figure 2. Indonesians who show this kind of behaviour are about 38% [3]. To compare, residents in India, China, and Spain who have a similar habit are 59%, 62% and 73% respectively [8, 9, 10].

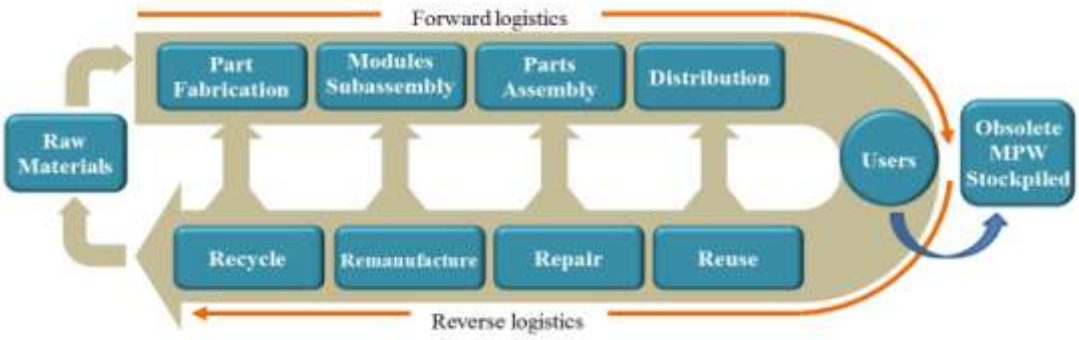


Figure 2. Minerals in stockpiled MPW outside the reverse logistics (modified from [11]).

Minerals recovery is imperative for MP since numerous metals including rare earth elements embedded in them. Although in a tiny amount, they are indispensable. They make the device working. As MP production is increasing, so does demand for these minerals. However, natural reserves of some metals are reaching their scarcity level nowadays [12, 13]. It makes the supply vulnerable. Moreover, the market and regulation fail to support mineral life cycle from MPW [14]. For this reason, promoting sustainable materials management through recycling is urgent because it can recover a lot of mineral. Effective recycling also supports reverse supply chain. It will lengthen the life cycle of critical metals. Secondary minerals extracted from e-waste, can be used for manufacturing new products. Besides, having better life cycle can preserve virgin material extracted directly from nature and reduce destructive environmental impact [15]. A study by Szamalek and Galos [16] estimated that the quantity of MPW in the world hidden by their owners was around 14 billion units and half of them are smartphones. These hoarded telecommunication handhelds may generate precious minerals such as 3,892,000 Kg of silver, 378,000 Kg of gold and 140,000 Kg of palladium [16].

The amount of metals in MP is diverse for each model. In general, minerals in 4G models are different in comparison to their predecessor 2G models. It corresponds to their design and features. Material consumption in modern smartphones with their rich feature is dissimilar from older models that only have basic functions. The type and amount of materials covered in a touch screen smartphone is in contrast with MP with QWERTY keyboard. For example, the usage of indium (In) is related to smartphones with LCD display [17]. Although MP models are varied, it should be noticed that valuable metals can be found in every model; from outdated to a modern one. These precious metals undoubtedly are driving factors for the high economic value of e-waste [15]. The average content of precious metals inside MP which are produced in three distinct generations; 2001, 2005 and 2010 are listed in table 1 [18, 19].

Table 1. Precious metals in mobile phones [18, 19].

	Mass (g)		
Metals	2001	2005	2010
Silver (Ag)	0.244	0.150	0.305
Gold (Au)	0.038	0.018	0.030
Palladium (Pd)	0.015	0.001	0.011

This study aims to assess the valuable metals that can be recovered from end of life MP, which passively lie in wait for entering reverse supply chain. It raises awareness among MP users that the recycling of materials embedded in MPW related to preserving minerals in nature and extending the circular economy. It also portraits that stockpiling MPW will affect the supply chain and cost the environment. Moreover, this research emphasizes how important for this country to have sustainable e-waste management with reliable collection systems. A trustworthy one so that it can motivate residents to recycle their MPW. The remainder of the paper structured as follows: the research method is presented in section 2, followed by result and discussion in Section 3 and conclusions in section 4.

2. Method

Two steps are employed to assess the valuable minerals from hoarded MPW. First, the number of MPW retired annually is calculated by adopting "consumption and used" method [19]. This method is also known as the approximation approach. It needs two input data; the number of active MP and their average lifetime. As the estimated proportion of stockpiled MPW, data presented by Maheswari et al. [3] in their research is utilized in this study. The calculation is conducted using the following formula:

$$Q_t = (N_t/\mathrm{l})\mathrm{H} \quad (1)$$

where Q_t (units/year) is the quantity of retired MPW in year t, N (units) is the number of active MP which is equivalent to mobile phone subscriptions in a particular year, l (years) is the average lifetime of MP, and H (%) is the proportion of MP stockpiled by customers. Maheswari et al. in their survey reveals that average useful lifespan of MP in this country is about 2.57 year [3]. While by applying the Weibull distribution, Santoso et al. [6] found that the average lifetime of MP in this country is around 3.42 years. Based on their research, in this study, 3 years is assumed as the average replacement time of MP. For example, if one bought his phone in 2005, he would replace it in 2008. Besides, in accordance with the previous study [3], 38% is adopted as a proportion of hoarded MPW.

Finally, the secondary minerals contained in hoarded MPW are estimated based on information presented in table 1. The quantity of MPW is grouped in three according to their generation. It is because every generation of MP has its own characteristics and may include a distinct amount of metals. The average mass of metals for MP produced around 2001 is a key to assess minerals for MPW generated from 2001 to 2007. Mostly they are phones with basic functions; making phone calls and sending text messages. As for metals covered in MP produced around 2005 is used for MPW generated from 2008 to 2012. These are for MP with several additional functions. For example, they have an embedded camera and speaker. Besides, they also have bigger capacity to save data. Finally, materials embedded in MP manufactured around 2010, are useful to estimate the valuable metals contained in MPW generated from 2013 to 2016. These are smartphones generation with touch screen models. Usually they have rich features and able to connect to the internet.

3. Result and Discussion

3.1. Retired mobile phones hoarded by owners

The annual quantity of MPW generated in Indonesia is assessed by applying formula 1. The results are presented in table 2. It shows that by the end of 2016, the total MPW generated in this country has already reached 893 million units. It includes 339 million MPW that are passively waiting outside the reverse supply chain. This extensive amount is an accumulation effect of low recycling rate. Besides, the vacancy of appropriate e-waste treatment and the lack of environmental awareness also play significant parts [3].

Table 2. Estimation of retired and hoarded MPW.

Year	MPW retired	MPW hoarded
2001	2,173,649	825,987
2002	3,900,000	1,482,000
2003	6,165,084	2,342,732
2004	10,112,202	3,842,637
2005	15,636,657	5,941,930
2006	21,267,672	8,081,715
2007	31,128,960	11,829,005
2008	46,859,414	17,806,577
2009	54,558,987	20,732,415
2010	70,430,078	26,763,430
2011	83,268,540	31,642,045
2012	93,987,888	35,715,398
2013	104,408,971	39,675,409
2014	108,527,606	41,240,490
2015	112,982,780	42,933,456
2016	128,524,466	48,839,297
Total	893,932,956	339,694,523

As shown in table 2, MPW that retired in 2001 but still in stored by their owners is about 825,987 units or 82.59 ton. It increased consistently every year. In 2016 the number reached 48,839,297 units or in terms of weight it is 4,883 ton. This number will grow persistently in the future as people will maintain their behaviour before trustworthy system to collect e-waste is available. The current finding has a small contrast with previous research performed by Santoso et al. [6] in which they estimated that the number of MPW in 2028 is about 40.78 million units or 4,078 ton. In total, the quantity of hidden MPW in the country is about 339 million units.

To answer the objective of this research, it is imperative to group the quantity of hoarded MPW in table 2 in three. The first one is for MPW generated from 2001 to 2007. Because in this period, the number of cellular subscribers was only about 93 million, this group has the lowest quantity; that is 34,346,005 units in total. The next group is for MPW generated from 2008 to 2012. The number of hoarded MPW from this generation is 132,659,865 units. The last group is MPW generated from 2013 to 2016 or smartphones models. With 172,688,653 units, the last group has the highest number compared to another two; almost half of the total quantity. Having megabytes capacity to save data, users find their smartphones bursting with personal data. It makes them have a stronger emotional attachment. Consequently, they hesitate to recycle their old gadgets and prefer to retain them for a longer period instead. The result is in agreement with Szamalek and Galos [15], that half of the hoarded phones are smartphones.

3.2. Valuable minerals lie in wait for reverse supply chain

This section discusses the estimated amount of valuable materials contained in three distinct generations of hidden MPW and their economic value. To determine the amount of valuable metals contained in hoarded MPW, metals weight in each MP as listed in table 1 is multiplied by the MPW quantity in each group. The result is presented in table 3. It shows that in total, silver, gold, and palladium that can be recovered from hoarded MPW in this country are about 80,949 kg, 8,873 kg, and 2,547 kg respectively.

Table 3. Amount of materials in hoarded mobile phone.

	Mass (Kg)			
Metals	2001-2004	2005-2009	2010-2015	Total
Ag (Silver)	8,380.43	19,898.98	52,670.04	80,949.44
Au (Gold)	1,305.15	2,387.88	5,180.66	8,873.69
Pd (Palladium)	515.19	132.66	1,899.58	2,547.43

When this study is conducted, the average price index for Ag, Au, and Pd in the global market were (in USD/t oz) 14.50, 1,280 and 1,290 respectively [20]. The monetary values of precious metals in table 3 are determined based on those prices. The potential economic value for each identified metal is approximately USD 37.7 million for silver, 365.2 million for gold, and 105.6 million for palladium. Those three metals worth USD 508.5 million in total or in local currency they are worth IDR 7.3 trillion. However, this study is assessing the value of three precious minerals only. It should be noted that the number would be higher if all the types of minerals including the rare earths covered in MPW is also considered.

4. Conclusion and Recommendation

This study assesses the quantity of precious minerals inside hoarded MPW and its economic value. Every MP contains various materials, which makes recycling imperative. Because sustainable mineral management has a positive correlation to sustainable e-waste management, consumer's awareness and behaviour play an essential role. Most people hesitate to bring their MPW to collection points; they hide these small devices in their home instead. The quantity of hoarded MPW in Indonesia is

estimated at around 339.69 million units, and half of them are smartphones. Economic intrinsic in the form of valuable metals contained in this volume of MPW is approximately 80,949 Kg of silver, 8,873 Kg of gold and 2,547 Kg of palladium. One disheartening fact is that these metals worth of USD 508.5 million is waiting outside the reverse supply chain. Therefore, sustainable e-waste management need to be developed to save these mineral.

By reliable collection system, secondary minerals extracted from e-waste will find their way back in the manufacturing cycle. Some measures can be applied to collect MPW from the society. Government can provide a formal and permanent collection facility as part of sustainable e-waste management. It is useful for the country for long terms period. However, asking residents for donating their MPW in a campaign to solve a specific issue may show effective result. It helps the reverse supply chain. For example, when Australian zoos campaigned for gorilla conservation, they successfully collected 115,369 MPW from their visitors from 2009 to 2014 [21]. Recently, Japan's Olympic Committee is asking e-waste donation from society in order to create the entire medals for 2020 Tokyo Olympic. Those are some evidences that organized missions can influence people and raise their awareness.

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Optimisation of subtractive rapid prototyping process parameters using response surface methodology

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Abstract. Subtractive rapid prototyping machine is the most suitable tool to manufacture a polymer based prosthetic part because it is able to achieve a low surface roughness value for a complex and customised part. Many investigations have been conducted to explain the relation among the surface roughness value, the material rate removal, and the subtractive rapid prototyping process parameters. It is important to find the optimum process parameters in order to achieve the most efficient and productive process. However, none of the research found in the literature optimises the subtractive rapid prototyping process parameters in fabricating polycarbonate part. Therefore, this research goal is to find the optimum process parameters to achieve the lowest arithmetic average of surface roughness value of the polycarbonate part in maximum material removal rate. In this research, the response surface methodology is implemented to optimised feed rate, step-over, and depth of cut of the subtractive rapid prototyping process. This research finds the feed rate, step-over, and depth of cut values that can be used to achieve the best result in manufacturing of polycarbonate material.

1. Introduction

Polycarbonate material has been applied for various prosthetic products as it is strong, tough, and transparent thermoplastic material. A prosthetic product is mostly an intricate product and customized for each patient. As a result, the feasible process to fabricate the product is by using rapid prototyping. Rapid prototyping process can be performed by using subtractive or additive methods. Subtractive rapid prototyping is carried out by implementing high speed milling process to cut the raw material in order to produce the part. Meanwhile, additive rapid prototyping carried out by depositing materials layer by layer to build the shape of the part. For a certain type of prosthetic parts such as a socket of prosthetic leg that require a specific surface roughness and dimensional accuracy, the subtractive rapid prototyping is preferable to be implemented. The main purpose of subtractive rapid prototyping is to achieve the required minimum surface roughness and dimensional error in the maximum material rate removal. Therefore, the optimisation of subtractive rapid prototyping process parameters in fabricating polycarbonate materials is considered as a significant problem and needs to be tackled. This paper only describes the optimisation of subtractive rapid prototyping processes to achieve the maximum material removal rate and the minimum surface roughness. The novelty of this research lies in optimising the subtractive rapid prototyping process parameters to achieve the maximum material

removal rate and half of the arithmetic average of surface roughness value resulted by using additive rapid prototyping process.

2. Literature review

Limited research found in the literature discussed rapid prototyping process of polycarbonate. The possibility to fabricate a thin fin of polycarbonate material by using subtractive rapid prototyping is investigated by Nieminem, I., et. Al [1]. However, they did not investigate the influence of the depth of cut and step-over on the surface roughness and the dimensional error of the polycarbonate material.

Other researchers conduct an investigation on the influence of high speed milling process parameters on metal materials. The research by Albertí, M., et. al., Vivancos, J., Urbanski, J.P., Oktem, H., et al., The, J.S., et. al., Ma, W., et.al., Zeroudi, N. and Fontaine, M., and Shimana, K., et. al. show that material removal rate, surface roughness, and dimension error of a material are affected by physical and mechanical characteristics of the material, depth of cut, step-over, feed rate, cutting speed, cut type, interpolation type, tool holder type, physical and mechanical characteristics of the tool, vibration, controller of the machine, and computer aided manufacturing software [2, 3, 4, 5, 6, 7, 8, 9].

Suteja, T.J. develops several models to show the influence of the depth of cut, feed rate, and step-over on the vertical and horizontal surface roughness, vertical length error, horizontal length error, and depth error of polycarbonate material in subtractive rapid prototyping [10, 11]. The models show that the vertical surface roughness is positively affected by the feed rate, the step-over, and the depth of cut. The parameter that has the most influence on the vertical surface roughness is the step-over. In addition, the depth of cut and the interaction between the step-over and the depth of cut has a positive influence on the horizontal surface roughness.

The expected surface roughness values to optimize the process parameters are determined based on literature review. As the additive rapid prototyping can also be used to fabricate a product made of polycarbonate, then a review of previous research is conducted to investigate the achieved surface roughness of part fabricated by using an additive rapid prototyping.

Ippolito, R., et. al. compared five methods of additive rapid prototyping [12]. According to Ippolito, R., et. al., the achieved arithmetic average of surface roughness of additive rapid prototyping process is varied in the range between 0.001 to 0.025 mm. In addition, the parallel arithmetic average of surface roughness is lower than the perpendicular feed rate direction.

Fox, J.C., et. al., conduct experiments performed on Laser Powder Bed Fusion type of additive rapid prototyping with the EOS M2701 system using the commercially available Stainless Steel powder [13]. According to their research, the value of arithmetic average of surface roughness increases as overhang angle decreases. The minimum and maximum surface roughness values achieved by using the additive rapid prototyping process are 0.015 to 0.045 mm respectively.

The purpose of this research is particularly for investigating the subtractive rapid prototyping of a polycarbonate prosthetic product. He, Y., et al. implemented Scanning Printing Polishing Casting to fabricate a prosthetic product [14]. Based on their research, the fabrication method can achieve a low arithmetic average of surface roughness (maximum 0.002 mm) and require low cost. However, the method requires more complex process and longer time.

Udroiu, R., et. al., investigate the surface quality for a polymer-based additive rapid prototyping [15]. The additive rapid prototyping machine used is EDEN 350 using PolyJet technology. Based on the result, the arithmetic average of surface roughness values for the PolyJet material jetting process with matte finish were in the range of 0.0005 to 0.015 mm. For the glossy finish, the arithmetic average of surface roughness values in the range of 0.0005 to 0.010 mm. Though PolyJet technology can achieve lower surface roughness, the cost of the process is still high.

The widely used additive rapid prototyping technology is Fused Deposition Modelling because the cost of the technology decreases into feasible price. The research by Kaji, F., et. al. proposes a model of surface roughness in Fused Deposition Modelling especially for the geometry of the cusp profile [16]. The result of the research shows that the layer thickness generally has a deep effect on the surface roughness. The minimum surface roughness value achieved by using 0.125 mm layer thickness is 0.015 mm.

Based on the literature review, the aim of this research is to optimize the process parameters in subtractive rapid prototyping to achieve the half of the arithmetic average of surface roughness values of the Fused Deposition Modelling, which is maximum of 0.0075 mm (7.5 μm), in the maximum material rate removal of polycarbonate material.

3. Methodology

Response Surface Methodology is implemented in this research to develop several mathematical models and validate the models. The shape and the dimensions of the polycarbonate material specimen fabricated by using the subtractive rapid prototyping process are shown in Fig. 1. Roland MDX 40 is used as the subtractive rapid prototyping machine. The machine is assisted by CAM Modela Player 4.0 software to generate the tool path from the STL format model. A carbide solid square end mill with 5 mm diameter is used as the cutting tool. In order to move the cutting tool, the software uses zigzag cut type.

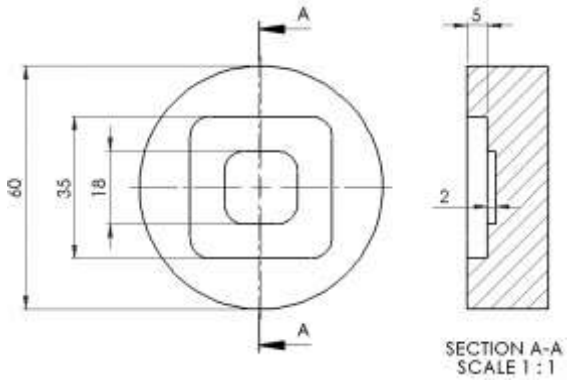


Figure 1. The specimen (in mm).

Different parameter values for roughing and finishing processes are determined based on the tools catalogue and interview with the expert. Table 1 shows the roughing parameter value of the subtractive rapid prototyping. Three levels of value for depth of cut, feed rate, and step-over are designed for finishing process. The value of each level for each parameter as shown in table 2 is determined based on the machine specification, literature study, and the preliminary experiment. The subtractive rapid prototyping is performed under dry operating condition. The spindle for finishing process is 10000 rpm and the entry speed for finishing process is 4 mm/s. The polycarbonate material is assumed always homogeneous. Then, the cutting temperature is assumed always constant. Finally, the tool wear is assumed to occur after performing three roughing and finishing processes.

Table 1. Parameter value for roughing.

Feed Rate	: 12 mm/s
Entry Speed	: 4 mm/s
Spindle Speed	: 8500 rpm
Depth of Cut	: 0.37 mm
Step-over	: 1 mm

Table 2. Parameter value for finishing.

	Low	Middle	High
Depth of Cut [mm]	0.1	0.235	0.37
Feed Rate [mm/s]	12	14.5	17
Step-over [mm]	0.3	0.65	1

Material rate removal and arithmetic average of surface roughness are investigated in this research as the responses. To calculate the material rate removal, the time needed to fabricate the specimen is measured by using a stopwatch. The arithmetic average of surface roughness is measured by using

Mitutoyo SJ 210 with 0.01 µm of accuracy at Industrial Metrology Laboratory of University of Surabaya. Two direction of arithmetic average of surface roughness measurement is conducted, which are horizontal and vertical directions. After the measurement process, the measured data is analyzed by using MINITAB release 14 software.

4. Results and discussion

The design of the first order experiment are shown in table 3. The first order experiment involves all two level factors using 2^3 factorial design with additional 5 center points. The result of the first order experiment is showed in table 3. RaVer is vertical arithmetic average of surface roughness [µm], RaHor is horizontal arithmetic average of surface roughness [µm], and MRR is material rate removal [mm^3/s].

Table 3. First order experiment results.

Std Order	Run Order	Feed Rate [mm/s]	Step-over [mm]	Depth of Cut [mm]	RaHor [µm]	RaVer [µm]	MRR [mm^3/s]
11	1	14.50	0.65	0.235	3.13	7.25	1.221673
13	2	14.50	0.65	0.235	3.22	7.83	1.220947
2	3	17.00	0.30	0.100	2.53	4.46	0.266056
12	4	14.50	0.65	0.235	3.18	8.65	1.222763
7	5	12.00	1.00	0.370	4.88	12.39	2.607133
9	6	14.50	0.65	0.235	2.89	7.83	1.220637
3	7	12.00	1.00	0.100	3.64	12.01	0.704914
5	8	12.00	0.30	0.370	3.00	4.70	0.801036
10	9	14.50	0.65	0.235	3.55	8.33	1.217333
6	10	17.00	0.30	0.370	4.18	4.59	0.983487
1	11	12.00	0.30	0.100	2.81	3.60	0.215947
4	12	17.00	1.00	0.100	4.30	12.08	0.868179
8	13	17.00	1.00	0.370	4.49	12.01	3.213400

Based on the result of the validation step, the first order models is not adequate as a linear regression model. For that reason, the second order experiment for material removal rate, vertical arithmetic average of surface roughness, and horizontal arithmetic average of surface roughness must be conducted. The central composite design is used to determine the number of the second order experiment run. The design and result of the second order experiment is shown in table 4.

By using the experiment result shown in table 4, the prediction model of material removal rate, vertical arithmetic average of surface roughness, and horizontal arithmetic average of surface roughness are shown in Eq. 1, Eq. 2, and Eq. 3.

$$MRR = 0.462 - 0.0260\ x\ F - 0.901\ x\ S - 2.833\ x\ D - 0.00067\ x\ F^2 - 0.162\ x\ S^2 - 0.345\ x\ D^2 + 0.0761\ x\ F\ x\ S + 0.2129\ x\ F\ x\ D + 7.804\ x\ S\ x\ D \quad (1)$$

$$Ra_{hor} = 2.61 + 0.007\ x\ F - 0.41\ x\ S + 1.31\ x\ D + 0.0038\ x\ F^2 + 1.450\ x\ S^2 + 12.46\ x\ D^2 - 0.067\ x\ F\ x\ S - 0.485\ x\ F\ x\ D + 3.73\ x\ S\ x\ D \quad (2)$$

$$Ra_{ver} = -8.9 + 0.88\ x\ F + 17.65\ x\ S + 6.4\ x\ D - 0.0146\ x\ F^2 + 3.34\ x\ S^2 + 13.9\ x\ D^2 - 0.521\ x\ F\ x\ S - 0.59\ x\ F\ x\ D - 4.10\ x\ S\ x\ D \quad (3)$$

where F is feed rate [mm/s], S is step-over [mm], and D is depth of cut [mm]. According to the result of the validation step for the second order experiment, the developed equations can be used as the best prediction model.

The aim of this research is to determined the feed rate, step over, and depth of cut in subtractive rapid prototyping to achieve the maximum material rate removal of polycarbonate material and the arithmetic average of surface roughness less than or equal to 7.5 µm. The multiple response optimizer based on desirability approach is used to maximize the material rate removal and minimize the horizontal and vertical arithmetic average of surface roughness [17]. The result shows that the optimum condition achieved when the feed rate, step-over, and depth of cut are set in 18.70 mm/s, 0.54 mm, and 0.46 mm respectively. The maximum material removal rate achieved by implementing these parameters is 2.3672 mm^3/s. The achieved horizontal and vertical arithmetic averages of surface roughness are 3.5842 µm and 7.4867 µm respectively.

Table 4. Second order experiment results.

Std Order	Run Order	Feed Rate [mm/s]	Step Over [mm]	Depth of Cut [mm]	RaHor [µm]	RaVer [µm]	MRR [mm^3/s]
18	1	14.5000	0.65000	0.235000	3.64	8.20	1.33510
19	2	14.5000	0.65000	0.235000	3.36	8.73	1.22121
10	3	18.7045	0.65000	0.235000	2.80	7.76	1.47727
15	4	14.5000	0.65000	0.235000	2.74	7.57	1.22204
20	5	14.5000	0.65000	0.235000	2.72	9.67	1.22152
13	6	14.5000	0.65000	0.007958	3.33	9.53	0.04138
14	7	14.5000	0.65000	0.462042	3.90	9.08	2.40249
5	8	12.0000	0.30000	0.370000	3.71	5.05	0.79896
11	9	14.5000	0.06137	0.235000	2.35	0.88	0.11581
8	10	17.0000	1.00000	0.370000	4.29	13.21	3.21431
6	11	17.0000	0.30000	0.370000	3.51	5.38	0.98372
2	12	17.0000	0.30000	0.100000	3.10	4.88	0.26597
9	13	10.2955	0.65000	0.235000	3.28	8.90	0.97840
7	14	12.0000	1.00000	0.370000	5.03	13.72	2.61059
12	15	14.5000	1.23863	0.235000	4.60	18.61	2.25131
4	16	17.0000	1.00000	0.100000	3.48	12.50	0.86892
3	17	12.0000	1.00000	0.100000	3,26	13,20	0.70532
16	18	14.5000	0.65000	0.235000	2,94	7,41	1.21149
1	19	12.0000	0.30000	0.100000	2,95	2,77	0.21595
17	20	14.5000	0.65000	0.235000	3,42	8,76	1.22183

5. Conclusions

The goal of this research is to optimize the subtractive rapid prototyping parameters for polycarbonate material by implementing the response surface methodology in order to achieve the maximum material rate removal of polycarbonate material and achieve the horizontal and vertical arithmetic average of surface roughness less than or equal to 7.5 µm at the same time. The optimized feed rate, step over, and depth of cut for the subtractive rapid prototyping are found to be 18.70 mm/s, 0.54 mm, and 0.46 mm respectively. By implementing these parameters, the achieved material removal rate is 2.3672 mm^3/s and the maximum achieved vertical arithmetic average of surface roughness is 7.4867 µm.

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A kinetic study of oil-in-water emulsion formation stabilized by rice husk ash and lecithin

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Abstract. Many food products have been in the forms of emulsions whereby at least one phase was dispersed in other phases. Since emulsions consisted of different immiscible phases, they tended to be unstable with time despite the incorporation of emulsifiers. In this study, the stabilities of oil-in-water (O/W) emulsions prepared using emulsifier mixtures of rice husk ash (RHA) and lecithin were monitored with time and destabilization kinetics of emulsion were studied. Rice husk ash of 2% was combined with various lecithin concentrations ranged from 0.5% to 3% and were added into the oil phase. The emulsification was carried out using a rotor stator homogenizer. The results showed that the rate of emulsion destabilization followed the first order kinetic model. The lowest value k_1 of 0.4 $x10^{-3}$ $minute^{-1}$ was obtained from the combination of 2% RHA and 2% lecithin. This implied the synergism action of RHA with lecithin in stabilizing the emulsion. The mixtures of lecithin and RHA seemed to be quite promising in stabilizing the O/W emulsion system for designing healthy O/W emulsion food based products.

1. Introduction

Food has been an essensial basic need of human being, therefore the overall quality of food products such as appearance, texture, flavour, nutrient, and stability has to be considered. Stabilizers are usually added into food formulations in order to improve the texture and appearance of food products. Emulsifiers are amongst stabilizers which commonly added into food formulations containing oil and water phases. Emulsifiers generally consist of one or more hydrophobic groups and one or more hydrophilic groups. Due to its amphiphilic nature, emulsifiers are adsorbed on the oil-water interfaces while reducing the surface tension arising between them and help dispersion of the dispersed phased in the continuous phase. There are increasing attempts to reduce the use of polymeric emulsifiers since they may cause some adverse effects, such as air entrapment, foaming, irritancy, and detrimental interaction with living matter [1] and also obesity [2].

Emulsion stabilized by particles which is so called Pickering emulsion has recently been gaining a great interest since it may impart an extreme stability to emulsion by hindering droplets coalescence, may reduce toxicity thus safer to use *in vivo*, and may bestow other preferred traits such as porosity, responsiveness, etc [3]. Solid particles such as carbon, silica, clays, iron oxides, hydroxides, metal sulfates, and alumina have been used as stabilizers of either O/W or W/O emulsions [4-7]. Recently some other solids such as hydroxyapatite, magnetic nanoparticles, chitosan, cyclodextrin, nanotube,

and some food-grade stabilizers and organic particles, including Janus colloidal particles, microsphere, and microcapsule can effectively serve as Pickering emulsifiers [3, 8-9]. Therefore, the applications of Pickering emulsions have become widespread for examples as catalysts, delivery vehicles, porous scaffolds, stimuli-responsive materials, and so on [3].

Silica as an abundant material found in the earth crust has also been richly accumulated in several parts of plants such as horsetail outer epidermal layer [10-12] and rice husk. Silica accumulated in the living tissues is generally known as biosilica [10-11] is considered safe and there was No Observed Adverse Effects Level (NOAEL) of 50,000 ppm (mg/L) for dietary silica [13]. Silica is also amongst the additive for foods (E 551) and is typically used as an anti-caking agent. There have been many evidences supported the potential health benefits of silica such as its contribution to collagen formation and bone health, as well as prevention of toxicity to the brain and maintenance of blood vessel integrity [13]. Therefore, biosilica has a great potential to be incorporated in food systems not only due to its function as emulsifier but also due to its inherent health benefit.

There has been little investigation on the use of biosilica as emulsifiers. Sapei *et al.* investigated the use rice husk biosilica combined with lecithin [14] and Tween 20 [15] for the stabilization of O/W emulsion and the use of rice husk silica/ Tween-20 for stabilizing the double W/O/W emulsion [16]. It turned out that the incorporation of biosilica together with emulsifiers enhanced the emulsion stability. The destabilization of emulsion with time followed the first kinetic model implying the predominant coalescence phenomena during the emulsion instability process. The lowest destabilization constants obtained were about $2.3x10^{-3}$ min^{-1} and $1.5x10^{-3}$ min^{-1} for the O/W emulsions stabilized with rice husk silica combined with lecithin and Tween-20, respectively. Some other researchers used colloidal hydrophilic silica particles (Aerosil) combined with other emulsifiers such as monoolein, lecithin, Tween-60, sodium caseinate) in order to develop "food grade" O/W emulsions [17-19]. It has been observed that use of mixed silica particles and emulsifiers produced O/W emulsions with higher stability due to the formation of smaller droplet sizes compared to those stabilized by either emulsifiers or silica particles. There has been no investigation yet on the use of rice husk ash for stabilizing O/W emulsion. In fact, rice husk ash consisted of about ~ 94% silica and other compounds containing metals such as K, Mg, Ca, Fe, etc [20]. This research aimed to investigate the potential use of rice husk ash combined with lecithin to enhance the stability of O/W emulsion based on the emulsion destabilization kinetic study.

2. Materials and Methods

2.1 Materials

Lecithin (PT. Brataco, Surabaya, Indonesia); rice husk obtained from paddy milling in Mojokerto, East Java, Indonesia; palm cooking oil (Sunco, PT. Milkie Oleo Nabati Industri, Bekasi, Indonesia); demineralized water.

2.2 Preparation of rice husk ash

Rice husks were separated from the dust and debris and then washed with water and finally rinsed with demineralized water prior to drying in an oven (Memmert, Germany) at 105^{o}C for 2 hours. Dry rice husks were burnt in the furnace (Ney VULCAN D-550, Dentsply Ceramco, USA) for removing out the organic compounds at 750^{o}C for 5 hours. Rice husk ash (RHA) which was gray in color consisted of silica of about 94% [20]. The rice husk ash was subjected to milling followed by screening with 200 mesh screen prior to further use as the emulsifier.

2.3 Preparation of O/W emulsion stabilized with RHA and lecithin mixtures

Oil phase with the fraction of 0.3 was heated up to 50^{o}C followed by the gradual addition of varying lecithin concentrations of 0.5 – 3% under stirring with a magnetic stirrer. RHA of 2% was subsequently added little by little into the oil. Mixing was continued to 15 minutes until lecithin was well solubilised in the oil. Aqueous phase consisting of demineralized water was heated to 50^{o}C prior to mixing with the oil phase. The emulsification was carried out using a rotor-stator homogenizer

(IKA T25 digital ULTRA TURRAX, *Germany*) at 20,000 rpm for 5 minutes after aqueous phase was poured into the oil phase. The emulsion was kept in a transparent 40 ml glass vial (ID= 25 mm, height= 95 mm) until the height of ~ 5.65 cm from the bottom was attained and then stored at a room temperature of ~ 28^{o}C. The percentages used belonged to weight %.

2.4 Determination of emulsion stability

The emulsion stability was simply determined by using equation (1). The height of emulsion was measured at a certain time interval, i.e. every 1 minute for the first 30 minutes, followed by the measurement in every 5 minutes until 60 minutes, and then the measurement was taken in every 10 minutes until 120 minutes and each day up to 7 days. The stable emulsion layer was indicated by a milky appearance with the formation of neither cream nor silica particles sediment.

$$\%S = \frac{h_t}{h_0} x100\% \quad (1)$$

whereas h_t is emulsion height at a certain time and h_0 is initial emulsion height.

2.5 Determination of kinetic models of destabilization rate of o/w emulsion.

The data used for the kinetic models determination was within 0-120 minutes, since the emulsion stability remained more or less constant after 120 minutes. The destabilization rate of o/w emulsion was fitted using the zero order and first order kinetic models. The most appropriate kinetic order would be chosen based on the best obtained correlation coefficient (R^2) calculated using the least square procedure. The emulsion destabilization rate could be written in an equation as follows [21]:

$$-r = -\frac{dS}{dt} = k\ S^a \quad (2)$$

$$S = S_0 - k_0 t \quad (3)$$

$$ln(S) = ln(S_0) - k_1 t \quad (4)$$

whereas $-\frac{dS}{dt}$ the rate of emulsion destabilization, a the order of emulsion destabilization rate, k_0 and k_1 the emulsion destabilization rate constants for the zero order (% stability/ minute) and for the first order (per minute), respectively, t the storage time (minute), the percentage of emulsion stability after time t and S_0 the initial emulsion stability percentage.

3. Results and Discussion

An emulsion is a mixture of at least two immiscible liquids whereas one phase is dispersed in another phase. An emulsifier is required to stabilize the dispersion of the dispersed phase in the continuous phase by lowering the interfacial tension between the two phases thus droplets coalescences or flocculation could be hindered. However, O/W emulsion will definitely undergo instability with time indicated by creaming due to the inherent thermodynamic instability of the emulsion. The macroscopic observation of O/W emulsion stabilized by 2% RHA and 2% lecithin could be seen in Figure 1. It turned out that the emulsion was not stable right after the emulsification (t= 1 min). Creaming and oil layer formation was seen as the results of oil droplets coalescences. RHA seemed to be suspended in the cream layer rather than being adsorbed on the oil-water interfaces. Some RHA was deposited at the bottom of the vials due to sedimentation. Possibly, RHA which was mainly composed of hydrophilic silica did not well intermixed with lecithin in the oil phase, thus lowering its emulsifying capacity on the interfacial layer. It could have been dispersed in the aqueous phase to improve its adsorption in the oil-water interfaces. Previous investigation used oil phase as the loading phase of hydrophilic silica, however sonication was applied to improve the silica dispersity [22]. The stability of the emulsions was slightly decreasing with time within the range of 50-60% as depicted in Table 1

which was hardly seen in Figure 1. After 7 days, the cream layer seemed thinner since the oil was out from the cream leading to the increase of oil layer. The RHA tended to be sedimented which was not clearly seen in Figure 1. The emulsion instability was mainly due to the coalescences of oil droplets leading to the enlargement of dispersed oil droplets as could be seen in Figure 2.

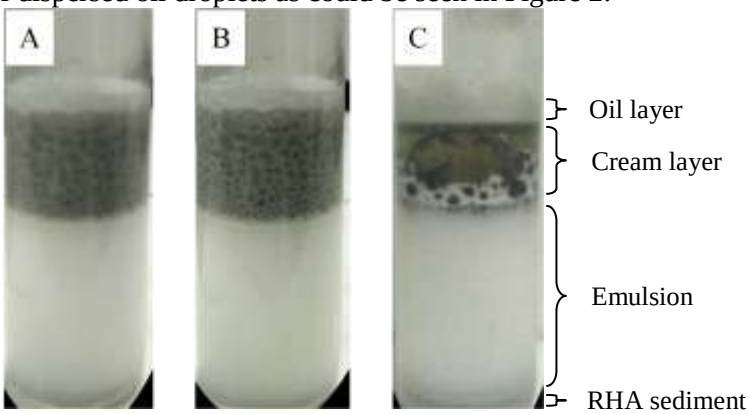


Figure 1. Stability of O/W emulsions stabilized with 2% RHA and 2% lecithin after being stored at a certain time. A) 1 min; B) 120 min; C) 7 days

Table 1. O/W emulsion stability stabilized using RHA/ lecithin

Emulsifiers	Emulsion Stability, S (%)		
	t = 1 min	t= 60 min	t= 120 min
2% RHA	60.18	56.64	54.87
1.5% lecithin	61.95	53.10	53.10
0.5% lecithin + 2% RHA	61.95	53.10	51.33
1% lecithin + 2% RHA	61.95	56.64	53.10
1.5% lecithin + 2% RHA	60.18	58.41	56.64
2% lecithin + 2% RHA	61.95	60.18	58.41
2.5% lecithin + 2% RHA	60.18	58.41	56.64
3% lecithin + 2% RHA	60.18	58.41	56.64

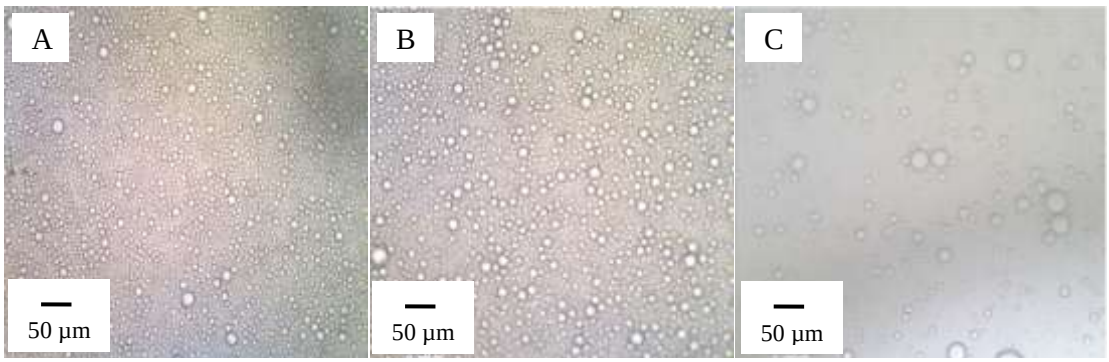


Figure 2. The microscopic images of O/W emulsion stabilized with 2% RHA and 2% lecithin after being stored at a certain time. A) 1 min; B) 120 min; C) 7 days

It was obvious from Table 1 and Figure 3 that the emulsion stability after 60 or 120 min was improved when lecithin concentration was increased up to 2% and then decreased. Furthermore, the emulsion stability was much improved when combined RHA/ lecithin was used instead of single emulsifier of RHA or lecithin only. The kinetics study was conducted to confirm the effect of lecithin

addition on RHA stabilized O/W emulsions as depicted in Table 2. The calculated k constant represented the rate of emulsion stability reduction as time elapsed.

The destabilization process of emulsion followed the first order rather than zero order kinetic models based on the best obtained correlation coefficient (R^2). This was in line with the previous study [14-15] implying the predominant coalescences of dispersed oil droplets as the main factor of emulsion instability. The lowest destabilizing rate constant k_1 of 0.4 x 10^{-3} min^{-1} was obtained for the emulsion stabilized with 2% RHA combined with 2% lecithin. Higher lecithin concentration reduced the emulsion stability indicated by the higher k_1. Lecithin was effective in stabilizing W/O emulsion due to its hydrophobicity therefore the excess of lecithin could lower O/W emulsion stability. Lecithin concentration seemed influenced the stability of emulsion stabilized with RHA in contrast to emulsions stabilized with rice husk silica/ lecithin [14]. Furthermore, the obtained k_1 was much lower with the order of 1 in comparison to those obtained from rice husk silica/ lecithin [14] and rice husk silica/ Tween-20 [15]. This may indicate a higher emulsifying capacity of RHA compared to rice husk silica. Probably this was due to the presence of salts containing metals such as Na, K, Ca, Mg retained in RHA which helped reduce the interfacial tension between oil and water.

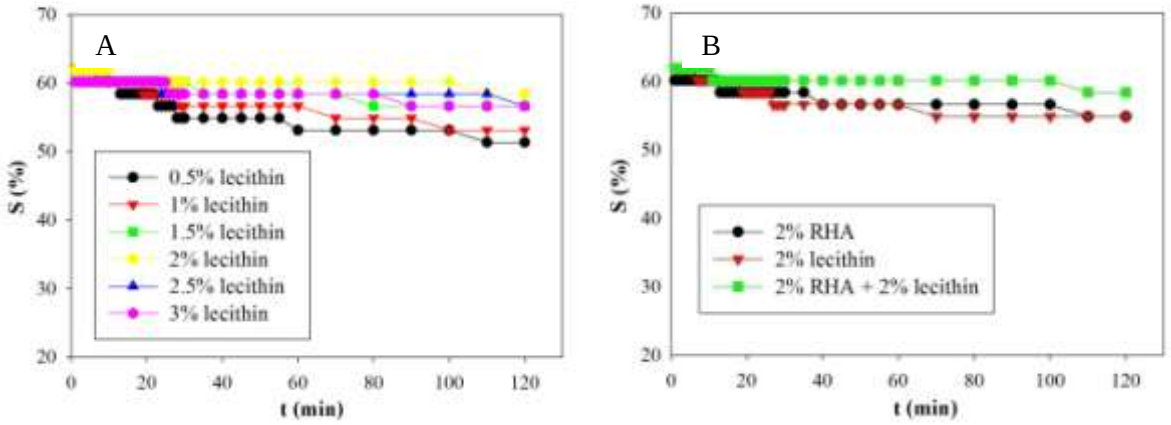


Figure 3. Emulsion stability *vs.* time. A) Comparison of stability of emulsions prepared using 2% RHA with varying lecithin concentrations; B) Comparison of stability of emulsions prepared using combination RHA/lecithin and single emulsifier.

Table 2. Kinetic emulsion destabilizing rates constants and R^2 values according to zero-order and first order kinetic models of O/W emulsions stabilized using 2% RHA and various lecithin concentrations.

Emulsifiers	Orde 0		Orde 1	
	k_0 (% stability/min)	R^2	k_1 x 10^3 (min^{-1})	R^2
2% RHA	0.0438	0.8768	0.8	0.8856
2% lecithin	0.0943	0.8420	1.6	0.8532
0.5% lecithin + 2% RHA	0.0894	0.8085	1.6	0.8275
1% lecithin + 2% RHA	0.0812	0.8982	1.4	0.9104
1.5% lecithin + 2% RHA	0.0445	0.9936	0.8	0.9949
2% lecithin + 2% RHA	0.0266	0.8182	0.4	0.8247
2.5% lecithin + 2% RHA	0.0264	0.8885	0.5	0.8940
3% lecithin + 2% RHA	0.0374	0.9398	0.6	0.9439

The synergism between silica particles with emulsifiers has been reported in many publications [14-15, 17-18, 22]. The presence of emulsifiers modified the wettability of solid particles and most likely enhanced the inter-particle interactions [23]. The adsorption of small amount of lecithin in the

interfacial layer helped reduce the interfacial tension between the two liquid phases followed by the adsorption of RHA which provided a steric hindrance surrounds the oil droplet. A rigid interfacial film consisting of RHA particles and lecithin could also contribute to the improved emulsion stability.

4. Conclusions

The use of mixed rice husk ash (RHA) with lecithin for stabilizing O/W emulsions was studied supported by the investigation of emulsion destabilization kinetics. Both RHA and lecithin was loaded into the oil phase prior to mixing with the aqueous phase. It turned out that the increase of lecithin concentrations up to 2% improved the stability of RHA stabilized emulsions. The excess of lecithin concentration decreased the emulsion stability. Lecithin adsorbed on the interfacial layer could help decrease the interfacial tension and together with adsorbed RHA particles could form a rigid film which provided a steric hindrance against droplet-droplet coalescence. The emulsion destabilization kinetics followed the first order model. The combination of 2% RHA and 2% lecithin resulted in the lowest k_1 value of 0.4 $x10^{-3}$ min^{-1}, which was 4 times smaller and 2 times smaller than k_1 obtained from lecithin only and RHA only, respectively. RHA/ lecithin stabilizing emulsions seemed promising for developing healthier food emulsion products.

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Improvement of salt raw material procurement and inventory planning at Bitung

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Abstract The aim of this study is to integrate demand forecast, determine the quantity of raw material requirements, and select the best supplier for the salt production process accurately. The steps start from demand forecasting, continue with supplier selection based on some criteria, and comparison between percentage of inventory costs and percentage of total costs in existing and proposed methods. After changing the period, the smallest error was achieved from moving average with 5 periods. The forecasting result was converted to raw materials in one period. Using Analytical Hierarchy Process, some supplier criteria like price, quality, service and delivery will give the total priority value of supplier A 0,356, supplier B 0,170, supplier C 0,249, supplier D 0,133, and supplier E 0,092. Supplier A became a selected supplier. The proposed method could decrease the percentage of stock out costs from 79,49% to 30,95%, but the percentage of saving cost increase from 20,35% to 68,62%. In total, the proposed method will save Rp2.587.609 or 28,61% from the existing method for six months.

1. Introduction

As main commodity, salt industry must guarantee the sufficiency of salt manufacturing as an important part to satisfy the customers. It is started with ordering the right amount and right time of raw material for production. In the opposite, lack of raw material will harm the business. Even though the salt manufacturing process is simple, the lack of raw material will delay the production process, moreover it will reduce trust from the customer, and increase the order cost because raw material must come in a short time, like backorder costs or penalty fees for the lateness. Supervision of raw material inventory must be done to make the company more efficient in spending costs and being able to arrange the supply of raw material to avoid the lack or exceed stock. This objective can be achieved by selecting good suppliers. The networking system in supply chain will be stronger with better supplier performance that will lead to mutual trust and mutually beneficial cooperation between the two parties. To get a good supplier, there is a supplier selection process to reduce risk and maximize buyer satisfaction.

Since the salt policy have implemented by the Minister of Maritime Affairs and Fisheries, Susi Pudjiastuti, supply of raw materials from outside the island has been regulated tighter. As a result, the number of suppliers that can send raw material to the company is due by shipping permit problems. This rare supply will lead to bigger problem, so the company must rearrange the order schedule to make sure the raw material will come on time. The conventional company usually does not have a standard procurement plan to determine the optimal quantity and order time, so it also leads to the lacks supply, lost sales, and lost the consumer demand. This research will help the company to determine suppliers through several criteria, so the selected suppliers can fulfil the demand in right

quantity and in right time. This objective will give minimum total costs because it has less stock out and over stock.

2. Literature Review

The push supply chain was known as the built-to-stock model. This process was developed so products were manufactured in anticipation of customer needs. The idea was that the inventory could be built cost effectively and delivered against potentially known demand. On the subject of demand or demand forecasting, the increase or decrease will have a serious effect on the replenishment side of the fence. The effect of the demand velocity will certainly have an influence the amount of inventory required. However, the confidence level variance of the demand is far more important to the inventory policy than the actual demand number [1].

Demand planning or forecasting, is what companies do when they attempt to answer this question. And yet it is remarkable how little attention companies in general give to forecasting and how little thought goes into designing a process that will yield the best possible result. Without good information about demand variability, companies are left to make critical decisions about what customer service levels to target and how to reasonably meet these targets on the basis of hunches or rules of thumb. The typical steps in the forecasting process are obtain or update historical sales (in units) of the item, cleanse the historical sales to remove noise due to predictable events, apply a statistical method to the historical sales to obtain a forecast, review the statistical forecast and adjust based on information not reflected in the historical sales, and review and publish the final unconstrained forecast and forecast--accuracy metrics [2].

The major reason for managing inventory is to reconcile the following potentially conflicting objectives between maximizing customer service and maximizing the efficiency of purchasing and production. Goods may be purchased in greater quantities than are needed in order to achieve cost efficiencies in purchasing or transportation. When goods are purchased in this way, some inventory may result. In manufacturing, long production runs (large lot sizes) of a single product are usually much more efficient than short runs. Independent demand models are methods to manage items whose demand is influenced by customer demand or demand from outside of the company control. Independent demand systems are used to determine levels of finished goods inventory. This method is used by retail, wholesale and manufacturing companies. Fixed Reorder Quantity Inventory Model is independent demand model places a “fixed order quantity” on a predetermined time schedule (daily, weekly, etc.). The actual order quantity will vary from order to order based on how many units have shipped. A maximum inventory level is established based on experience, budget or targeted inventory levels. The order quantity will be the difference between what was used during the period and the maximum (targeted) inventory. In this model a fixed quantity is established, usually using the Economic Order Quantity (EOQ) formula. The fixed order quantity is placed every time the inventory reaches a predetermined order point. This order point is set at a level whereby there is sufficient inventory to cover the demand from the time material is ordered from the supplier until it is received in the warehouse [3].

Large quantities will give lower ordering costs. If we buy a larger quantity of an item less frequently, the ordering costs are less than buying smaller quantities over and over again. In the opposite, the costs of holding the item for a longer period of time will be greater. Inventory is basically divided into raw materials, finished goods, and work-in-process. Raw materials is used to produce partial products or completed goods. Finished product is product that is ready for current customer sales. It can also be used to buffer manufacturing from predictable or unpredictable market demand. In other words, a manufacturing company can make up a supply of toys during the year for predictably higher sales during the holiday season. Work-in-process (WIP) is the item that is considered to be WIP during the time raw material is being converted into partial product, subassemblies, and finished product. WIP should be kept to a minimum. WIP occurs because of such things as work delays, long movement times between operations, and queuing bottlenecks [4].

3. Research Methods

Literature study is needed as basic theories and concepts. The literatures can be obtained from books, journals and articles from the internet. The topics that are studied are purchasing, forecasting, supplier selection, inventory management, and decision making. The data collection in this study was done by interviewing the owner and some employees and doing observation in that company. Primary data has been obtained from direct interviews with company owners about company history, organizational structure, job description, factory operational standards, type and quantity of products produced, reduction of raw materials to be processed, lost sales, employee salaries, company facilities, and performance of suppliers. The secondary data is obtained by purchasing raw materials and information about suppliers.

After data collection, the next step is processing the data and analysing the results, with the following steps like calculate total cost of initial inventory method for 6 months and analysing it, do the back-forecast demand for 6 months using data histories. Moving average will be used with 3 until 6 periods to find the smallest MSE. It will continue with supplier selection based on certain criteria and find the best supplier using Analytic Hierarchy Process. This method is used because it can combine several criteria and find the best supplier. Then we will calculate order quantity and safety stock based on forecast using probabilistic model. The order quantity must follow the supplier's regulation for order limitation. In probabilistic model, it treats demand as uncertain and there is possibility to stock out. To cover this problem, the probabilistic model will measure for the safety stock during lead time. We also measure Reorder Point, total cost for 6 months, and compare total costs of the initial and proposed method and analysing it. The conclusion of this research will give the company suggestion about quantity and time to order to minimize the total cost.

4. Results and Discussion

The calculation of the inventory fraction based on company assets is as follows:
Bank deposit interest = ± 5.9%/year ≈ 0.492%/month = 2.95%/6 months
Fixed employee salary = (Rp 3,000,000 + Rp 2,200,000)/month = Rp 31,200,000/6 months
Warehouse Operating Costs = Rp. 700,000/months = Rp.4,200,000/6 months

The value of raw materials in the warehouse
= 25,000 kg /month x Rp. 3,500/kg x 6 months = Rp 525,000,000/6 months
The inventory fraction of the warehouse goods
= (31,200,000 + 4,200,000)/525,000,000 = 0.0674 ≈ 6.74% /6 months
Inventory fraction (F) = 2.95% + 6.74% = 9.69% /6 months
Inventory fraction is come from interest of bank deposit and inventory fraction of the warehouse goods.

Requirement per day during January were 853.98 Kg. Initial inventory was 5,000 kg. Order was assumed made on the 1st of the month, and the order quantity was 25,000 kg per order. Example of calculations during January 2018 is as follows.

The value of the stockout cost per unit lost is as follows.
HPP = Direct Material Cost + Direct Labor Cost + Overhead Cost (1)
= Rp 3,500/kg + Rp 360/kg + Rp 237.12/kg = Rp 4,097/kg
Stockout Cost per lost unit = Rp 6,140 - Rp 4,097 = Rp 2,043 per kg lost

The total inventory cost of the company consists of purchasing costs, order costs, inventory costs and stockout costs for 1 period (6 months). The amount of raw material needs for one period is converted from the number of consumer demand (pack units) to kilograms raw material.

After knowing and analysing inventory, the calculation of the total cost can be done in the following way. Total cost = purchase cost + order cost + inventory cost + stockout cost (2)
= Rp 525,000,000 + R. 15,120 + Rp 1,840,082 + Rp 7,187,969
= Rp 534,043,171/6 months

After the initial method total cost has been calculated, the proposed method is needed as a comparison with the initial method in order to find out which method is better. The first step in determining the total cost in the proposed method using consumer demand forecast. From the data plot, the demand pattern is random because demand data tends to fluctuate around the average value without showing a clear pattern. By using Minitab 16 software, the most appropriate forecasting method to use is the moving average and single exponential smoothing. The method that is finally used is a moving average with 5 periods length because it has the smallest MSE value. The demand ratio for product A and product B is 1: 5. After finish product's demand every month is converted into raw material for 6 months, there are 153,953.90 kg that will be needed to order.

The difference in the proposed method compared to the initial method is that there is a safety stock and reorder point to anticipate consumer demand so that it can be fulfilled. The calculation is based on the Service Level that is applied by the company. The company use Service per Demanded Unit it is known the unfulfilled demand quantity. The Q value is obtained from the demand forecasting results per month which is converted to Kg units. By using the MSE value of 21,916,777 (from demand forecasting), the calculation of the Z value is as follows.

SLU = 1 - (E (M> B)) / Q (3)
For normal distributions, expectation values for shortages or E (M> B) are:
E (M>B) = σE(Z) (4)
The Z value obtained is equal to 0.859. After getting the Z score, the safety stock for a lost sales company can be calculated in the following way.
E (M> B) = σSS + Z = 0.859 × 0 .921,916,777 + √21,916.777 × 0.1082 = 4,527.98 kg

So, the size of the safety stock that must be prepared by the company is 4,527.98 Kg. Safety stock is a stock to anticipate the demand uncertainty that occurs during the lead time and to prevent lost sales. The company initially ordered raw materials at supplier A, because they have a good relationship for a long time. Decision making will be done by the Analytical Hierarchy Process or AHP method [5]. After identifying the criteria in the previous sub-chapter, the company weighted the importance of each criterion. After that the company will give weight to each supplier for each of the criteria. The criteria that is used in AHP is as Table 1.

Table 1. Preference value matrix supplier selection criteria

Criteria	Price	Quality	Service	Delivery
Price	1	3	7	5
Quality	0,33	1	4	3
Service	0,14	0,25	1	0,2
Delivery	0,2	0,33	5	1
Total	1,68	4,58	17	9,2

After normalizing, the next step is to determine the priority weight or Eigen Value by multiplying the criteria preference value with the Total Present Value of each criterion. The next step is to calculate the max λ value, and the result is 4,269. A Consistency Index or CI is needed to ensure that the ratings and perceptions given are consistent. The CI values obtained were then converted into

inconsistency ratios by dividing them by random index (RI). The random index value is determined based on the value of n. The comparison between CI and RI values is also called Consistency Ratio or CR. CI has value 0.09 and CR is 0.1. Because the result of CR "≤" 0.1, a consistent assessment can proceed to the next calculation and the data above does not need to be changed or corrected again. Furthermore, the company gives weight to each supplier alternative based on the criteria discussed earlier and compares it with other alternatives in the table. After that the values in each column will be added up. After adding up, the value of each entry or cell in the table will be divided by the sum of the column values to obtain the normalized matrix. In the normalization table, the value in each row will be summed and divided by the amount of data in that row (the value is equal to the number of alternatives). The result of the division is the TPV value for each alternative. The whole calculation is the same as the calculation done to obtain the TPV value on the criteria. Determination of TPV in each criterion for each supplier functions as an approach to replace supplier real data that is not owned by the company and can help companies to find out the best supplier in each criterion. The next step is to add the multiplication value of TPV in the criteria table with TPV in the supplier table (in each of the criteria). The sum value is called Final Priority Value.

Examples of calculations are as follows.
Total Price Weight (supplier A) = 0.437 × TPV Price criteria = 0.437 × 0.55 = 0.241
Final Priority Value = ∑ "Total Weight of Supplier A" = 0.241 + 0.064 + 0.004 + 0.047 = 0.356
Total Priority Value for supplier A was 0.356; B supplier of 0,170; supplier C of 0.249; D supplier is 0.133 and E supplier is 0.092. Supplier A is chosen to be the supplier of the company's raw materials because it has the highest priority value.

After knowing the number of needs during one period and choosing the best performance supplier, the next step is to calculate the Fixed Order Quantity of the salt raw material. The aim is to find out the optimal number of orders of raw materials that companies should do to suppliers. The calculation is as follows:

$$\text{FOQ} = Q^* = \sqrt{\frac{2 \times 2.520 \times 151.954}{3.500 \times 9{,}69\%}} = 1.502{,}71 \text{ kg} \approx 1.503 \text{ kg}$$

But the consideration is the minimum order amount that the company can do in supplier A is 15,000 kg (the smallest container size). Q * value of 1.503 kg means the most optimal number of orders to minimize the total cost, but in fact the order can only be done on a quantity of 15,000 kg (minimum size of supplier A order). Reorder point is the point of reorder that the company must plan. Reorder point calculations are based on average demand during lead time or M and safety stock.

$\bar{M}$ = (lead time / number of working days in 6 months) × R= (7/180) × 151,954 kg = 5,909.32 kg

After $\bar{M}$ is obtained, the size of the reorder point can be calculated by adding $\bar{M}$ to the safety stock that has been calculated previously.
B = $\bar{M}$ + SS = 5,909.32 kg + 4,527.98 kg = 10,437.3 kg
Thus, reorder point will be done when inventory in the warehouse reaches 10,437.3 kg.

The company uses the same supplier in the proposed method, so there is no change in the purchase price of raw materials even though there is a change in the number of purchases. After knowing and analysing the proposed inventory from January to June 2018, the calculation of the total cost can be done in the following way.

Total cost = purchase cost + inventory cost + safety stock cost + stockout cost (5)
= Rp 577,500,000 + Rp 27,720 + Rp 4,430,074 + Rp 1,997,768 = Rp 583,955,562/6 months

Once calculated, the total cost from January to June 2018 for the proposed method is Rp 583,955,562. Whereas the total cost in the initial method is Rp 534,043,171. Results that differ between the initial method and the proposed are due to different purchase quantities as in Table 2, can be compared based on the order costs, inventory cost and stockout cost.

Table 2. Comparison of percentage of cost of initial and proposed methods

Cost	Method		Percentage	
	Initial (Rp)	Proposed (Rp)	Initial (Rp)	Proposed (Rp)
Order	15,120	27,720	0.17	0.43
Inventory	1,840,082	4,430,074	20.35	68.62
Stockout	7,187,969	1,997,768	79.49	30.95
Total	9,043,171	6,455,562		

5. Conclusions and Recommendations

The method used to forecast demand from January to June of 2018 is the Moving Average with length 5, because it has the smallest MSE value. Based on forecasting result, the need for production raw materials every month is 25,325.65 kg, so that the total requirement for one period or six months is 151,954 kg.

Based on the value of the TPV, the order of importance of the criteria is price, quality, delivery, and service. During January to June 2018 the company ordered raw materials at supplier A. Inventory cost efficiency of each method is seen from its percentage to total cost (without purchase costs, because it is a fixed cost and the result depends on the amount of raw material purchases), and the result of the proposed method stockout cost percentage decreases from 79.49% to 30.95% but the percentage of savings costs increases from 20.35% to 68.62% because the proposed method has safety inventory to anticipate demand. The difference becomes benefit for the company because the reduction in stockout costs is greater than the addition of the cost of savings, the saving is Rp2,587,609 during January to June 2018 or 28.61% of the initial method total cost.

The contribution of this paper is a procedure to integrate among finish product forecasting, raw material ordering, and choosing the best supplier. All steps will guarantee an efficient total cost that it is developed by inventory, order, stock out and safety stock cost. In addition, companies must begin to pay attention and improve procurement planning and production of raw materials. Improvements can be initiated by predicting consumer demand to determine the time and quantity of ordering of raw materials. Another step that can be applied is to determine and provide safety stocks to anticipate consumer demand. For further research, the scope can be expanded to all types of products. In addition, sales data used as a reference for forecasting demand is real data and should be longer in duration (more than or equal to two years) to minimize errors in forecasting.

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Price and inventory policy strategy model in a price sensitive dual channel supply chain structure considering product substitution

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Abstract. Dual channel supply chain structure, which utilize both online and traditional offline channel, is widely adopted by a lot of companies. The structure offers better market coverage and profitability. Despite the advantages, it also brings some challenges to coordinate the strategy of the channel. This paper proposed a pricing and inventory policy model to achieve better performance of the structure, where a product substitution was introduced in the offline channel. A price sensitive linear demand function was also incorporated in this EOQ model. The model then evaluated by analysing the profit in two scenarios, the Stackelberg Leadership scenario and Total Profit scenario. The results showed that the total profit of this structure is higher under Total Profit scenario, in which the supply chain entities make decision simultaneously. The model also showed that the product substitution gave a positive effect to the profit and become a competitive advantage of the offline channel.

1. Introduction

The speedy information technology development has significantly improving supply chain performance in every industry. The use of internet brought many opportunities to the companies [1]. The development enables a new supply chain structure which integrates conventional selling at retail store (offline) with internet based direct selling (online) called dual channel supply chain (DCSC) [2]. Simple DCSC structure usually consists of manufacturer, retail store, and online channel. The structure can be directly managed by manufacturer. Offline consumers demand are fulfilled by inventory in retailer, while online consumers demand are fulfilled by inventory in manufacturer [3].

In DCSC structure, online and offline channels can compete each other to attract consumers, mostly by pricing strategy. In this structure, where the supply chain consists of several entities, there is a power hierarchy that influence decision making process [4]. In DCSC structure consists of manufacturer and retailers, manufacturer usually has higher bargaining power, which has role as the leader, that decides the pricing first. The retailers have roles as followers that decide the pricing based on manufacturer price [1]. This decision making scenario is known as Stackelberg Leadership. In this scenario, each player works hard to maximize their own profit without considering the whole profit of supply chain [5]. On the other side, there is a scenario where players make decision at the same time (simultaneous) [4] that we refer as the Total Profit scenario. In Total Profit scenario, players cooperate each other to maximize profit of the whole supply chain [5].

Besides price, inventory also has very important role, especially in fulfilling consumer demand to reach the required service level. The high level of inventory causes high saving cost and company's capital is stuck in inventory form, while if the number of inventory is too low, consumer demand cannot be fulfilled and it causes loss of sakes [6]. Therefore, the decision about the level of inventory becomes the main problem in minimizing inventory cost while still maintaining good service level [7].

In previous research [8], EQQ model with linear demand function is used to maximize profit from DCSC structure. It also introduced product substitution in offline channel. Product substitution plays important role especially when consumer think that main product price in both channels is too expensive and/or when there is empty inventory for the main product in both channels. The model used Stackelberg Leadership scenario. Coordination by sharing information within entities to maximize total profit of the whole supply chain, as in the Total Profit scenario explained earlier, is not considered yet. Hence this study developed pricing and inventory policy in DCSC structure by considering product substitution, and apply the two scenarios, Total Profit and Stackelberg Leadership.

2. Model

The development of the model is based on [8], which is a profit model of DCSC structure, considering product substitution, using Stackelberg Leadership scenario.

2.1. Conceptual model

The model considers a dual channel supply chain structure consist of a central warehouse, one offline channel and one online channel (see figure 1). We assume that the product substitution only available in offline channel. Central warehouse got its product supply from two manufacturers, Manufacturer A for main product and Manufacturer B for substitute product. The warehouse then distributing the product to the offline and online channel. There will be either one of the two possible scenarios occur. First is Stackelberg Leadership scenario, where central warehouse as a leader will make the prices decision first and announce the prices to offline and online channel, followed by online and offline channel sequentially. Second is Total Profit scenario, where all entities in the structure will make joint prices decision in order to maximize total profit of the structure.

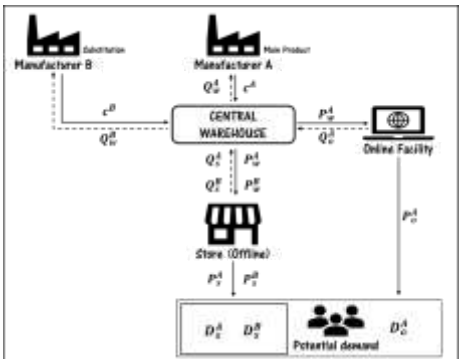


Figure 1. Dual channel supply chain structure with product substitution.

2.2. Notation

Parameters and variables used in this model are denoted by these following notations.

i : index for product type, A for main product and B for substitute product;

j : index for the structure's entity, w for central warehouse, s for offline channel and o for online channel;

P_j^i : price of product i for entity j (Rp) (decision variable);

β_s : price sensitivity in offline channel (unit/Rp);

γ_{so} : cross-price sensitivity of offline channel to substitute online channel (unit/Rp);

γ_{BA} : cross-price sensitivity of product B to substitute product A in offline channel (unit/Rp);

Q_{ij}^* : optimal order quantity for product i in entity j (unit) (decision variable);
T_{ij}^* : reorder point for product i in entity j (days) (decision variable);
ρ : proportion of customers who prefer online than offline channel relative to the total demand;
σ : proportion of customers who prefer substitute product over main product in offline channel;
β_o : price sensitivity in online channel (unit/Rp);
γ_{os} : cross-price sensitivity of online channel to substitute offline channel (unit/Rp);
D_{max} : maximum demand when the price is equal to zero (unit/period);
D_j^i : demand of product i for entity j (unit/period);
R_j : revenue of entity j;
c_i : cost of product i from manufacturer (Rp/unit);
π_j : profit of entity j;
h_j : holding cost for entity j (Rp/unit/period);
s_j : ordering cost for entity j (Rp/order);
O_{bj} : total purchasing cost for entity j (Rp);
O_{sj} : total ordering cost for entity j (Rp);
O_{hj} : total holding cost for entity j (Rp);
O_{Tj} : total inventory cost for entity j (Rp);

2.3. Model development

Referring to [7], linear demand functions of this model are as follow.

$$D_o^A = \rho D_{max} - \beta_o P_o^A + \gamma_{os} P_s^A \quad (1)$$

$$D_s^A = (1-\sigma)(1-\rho) D_{max} - \beta_s P_s^A + \gamma_{so} P_o^A \quad (2)$$

$$D_s^B = \sigma(1-\rho) D_{max} - \beta_s P_s^B + \gamma_{BA} P_s^A \quad (3)$$

2.3.1. Inventory model. We use a basic EOQ model as the inventory control method. All the assumptions in EOQ model is applied in this model. According to Bahagia [9], inventory cost in EOQ model consist of purchasing cost, ordering cost, and holding cost.

$$O_{Tw} = c_A(D_o^A + D_s^A) + (c_B \times D_s^B) + s_w\left(\frac{D_o^A + D_s^A}{Q_{Aw}^*} + \frac{D_s^B}{Q_{Bw}^*}\right) + h_w\left(\frac{Q_{Aw}^* + Q_{Bw}^*}{2}\right) \quad (4)$$

$$O_{Ts} = (P_w^A \times D_s^A) + (P_w^B \times D_s^B) + s_s\left(\frac{D_s^A}{Q_{As}^*} + \frac{D_s^B}{Q_{Bs}^*}\right) + h_s\left(\frac{Q_{As}^* + Q_{Bs}^*}{2}\right) \quad (5)$$

$$O_{To} = (P_w^A \times D_o^A) + s_o\frac{D_o^A}{Q_{Ao}^*} + h_o\frac{Q_{Ao}^*}{2} \quad (6)$$

Optimality of order quantity and reorder point are the decision variable of inventory policies in EOQ model. Formulation of optimal order quantity and reorder point for central warehouse can be expressed by the following equations.

$$Q_{Aw}^* = \left(\frac{2s_w(D_s^A + D_o^A)}{h_w}\right)^{-1} \quad (7)$$

$$Q_{Bw}^* = \left(\frac{2s_w D_s^B}{h_w}\right)^{-1} \quad (8)$$

$$T_{Aw}^* = \left(\frac{2s_w}{(D_s^A + D_o^A)h_w}\right)^{-1} \quad (9)$$

$$T_{Aw}^* = \left(\frac{2s_w}{(D_s^A + D_o^A)h_w}\right)^{-1} \quad (10)$$

Optimal order quantity and reorder point for offline channel can be expressed by the following equations.

$$Q_{As}^* = \left(\frac{2s_s D_s^A}{h_s}\right)^{-1} \quad (11)$$

$$Q_{Bs}^{*} = \left(\frac{2s_s D_s^B}{h_s}\right)^{-1} \quad (12)$$

$$T_{As}^{*} = \left(\frac{2s_s}{D_s^A \times h_s}\right)^{-1} \quad (13)$$

$$T_{As}^{*} = \left(\frac{2s_s}{D_s^B \times h_s}\right)^{-1} \quad (14)$$

Formulation of optimal order quantity and reorder point for online channel can be expressed by the following equations.

$$Q_{Ao}^{*} = \left(\frac{2s_o D_o^A}{h_o}\right)^{-1} \quad (15)$$

$$T_{Ao}^{*} = \left(\frac{2s_o}{D_o^A \times h_o}\right)^{-1} \quad (16)$$

2.3.2. Revenue model. Revenue of each entity can be obtained by multiplying demand of its product with the product's price and can be expressed by the following equations.

$$R_w = P_w^A(D_s^A + D_o^A) + (P_w^B \times D_s^B) \quad (17)$$

$$R_s = (P_s^A \times D_s^A) + (P_s^B \times D_s^B) \quad (18)$$

$$R_o = P_o^A \times D_o^A \quad (19)$$

2.3.3. Stackelberg Leadership model. Central warehouse maximized its profit by the following equation.

$$\pi_w = (P_w^A - c_A)(D_s^A + D_o^A) + (P_w^B - c_B)D_s^B - s_w\left(\frac{D_o^A + D_s^A}{Q_{Aw}^{*}} + \frac{D_s^B}{Q_{Bw}^{*}}\right) - h_w\left(\frac{Q_{Aw}^{*} + Q_{Bw}^{*}}{2}\right) \quad (20)$$

Maximization of function (20) should consider these following constraints.

$$P_w^A \geq c_A \quad (21)$$

$$P_w^B \geq c_B \quad (22)$$

$$Q_{Aw}^{*}, Q_{Bw}^{*} \geq 0 \quad (23)$$

The profit of online channel can be expressed by the following equation.

$$\pi_s = (P_s^A - P_w^A)D_s^A + (P_s^B - P_w^B)D_s^B - s_s\left(\frac{D_s^A}{Q_{As}^{*}} + \frac{D_s^B}{Q_{Bs}^{*}}\right) - h_s\left(\frac{Q_{As}^{*} + Q_{Bs}^{*}}{2}\right) \quad (24)$$

The previous variables, P_w^A and P_w^B now become parameters in function (24), where their values were determined from equation (20). Function (24) should consider the following constraint.

$$Q_{Ao}^{*} \geq 0 \quad (25)$$

Using the prices at central warehouse (P_w^A and P_w^B), the price at online channel (P_o^A) and the demand at online channel (D_o^A), offline channel maximized its profit.

$$\pi_o = (P_o^A - P_w^A)D_o^A - s_o\frac{D_o^A}{Q_{Ao}^{*}} - h_o\frac{Q_{Ao}^{*}}{2} \quad (26)$$

2.3.4. Total profit model. In this scenario, all entities in the structure will make a joint decision to maximize the entire structure's profit. Total profit can be expressed by the following equation.

$$\pi_{total} = \{(P_s^A - c_A)D_s^A + (P_o^A - c_A)D_o^A + (P_s^B - c_B)D_s^B\} - \left\{s_w\left(\frac{D_o^A+D_s^A}{Q_{Aw}^*} + \frac{D_s^B}{Q_{Bw}^*}\right) + h_w\left(\frac{Q_{Aw}^*+Q_{Bw}^*}{2}\right) + s_s\left(\frac{D_s^A}{Q_{As}^*} + \frac{D_s^B}{Q_{Bs}^*}\right) + h_s\left(\frac{Q_{As}^*+Q_{Bs}^*}{2}\right) + s_o\frac{D_o^A}{Q_{Ao}^*} + h_o\frac{Q_{Ao}^*}{2}\right\} \quad (27)$$

3. Numerical example

Parameters in this model are adopted from [8]. There are some parameters' value that we change, price and cross-price sensitivity, because the data from previous research was not feasible in this model. Consider a DCSC structure with the following data: D_{max}=84 units/month, ρ=0.7, σ=0.5, β_o=0.1x10^{-3} unit/Rp, β_s=0.08x10^{-3} unit/Rp, γ_{os}=0.06x10^{-3} unit/Rp, γ_{so}=0.04x10^{-3} unit/Rp, γ_{BA}=0.05x10^{-3} unit/Rp, c_A=Rp320,000/unit, c_B=Rp295,000/unit, s_w=Rp95,000/order, h_w=Rp20,000/unit/month, s_s=Rp135,000/order, h_s=Rp22,000/unit/month, s_o=Rp110,000/order and h_o=Rp22,000/unit/month. Using LINGO 11, the optimal value for the objective function and each variable in both scenarios can be obtained. The result is presented in Table 1.

Table 1. Numerical example results.

	Stackelberg Scenario					Total Profit Scenario				
	Central Warehouse		Offline Channel		Online Channel	Central Warehouse		Offline Channel		Online Channel
	A	B	A	B	A	A	B	A	B	A
P_j^i	502,143	383,839	552,143	452,589	789,286	338,732	297,976	477,144	393,215	664,286
Q_{ij}^*	13.78	8.15	0	7.01	11.42	14.46	6.89	3.50	7.83	14.49
T_{ij}^*	20.68	34.99	0	52.55	26.31	19.71	41.35	105.10	47	20.70
O_{Tj}	8,903,776		1,689,500		8,083,277	8,941,977		2,078,018		7,432,177
O_{Ttotal}	18.676.553					18.452.173				
π_j	3,825,956		120,857		2,177,437	0		365,196		6,517,823
π_{total}	6,124,250					6,883,019				

4. Analysis

It can be seen from table 1 that the total profit in Total Profit scenario is higher than in Stackelberg Leadership scenario. It is also found that the prices at each entity is lower in Total Profit scenario, which shows better competitiveness.

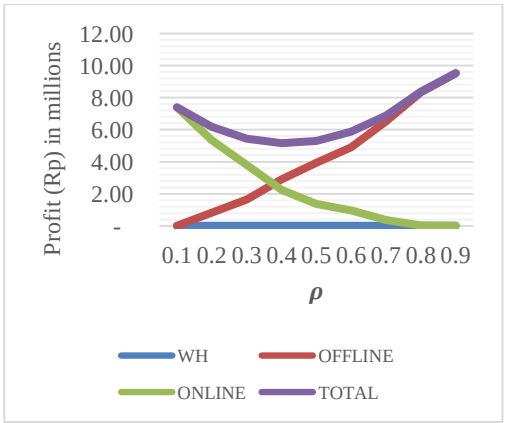


Figure 2. Impact of ρ to profit in Total Profit scenario.

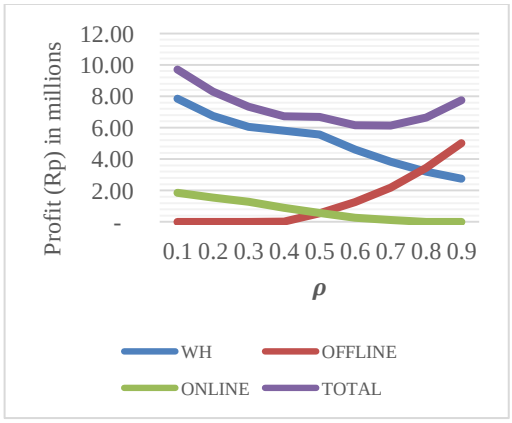


Figure 3. Impact of ρ to profit in Stackelberg Leadership scenario.

The consumer preference to online channel (ρ) influence the profits of each entity, also the whole structure. The impact can be observed in figure 2 and figure 3. Parameter γ_{BA} measure cross-price sensitivity of product B to substitute product A in offline channel. In both scenarios, higher γ_{BA}

will give positive impact to the profit of offline channel. The impact can be observed in figure 3 dan figure 4.

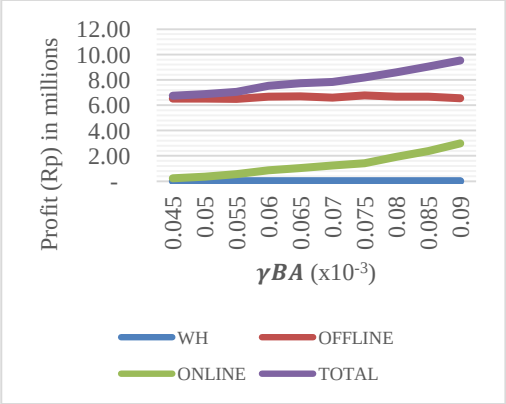


Figure 4. Impact of γ_{BA} to profit in Total Profit scenario.

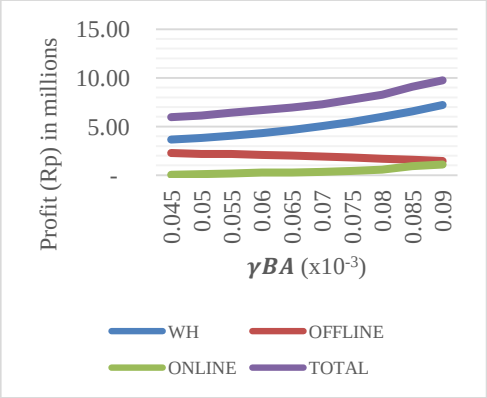


Figure 5. Impact of γ_{BA} to profit in Stackelberg Leadership scenario.

5. Conclusion and further research

This study has developed a model to accommodate price and inventory strategy in DCSC structure, implementing two scenarios namely Total Profit dan Stackelberg Leadership. The result showed that the total profit in Total Profit scenario is higher compared to Stackelberg Leadership scenario. There is a requirement to enable Total Profit scenario, which is coordination and information sharing, to get prices decision altogether. Hence, if all entities can collaborate and share information, Total Profit scenario is preferable. The study can be further developed by considering probabilistic demand and product lead time. There is also possibility to develop application and the platform suitable, to enable the coordination. Application of the model to several different products is also interesting further research.

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Tofu wastewater treatment through a combined process of coagulation-flocculation and ultrafiltration

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Abstract. Wastewater from tofu industries contain many parameters such as total suspended solid (TSS), total dissolved solid (TDS), turbidity, and chemical oxygen demand (COD). These parameters are present in high amount and can endanger the aquatic environment and also decrease water quality. Several studies have been conducted to reduce these parameters, but still require a longer time which is around 12 to 78 days. This study aims to discuss the processes and methods to reduce TSS, TDS, turbidity, and COD parameters from tofu wastewater. The processes discussed in this study include a combined process of coagulation-flocculation and ultrafiltration (UF). The results of the study show that TSS, turbidity and COD were reduced to 60%, 60% and 20%, respectively, in the coagulation-flocculation process, but TDS was increased to around 90% because of the neutralization process using Sodium Hydroxide (NaOH) solution. Furthermore, it was shown that the combined process of coagulation-flocculation and UF was able to reduce TSS, turbidity, COD and TDS up to 99%, 99%, 75% and 50%, respectively. All the parameters contained in the water produced from the combined process of coagulation-flocculation and UF was in line with the National Environmental Quality Standard requirements, excluding COD due to the COD content in fresh tofu wastewater is very high.

1. Introduction

Tofu is a favorite food in Asia [1, 2], especially in Indonesia because of its low-cost, and it contains good and healthy nutrition. Almost every city in Indonesia has tofu processing industries, which are usually run by small household industries, and are managed with simple technology [3]. Therefore, there is low effective and efficient use of resources such as raw materials and water [4, 5]. High amount of harmful organic and chemical compounds are present in tofu wastewater such as biological oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solid (TSS) in the range of 5000 - 1000 mg/L, 7000-26000 mg/L and 6000-8000 mg/L, respectively [2, 6, 7].

The waste from the tofu industry can be in the form of liquid waste and solid waste, where a portion of liquid waste can be used for subsequent production, while solid waste can be utilized as feed for animal [5, 8]. However, because of the large amount of water used for tofu processing, the wastewater is also released in great volume, and it is generally not fully reusable; so the remaining liquid waste is released into the nearby aquatic environment. Unfortunately, discharging of tofu wastewater causes environmental pollution such as bad odors and soil pollution, increased water turbidity, decreased in the photosynthetic rate of phytoplankton and other aquatic plants; thereby decreasing water productivity. Several health problems such as skin diseases, stomach aches, and digestive problems can also be triggered by consuming water that has been polluted by tofu wastewater [5, 9, 10].

Several recent research studies have been conducted on the utilization of tofu wastewater to produce products such as bio-ethanol [11], vitamin B12 [1, 2, 12] and cultivation of micro algae [13,

14]. Several attempts have also been made to treat tofu waste water in Indonesia through anaerobic processes in the fixed dome anaerobic and anaerobic baffled reactor [5] and the combination of anaerobic baffled and activated sludge system. However, the processes take longer time which is around 12 to 78 days [15]. Another method used is ozonation. In this process, the waste water is diluted first prior to processing [16]. The aim of the study is to assess the success of the combined process of coagulation-flocculation and ultrafiltration (UF) in treating tofu industrial wastewater. The COD, TSS, TDS, and turbidity are the parameters that will be observed to assess the success and effectiveness of the proposed process. A coagulant used in the coagulation-flocculation process is poly aluminum chloride (PAC), and it is one of the best options for reducing COD, TSS, and turbidity of wastewater [17]. Meanwhile, the UF process is expected to further reduce COD, TSS, and turbidity level of the wastewater.

2. Materials and Methods

2.1 Materials

The experimental set up for the combined process of coagulation-flocculation and UF is schematically shown in Fig. 1. The wastewater was provided by the tofu industry in South Jakarta, Indonesia. The sodium hydroxide used for pH adjustment was analytical grade and is obtained from Merck Indonesia and the filter paper used was sized 10 μm BIPMED. Meanwhile, the PAC used was technical grade and is purchased from PT Brataco Indonsesia. There were three hollow fiber membrane modules used in this study, which are made of polysulfone, cellulose acetate, and ceramics and were supplied by CV GDP Filter Bandung Indonesia.

2.2 Methods

Prior to the coagulation process, the wastewater's pH was set to about 7.0 by addition a certain amount of 2 M NaOH as a base solution. The wastewater solution was added with 1 ml of coagulant solution in the coagulation-flocculation process, and the process was performed at 120 rpm for 2 min and then continued at 40 rpm for 10 min in the VELP JLT-6 Jar Test. After 30 minutes, the solution was filtered using a 10 μm filter paper, and the filtrate was used as feed for the UF process. In the UF process, compressed air was employed to generate the pressure driving force a cross the membrane. TSS and turbidity, COD, and TDS and pH were measured by Hach DR/890 Colorimeter, Spectrophotometer UV-Vis BEL UV-MS1 single beam and Hanna Waterproof Tester Combo pH and EC, respectively. The whole experiments were repeated for three times.

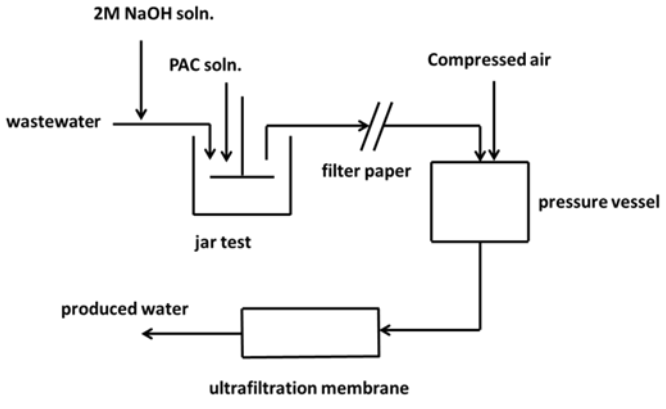


Figure 1. Schematic diagram of a combined process experiment.

3. Results and Discussion

3.1 Coagulation-flocculation Process

The tofu wastewater characteristic as well as the National Environmental Quality standard[18] is shown in Table 1. Based on the data present in Table 1, it is clear that all the observed parameters have already passed the threshold set by the government. Besides being acidic as shown by the

wastewater's pH which is below 4.0, tofu wastewater also contains a high suspended solid as indicated by high turbidity, TSS and COD. The TSS as well as turbidity of the wastewater decreased, while TDS and COD increased after the addition base solution to neutralize the wastewater as shown in Fig. 2. The increase in TDS was mainly due to the increase in the level of dissolved ions present in the wastewater which is derived from Na^+ ions. Meanwhile, the decrease in TSS and turbidity was due to a small amount of suspended solids that precipitate during the addition base solution.

Table 1. Tofu wastewater characteristic

Observed Parameters	Concentration range	Government Regulation [18]
TSS (mg/L)	280 - 415	100
Turbidity (FAU)	370 - 525	25
COD (mg/L)	5980 - 7950	275
TDS (mg/L)	850 - 1050	2000
pH	3.4 - 3.8	6.0 - 9.0

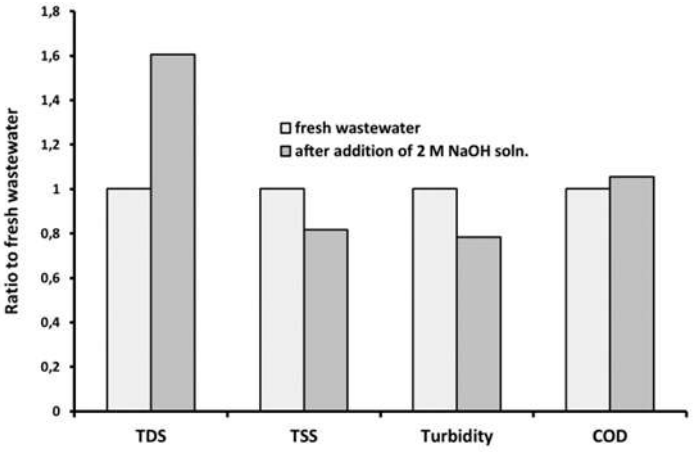


Figure 2. The Observed Parameters in the Tofu Wastewater before and after adding of 2 M NaOH Solution.

The initial pH of solution effect on the TSS, turbidity and COD in the coagulation-flocculation process is presented in Fig. 3. These parameters decrease in the range of pH 6 to 7, and then increases until pH 9. At low pH the hydrolyzate produced by PAC is $Al(OH)^{2+}$, $Al_2(OH)_2^{4+}$ and $Al_3(OH)_4^{5+}$. The positive hydrolyzate can easily neutralize the negative charge on the outer part of the organic molecule in the solution to destabilize the colloid. At pH between 6 and 8, positive polymer hydrolyzate and $Al(OH)_3$ are formed in the solution. These hydrolyzates have low solubility and high surface area which makes it easy for them to precipitate to the bottom of the container. When the pH is above 8, the solution will be difficult to destabilize because the hydrolyzate formed is $Al(OH)_4^-$[19].

The TSS, turbidity, COD and TDS of wastewater after the process of coagulation-flocculation are demonstrated in Fig. 4. The TSS, turbidity and COD decreased until the settling time of 30 minutes, and relatively constant from 30 to 90 minutes. The decrease in TSS and turbidity reaches 60%, while the decrease in COD is around 33% after the coagulation-flocculation process. The decrease occurred due to the flock formed was broken so that it dissolves back into the wastewater. Meanwhile, TDS increases with increasing settling time due to more solids that keeps dissolving into wastewater. The increase can reach 90% as presented in Fig. 4.

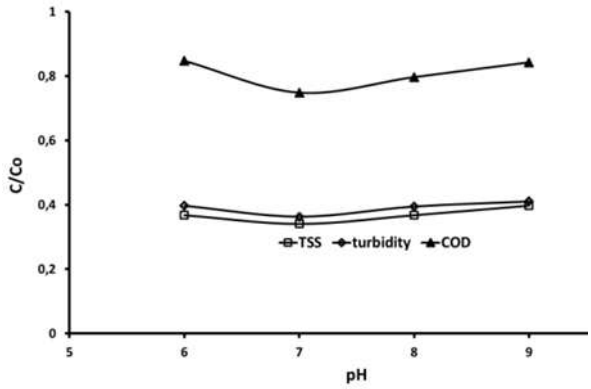


Figure 3. The effects of initial pH on TSS, turbidity, COD and TDS in the process of coagulation-flocculation.

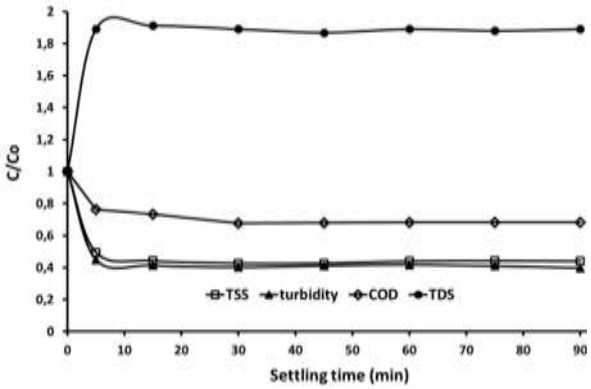


Figure 4. The settling time effects on the TSS, turbidity, COD and TDS in the coagulation-flocculation process.

The effect of PAC dose on TSS, turbidity, COD and TDS in the process coagulation-flocculation of wastewater solution at pH 7.0 is shown in Figure 5. There is decrease in the level of TSS, COD and turbidity, while TDS increase after the process of coagulation-flocculation. The pH of the solution applied in the process of coagulation-flocculation is closely associated to the coagulation process efficiency. The PAC has low solubility at a pH in the range of 6 -7, so that the coagulant can be maximally transformed into flock. The coagulation-flocculation process involves colloidal particles destabilizing by neutralizing forces that cause the colloids to stay far away from each other. Cationic coagulants provide a positive electrical charge which reduces the negative colloids charge. As a result, the particles collide with each other to produce macro particles known as flocks[20].

Generally, coagulants to form hydroxides when it dissolves in water, so that the metal hydroxide polymers formed will be of amorphous structures, positively charged, and have a large surface area. These hydroxides are hydrophobic, which can be absorbed onto the surface of organic anionic particles, therefore becoming insoluble[17]. As it is shown in Figure 5, TSS from the wastewater has been reduced to nearly 50% after the coagulation-flocculation process due to destabilization of suspended solids, so the process runs effectively. The flock formed from the process has sufficient time to settle at the bottom of the Erlenmeyer so that the filtrate of tofu wastewater free of particles larger than 10 microns. Similar effects also occurred for the turbidity as it can be seen that the decrease is almost equal to that of TSS, so that the turbidity decreasing curve coincides with the TSS decreasing curve. Since the turbidity of the solution is strongly influenced by the amount of suspended solids, so that the solution turbidity increases with suspended solids, while the brightness of the solution decreases with suspended solids. Figure 5 also shows that the decrease in COD only in the range of 8 to 28%. Particle deposition can indeed decrease the value of COD, especially in wastewater with high TSS content. Generally, a 1mg/L decrease in TSS will also decrease COD by about 10 mg/L[21]. In this process, TSS was successfully decreased by about 175 mg/L, while the COD was decreased by 1584 mg/L. Thus, for every 1mg/L decrease in TSS, there is also a 9mg/L decrease in COD. Meanwhile, Fig. 5 shows that TDS tends to increase due to the addition of a base solution to neutralize the wastewater's pH. An increase in TDS can also arise due to the fact that dissolved medium solids (colloid transition) in the wastewater solution passes through the filter paper because their size is less than 0.45 microns.

3.2 Ultrafiltration process

Figure 6 shows the water fluxes in the UF process for polysulfone (PS), cellulose acetate (CA) and ceramic membranes. As expected, water flux increases with increasing trans-membrane pressure (TMP) in the ultrafiltration process. The fluxes of the PS and ceramic membranes are almost the same, while that of the CA membrane is lower due to the smaller membrane pore size.

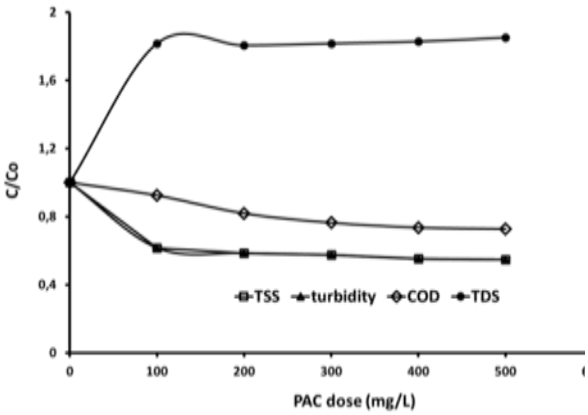


Figure 5. The effects of PAC dose on TSS, turbidity, COD and TDS in the process of coagulation-flocculation.

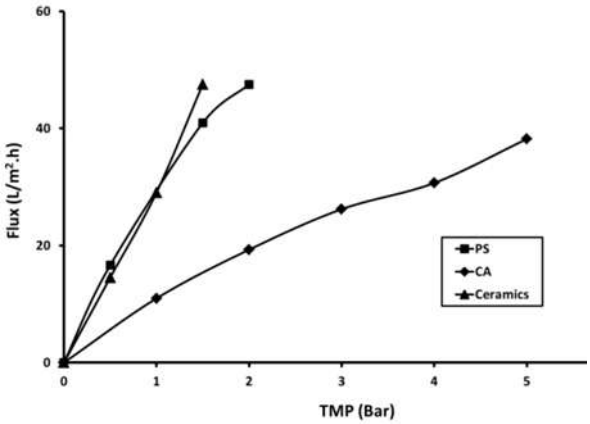


Figure 6. The Effects of Trans-membrane Pressure, TMP, on the Water Flux in the Ultra filtration Process.

The effect of TMP on TSS in the ultrafiltration process using PS, CA and ceramic membranes is shown in Figure 7. It is shown in Figure 7 that all the membranes used were able to produce products with very low TSS levels (<10mg / L) with a rejection of 92 to 99%. It also reveals that suspended solids cannot penetrate the membrane in the UF process. The lowest TSS of water produced in UF process was 2 mg/L, which far below the National Environmental Quality standard of 100 mg/L. This effect also occurs in turbidity where turbidity significantly decreases by more than 95% as shown in Fig. 8. The lowest turbidity of the water produced was 4 FAU which is far below the National Standard of 25 FAU. The effects of TMP on TDS and TDS rejection on the UF process is shown in Fig. 9. TDS decreases at TMP of 1.5 bar and then increases at TMP of 2.0 bar for PS membranes. This is due to the fact that at TMP of 2.0 Bar, more dissolved solids penetrate the membrane, so it increases the TDS of the water produced.

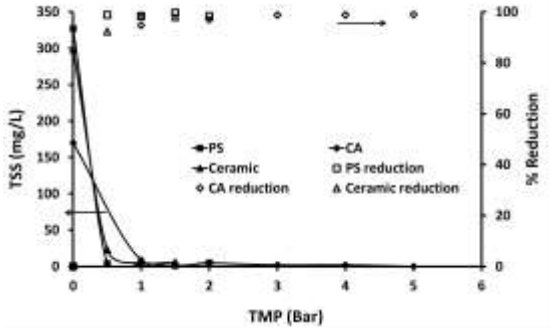


Figure 7. The effects of trans-membrane pressure (TMP) on TSS and TSS Reduction in UF process using PS, CA and ceramic membranes.

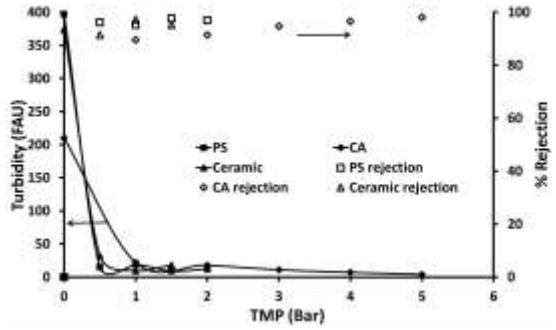


Figure 8. The effects of trans-membrane pressure (TMP) on turbidity and turbidity reduction in UF process using PS, CA and ceramic membranes.

Figure 10 shows the COD of the water produced after the UF process. The COD decreases with TMP of 1.5 and 1.0 bar and then increases at TMP of 2.0 and 1.5 bar for PS and ceramics membranes, respectively. Meanwhile, the COD decreases with TMP applied in the experiments for the CA membrane. It reveals that the UF membranes could retain the soluble and particulate organic matter in water not to cross the membrane pores up to TMP of 1.0 and 1.5 Bar for ceramic and PS membranes, respectively. The CA membrane was also able to hold soluble and particulate organic matter in water not to cross the membrane pores in the TMP applied in the experiment. The lowest COD of water that can be produced in the UF process is around 1460 mg/L, which still does not meet the National

Standards. A high COD contents is mainly due to the presence of soluble and particulate organic matter in water which cannot be completely discarded by membrane pores in the UF process. Therefore, it is necessary to do a further process so that the COD of produced water complies with government regulations. The reverse osmosis (RO) process can be recommended for this purpose.

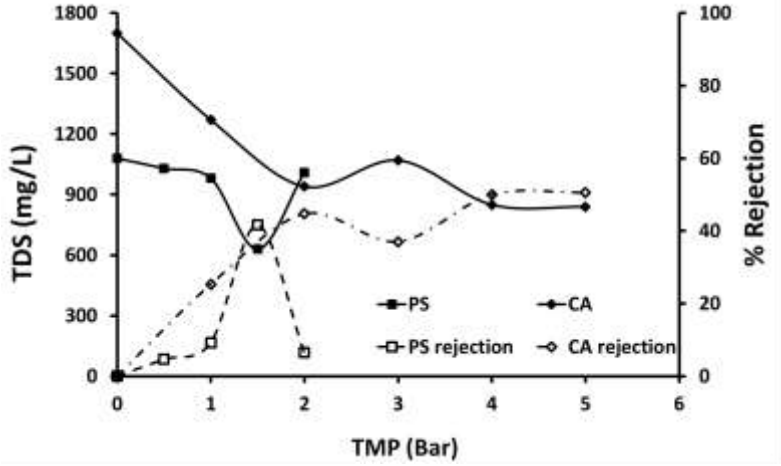


Figure 9. The effects of trans-membrane pressure (TMP) on TDS and TDS Rejection in UF process using PS, CA and ceramic membranes.

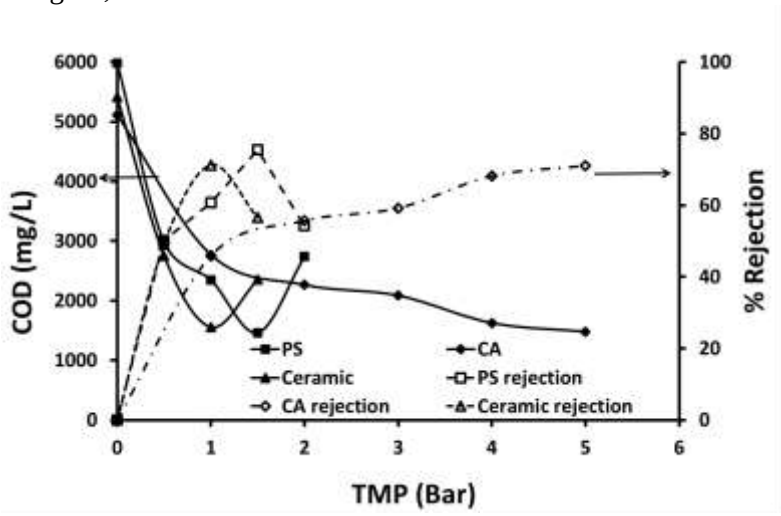


Figure 10. The effects of trans-membrane pressure (TMP) on COD and COD rejection in ultrafiltration process using PS, CA and ceramic membranes.

4. Conclusion

Tofu industries produce a lot of wastewater that cannot be discharged directly into the aquatic environment without any treatment process as they contain a high level of TSS, TDS, turbidity and COD. This study aims to reduce TSS, TDS, turbidity, and COD parameters from tofu wastewater through a combined process of coagulation-flocculation and UF. The results of experiment revealed that TSS, turbidity and COD can be reduced up to 60%, 60% and 20%, respectively, while TDS increased by about 90% in the coagulation-flocculation process. The increase in TDS was due to adding of base solution when neutralizing the wastewater. Meanwhile, TSS, turbidity, COD and TDS can be reduced up to 99%, 99%, 75%, 50%, respectively, after UF Process. All parameters in the water produced from UF process fulfill the National Standard except COD, which still above the standard due to the high COD content in the fresh tofu wastewater. COD content in the fresh tofu

wastewater can be reduced from 8000 ppm to 1460 ppm, while the requirement should not exceed 275 ppm.

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Risk-based sustainability balanced scorecard to prioritize integrated improvement and to consider high level structure

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Abstract. Today, countries pay attention to the issue of sustainable development which begins to underlie activities from various fields. This issue forces companies to concern about sustainability issues by improving the process to become a green process. Consequently, the performance measurement system to measure the success of the green process needs to be developed. One of the examples is Sustainability Balanced Scorecard (SBSC) which is a developed form of Balanced Scorecard. SBSC is a tool for measuring performance by considering evaluation aspects of profit, planet and people. Currently, the assessment of the success of a company, however, is completed by observing the achievements of Key Performance Indicator (KPI) only, whereas the good performance of the company is also influenced by the risks of other businesses. Therefore, risks that affect the company need to be regulated and considered so that control to the company activities can be integratively conducted. Based on this research gap, this paper aims to initiate the integration of risk management with SBSC in measuring company performance. This integration effort can affect the priority of improvement for the company. As a case study, the results of the integration were tested to measure the performance of companies that produce construction materials. Based on this integration, the obtained results show that risk-based thinking in the Performance Measurement System can provide a new approach to assess the performance of a company.

1. Introduction

The issue of sustainable development does not only affect the technical field to develop sustainable manufacturing globally but also has consequences for the way of measuring performance as in the Balanced Scorecard. Balanced Scorecard (BSC) is a management system that guides organizations to translate their vision and mission into controlled real actions [1]. By using BSC, companies can measure their financial performance, learning and growth, customer focus and internal business processes. In the influence of the issue of sustainable development, BSC is developed by adding aspects of performance measurement, i.e. the sustainability aspect that will control environmental activities and social activities. Considering the importance and development of sustainability issues for company to control the activities regarding 4 aspects and sustainability aspect makes BSC converting into SBSC. In implementation, SBSC is developed by directly adding sustainability aspect into the old BSC's aspects so it has financial, learning and growth, customer focus, internal business and sustainability as perspectives. The other method to develop BSC is inserting sustainability aspects into each perspective of financial, learning and growth, customer focus, internal business. Basically, the fundamental difference between BSC and SBSC is on the sustainability aspect. Hence, the company can control its activities as a whole so that all companies can guarantee that their entire activities are in accordance with the established business strategies. The success of a company's business strategy,

however, is not only influenced by performance achievements that are relevant to a particular strategy but also influenced by the risks that affect the course of the company. It relates to the evaluation and the forecasting of future undertakings, processes and activities which are accompanied by uncertainty and risk [2]. Performance achievement itself is also influenced by the risks that affect it [3]. This risk awareness also lies behind the improvement of ISO that is developed by paying attention to the concept of risk-based thinking. With the concept of risk-based thinking, the design and implementation of ISO can be carried out integratively among ISO standards. By considering the effect of risks, companies can reduce uncertainty in achieving objectives, taking preventive actions, and complementing quality management principles, especially the principles of the process approach [4]. The rationale can be applied to the performance measurement system. By taking the effects of risks into account, the company can reduce the uncertainty in achieving the target of each Key Performance Indicator (KPI) and take preventive actions against the inability of achieving the targets for each KPI with the principles of process approach. Thus, companies consider the high level structure in controlling their business. The integration of risk based thinking in performance measurement can contribute to the determination of the priority of improvement. Some of the obtainable benefits from the integration of risk based thinking with SBSC, performance measurement system, are developing or improving the company activity management that is more comprehensive and integrated, familiarizing proactive culture in achieving KPI targets as a form of risk awareness, and assisting to match the targets and the execution ways so that the affecting risks can be managed properly.

2. Methodology

The methodology used in this paper is the development of general performance measurement framework. The development is viewed in the integration of risk-based thinking so that the framework for performing the risk management will appear in the framework as a whole. For more details, the framework used in this paper is shown in Figure 1.

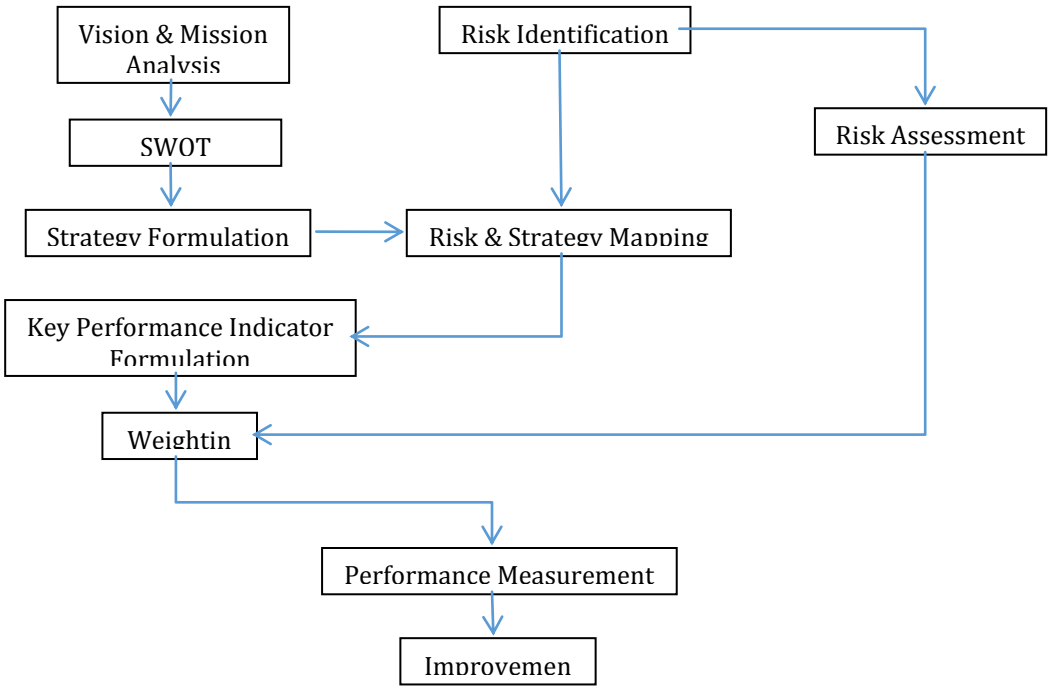


Figure 1. Framework of research

3. Literature Review

3.1 Performance Measurement System

Performance measurement is a process of quantifying the success of a company in achieving its predetermined targets. Performance measurement can also be employed to assess human behaviour in carrying out their roles in the company. In the implementation, performance measurement should include several related aspects such as aspects of cost, quality, time and flexibility [5]. In its development, several performance measurement tools define these aspects of performance. Performance prism, for example, is a tool for measuring performance that defines aspects of performance based on the interests and contributions of stakeholders [6]. Malcolm Baldrige defines 7 aspects of performance that are crucial in assessing the performance of a company [7]. Balanced Scorecard is a tool for measuring performance from 4 aspects, i.e. financial, learning and growth, customer focus, and internal business process [8]. Meanwhile, Sustainability Balanced Scorecard is the development of Balanced Scorecard to measure the implementation of sustainable strategies in an organization. Sustainability means paying attention to environmental and social elements besides economy in every business consideration that is carried out. In SBSC, a new aspect of performance is introduced as nonmarket aspect [8]. Non-market aspect is used to integrate relevant environmental and social strategic aspects. In addition, non-market aspect is often referred to as sustainability aspect. The addition of this aspect shows that the issue of sustainable development has affected the field of performance measurement. In accordance with the pillars of sustainable development, performance measurement must also be carried out equally on the triple bottom line of the company, which includes profit, people and planet. The inequality in those three pillars will cause the non realization of sustainability. With this perspective, it is expected that top management will bring the company to pay more attention to the environment and human welfare.

Moreover, in SBSC, it can be explained that financial perspective is used to measure financial performance such as income growth, cost reduction, return on capital employed (ROCE), and so on. Customer perspective focuses on customer satisfaction, customer loyalty, new customer acquisition, customer value and profitability, market share and so on. Internal business process perspective includes the discussion on the way to identify and arrange processes efficiently and effectively. Growth and learning perspectives discuss the capabilities of workers, internal abilities, skills, training, and harmony. Sustainability perspective includes the discussion on produced emissions, waste reduction, environmental preservation and energy consumption.

3.2 Risk Management

Risks describe the magnitude of the possibility of danger that can cause interference and the magnitude of severity that it causes. There are many benefits obtained when an organization decides to carry out risk management, such as increasing the awareness of all members of the organization about risks, focusing the efforts on very impactful things, instilling preventive culture and risk management, and making the organization more successful due to minimum errors. In order to manage risks, there are steps that can be taken, which are 1) Identifying risks aimed at recognizing the possibilities of risks occurring in the organization, 2) Analyzing risks aimed at determining the value of a risk by taking the possibility of occurrence and the magnitude of the consequences of these risks into account, 3) Evaluating risks aimed at classifying the level of risks using the Failure Mode & Effect Analysis (FMEA) method that serves to sort potential risks that can occur so that the organization is expected to determine the risks that must be corrected, 4) Determining risk management efforts that aim to reduce the value of a risk after determining the priority, and 5) Performing risk monitoring which serves as a risk control tool and continuous improvement efforts.

4. Data Processing and Result

Based on the methodology presented previously, the integration between risk based thinking and SBSC is applied to measure the performance of a company that produces construction materials such as light bricks and cement. Next, the company in the case study is named PT. XYZ for the confidentiality of the company. In running its business, PT. XYZ still continues to excel in its business

competition and is always committed to keep providing short-term and long-term benefits to its users, as well as providing environmentally friendly construction materials. Therefore, the manufacturing process that is in accordance with the principle of sustainable development must be measured using a performance measurement system that is also in accordance with the principles of sustainable development. Broadly speaking, the vision of PT. XYZ is to be a producer of construction materials that can be accepted by the world market by considering quality and sustainability. Based on the SWOT analysis, there are seven strategies. In addition to paying attention to the implementation of the strategies, PT. XYZ also possesses the awareness of risk. Based on the business strategies, KPI is structured as a control tool for certain business strategy implementation. Then, the company sets its targets and assessment standards or scorecards for each KPI. In measuring the performance, the score will be multiplied by the weight of KPI to determine the performance of the company. So far, KPI weighting has only been done without taking the risk factors that affect the strategies into account. In this paper, it is initiated to carry out the weighting by involving the size of risks that have been assessed. Therefore, in addition to using the pair wise comparison method, KPI weight is also multiplied by normalized RPN. The following are the results of mapping between identified risks and business strategies along with the risk assessment using Failure Mode and Effect Analysis (FMEA) for first semester of 2017 (January-June):

Table 1. Strategies & Assessed Risks Mapping and KPI Formulation

No.	**Strategy**	**Risk**	**Severity**	**Occurrence**	**Detection**	**RPN**	*Key Performance Indicator (Final Weight; Score)*				
							Financial	*Customer*	*Sustainability*	*Learning and Growth*	*Internal Business Process*
1	Expanding market share throughout the world	Quality management system does not work well	3	4	2	24	Return on Equity (0,167; 4), Net Profit Margin (0,105; 5)				
2	Improving the effectiveness of quality management system	KPI targetsare not reached	3	3	2	18		*Customer complaint (0,218; 4)*			*Defect (0,023; 5)*
3	Reducing the level of machine damage/*breakdown* and performing routine machine*maintenance*	Maintenance is not carried out according to schedule	3	3	2	18					*breakdown (0,009; 4), achieved quality target (0,009; 3)*
4	Improving the competence of company employees	KPI targetsare not reached	3	3	3	27				Number of employee training (0,062; 5), turnover (0,029; 4)	Productivit y level (0,009; 5)

No.	Strategy	Risk	Severity	Occurrence	Detection	RPN	*Key Performance Indicator (Final Weight; Score)*				
							Financial	*Customer*	*Sustainability*	*Learning and Growth*	*Internal Business Process*
5	Improving good relationships with *suppliers* and logistics companies	Material, information and financial flows are not smooth	4	2	2	16					*Supplier On Time Delivery (0,014; 3), defective raw material (0,014; 4)*
6	Increasing production capacity by paying attention to environmental and social aspects	Increasing waste	3	2	2	12			*Waste (0,076; 1), Amount of electricity kWh (0,026; 1), Number of employee program (0,011; 1)*		
7	Taking part in providing open job vacancies	Availability of decent workforce is not suitablewith needs	2	2	5	20			Local community workers (0,007; 5)		

The data above was taken based on measuring and interviewing the representative of management. It includes for assessing the severity, occurance and detection for the risks. The value of severity shows the consequence of risk happened, the value of occurrence shows the probability of risk happened, and the value of detection shows the easiness to recognize the risk before it happens. To assess the risk, we can calculate the RPN (Risk Priority Number) value by multiplying those the three values. The higher RPN is, the more important risk is. Based on the results of performance measurements, priority improvements in sequential perspective are Sustainability, Internal Business Process, Learning and Growth, Customer, and Financial. By integrating the risk and performance, those priority improvements have already covered the value of risk which is considered in high level structure and covered the achievement of each KPI. However, we still need other emprical study to explore the benefit of the integration between risk management and performance measurement system.

5. Discussion

Basically, risk is divided into two, i.e. strategic and operational risks. Both of these risks will certainly affect the company, not only in the aspects of quality, environment, and safety but also in other operational or strategic activities of the company. It will be useless if the company only pays its attention to the achievement of the success indicators in every activity without considering those risks. Awareness of the importance of risk management also becomes the background of the change for ISO, version of 2015, where the application of ISO requires organizations to identify and mitigate risks. Since risk management is integrated and pervasive, the ISO, version of 2015, is also integrated between management systems which are commonly known as High Level Structure.

Based on background of the change in ISO, there is a thought that risks affect company activities both at the strategic level and at the operational level. Therefore, in the monitoring of company

activities that are also commonly carried out through performance measurement needs to integrate risk based thinking into performance measurement. This will affect the company in giving weight to KPI or performance perspective. By explaining the existence of risks that can affect the achievement of targets for every KPI, the company is asked explicitly to give weight to KPI and considers the value of the affecting risks as well. The integration of risk based thinking into performance measurement can change the priority of improvement from the company. For example, if a KPI has low performance but not too risky, it will lose its priority with KPIs that have higher performance but high risk. It will be different if the company does not consider risk factors because the company will pay more attention to KPIs with low performance. However, there will be a possibility that the priority results will be the same for both methods if the risk value ranking is the same as the KPI weighting ranking.

6. Conclusion

The integration of management risk with performance measurement can influence the way companies provide priority improvements because these priorities are influenced by the way the company gives weight to each of the performance perspectives. Through this integration, the company is reminded that there are risk factors in performance that need to be really taken into account. Thus, performance measurement will also be High Level Structure. So far, the weighting of KPI comes from the decision maker's preferences which can be very subjective. In that preference, there may indeed be a risk assessment which is also missed, however. In this case study, the priority of improvements in PT. XYZ was obtained from sequential perspective, which includes Sustainability, Internal Business Process, Learning and Growth, Customer, and Financial.

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Effect of NR-*g*-cellulose coupling agent into NR-cellulose composite dispersibility and its physical properties

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Abstract. Natural rubber and cellulose are two materials with very different compatibility, so it is difficult to produce homogenous composite without using coupling agent. Natural rubber is nonpolar while cellulose is polar. The combination of natural rubber with cellulose expected produce composite with higher strength. The reinforcement concept of polymeric materials, such as natural rubber with cellulose as filler, result from increased rubber-filler interactions. This study aimed to determine the effect of NR-***g***-Cellulose as coupling agent on the dispersibility of the composite and its physical properties. Hexamine/resorcinol and silane was used as a reference for a commercial coupling agent. Cellulose material was mixed in two-roll open mill together with natural rubber and other chemicals using three types of coupling agents, hexamine/resorcinol, silane, and NR-***g***-Cellulose. The FESEM result of the surface of composite showed that composite with NR-***g***-Cellulose as coupling agent showed homogenously dispersed compared to two other types of coupling agent but lower in physical properties, especially in tensile strength, tear strength, compression set, and rebound resilience of the composite. It may be caused by the NR-***g***-Cellulose coupling agent not working optimally and need a high temperature to optimization the coupling agent reacts with natural rubber and cellulose.

1. Introduction

Composites, the wonder materials are becoming an essential part of today's materials due to the advantages such as low weight, corrosion resistance, high fatigue strength, and faster assembly [1]. Polymer composites are the name given to composite materials in which different polymers (binders) are used as the matrix; here, the second strengthening component (the filler) can be of any nature, including polymeric. The components of composite materials possess a clear phase boundary, while the properties of composite materials are formed by the volume combination of components and differ considerably from the properties of the individual components [2].

Natural rubber (NR) contains the high molecular weight, which is based on cis-1,4-polyisoprene. It has excellent mechanical and physical properties such as tensile strength, tensile modulus, tear strength, and hardness. However, NR has poor chemical resistance and processing ability. The combination of its unique morphology, physical properties, cost-effectiveness, and environmental friendliness make natural rubber an appealing constituent for many materials and applications [3].

Natural fibers (NF) have been studied as reinforcement in composites due to its availability, environmentally benign, and renewable [4]. One of NF that widely applied in many applications is palm oil Empty Fruit Bunch (EFB). Empty Fruit Bunch (EFB) is a biomass waste produced by oil palm industries (about 25-26%). The empty fruit bunch of palm oil contains cellulose up to 36.67% [5]. The cellulose could be extracted using the pre-treatment process. The purified cellulose was then undergoing acid hydrolysis to break the cellulose structure into nano-sized. Nano-sized cellulose that been formed is fibrous and nanofibrillated [6]. The nanosize of the cellulose (Cellulose Nano Fiber, CNF) provides excellent properties such as high crystalline content, good optical properties, and excellent mechanical properties [7].

In composite preparation, natural rubber (NR) is a material commonly used as matrix [8]. The mechanical properties of bio filler filled rubbers depend on several factors of which most important ones are dispersion level, interfacial strength, and type of filler used [9]. The combination of NR and cellulose was good combination to improve tear strength. The reinforcement concept of polymeric materials, such as natural rubber with cellulose as filler, result from increased rubber-filler interactions [10]. To improve interfacial bonding and mechanical properties, compatibilizer was commonly added [5].

NR and MFC cannot disperse well because of the differences in polarity. To dispersed better, an appropriate coupling agent must be used. One kind compatibilizer or coupling agent for natural rubber (NR)-cellulose composite had been synthesized by grafting copolymerization between cellulose and natural rubber resulted in NR-***g***-cellulose; this is the novelty of this research. This research aims to study the effect of its synthesized coupling agent and two commercial coupling agents as comparison into NR-cellulose composite dispersibility and its physical properties. The composite was produced using two roll open mill. The composite samples were vulcanized, and its physical properties were analyzed. The effects of coupling agent on sample morphology were observed using Scanning Electron Microscopy (SEM).

2. Materials and Methods

1.1. Materials

The materials used in this study include Natural rubber (NR), *Standard Indonesia Rubber* (SIR) 20 obtained from local suppliers, and also technical quality rubber compounding chemicals from local suppliers. The rubber compounding chemicals include Sulphur as vulcanization agent, stearic acid and zinc oxide as an activator, hexamine/resorcinol and silane Si-69 as commercial coupling agent, and TBBS as an accelerator.

1.2. Preparation of Microfibrillated Cellulose (MFC)

Microfibrillated Cellulose (MFC) and coupling agent NR-***g***-MFC produced by ITI. The initial microcrystalline cellulose (MCC) sample was prepared from oil palm Empty Fruit Bunches (EFB) by grinding and crushing to resulting powder form. The MFC was obtained chemically from MCC by delignification process using sodium hydroxide with high-pressure and bleaching using magnesium oxide and hydrogen peroxide. The dry nano-powder was obtained by evaporated in vacuum at 80 ℃ and finally dried at 50 ℃ up to constant weight [11]. The characterization of MFC was analysis using Particle Size Analyzer (PSA), Scanning Electron Microscopy (SEM), and Simultaneous Thermal Analysis (STA).

*1.3. Preparation of NR-**g**-MFC*

The coupling agent between natural rubber and MFC was synthesized via copolymerization reaction by Atomic Transfer Radical Polymerization (ATRP) method using macroinitiator MCF-Bromide in an autoclave [12]. The characterization of the copolymer was analysis using Fourier Transform Infrared Spectroscopy (FTIR).

1.4. Synthesized of Natural Rubber/MFC Composite

Natural rubber and MFC are mixed with other ingredients in the two-roll open mill according to the compound formula. The addition of chemicals uses a unit of phr (per hundred rubbers), this is used for calculating formulas where other chemicals are calculated as parts per 100 weight of rubber. Compound formulated with variations in 3 types of coupling agent, as seen in Table 1. Natural rubber/cellulose composites were made without coupling agent as a control. The compounds were then tested for physical properties.

Table 1. The formula of natural rubber/cellulose composite with varied kinds of coupling agents

Materials	Dosage (per hundred rubber, phr)			
	A	B	C	D
NR	100	100	100	100
MFC	25	25	25	25
NR-*g*-MFC	-	-	3	-
Silane Si-69 (*bis-triethoxy silyl propyl-tetrasulfide)*	1.5	3	-	-
Hexamine (hexamethylenetetramine)	1.5	-	-	-
Resorcinol (1,3-isomer from benzenediol)	1.5	-	-	-
Zinc Oxide	5	5	5	5
Stearic Acid	2	2	2	2
TBBS (N- tert-butyl-benzothiazole sulphonamide)	0.7	0.7	0.7	0.7
Sulphur	2.25	2.25	2.25	2.25

3. Results and Discussion

1.5. Preparation of Microfibrillated Cellulose (MFC)

The morphology of the MFC structure was analyzed using Scanning Electron Microscopy (SEM); the results showed a cellulose structure in the form of fibrils with a relatively wide diameter (Figure 1). Based on the PSA analysis, MFC has polydispersity 2.174 with size 4.625.5 ± 18.862.9 nm. These results indicate that the synthesized MFC still has various particle sizes that need to be refined and homogenized again to reach smaller size particles. Meanwhile, the thermal properties of MFC based on the STA diagram analysis (Figure 2) show good thermal resistance as evidenced by high degradation temperatures (> 300 ° C).

*1.6. Preparation of NR-**g**-MFC*

The NR-***g***-MFC that were successfully synthesized can be proven through FTIR analysis. Figure 3 shows the results of the FTIR spectrum of MFC before and after the synthesis of MFC graft copolymers with natural rubber. Based on Figure 3, it can be seen that the aromatic ring at wave number 1593.12 has disappeared which indicates that the aromatic ring breaks up and binds to the double bond carbon group (C = C) and with the side groups of natural rubber form a double bond and carbonyl group. A Double bond carbon and carbonyl group formed can be seen at wavenumbers 1661.77 and 1737.47 which are characteristic for the absorption of carbon groups C = C and C = O.

1.7. Synthesized of Natural Rubber/MFC Composite

Amount of four NR/MFC composite formulas according to Table 1 have been made compound and cured on a press machine to produce vulcanized rubber as can be seen in Figure 4. Visually based on Figure 4 it can be seen that mixing of natural rubber with MFC and other materials in the two rolls open mill did not result in homogeneous dispersion, the particles of cellulose are still visible on the surface, not well disperse with natural rubber. This is evidenced by the results of SEM analysis for three composites A, B, and C while SEM results for D composites are still tested (Figure 5).

From the results of SEM analysis, it can be seen that the mixing process has not produced a composite with uniform dispersion. In composite A, cellulose particles still appear on the surface, which is characterized by the appearance of white spots. This indicates that the MFC particles have not completely filled in the natural rubber matrix. In composite B, white spots appear more than composite A, while in composite C, white spots look less than composites A and B. This indicates that the mixing of materials in composite C using NR-***g***-MFC as coupling agent is relatively more homogeneous compared to the other two composites.

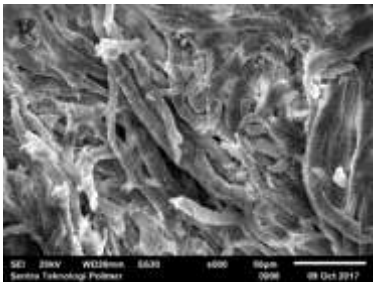


Figure 1. SEM micrograph of microfibrillated cellulose (MFC)

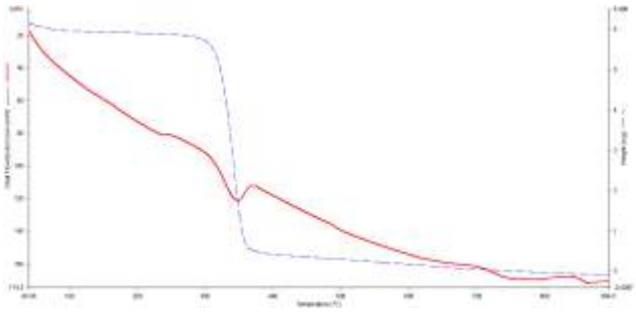


Figure 2. Thermal analysis of microfibrillated cellulose (MFC)

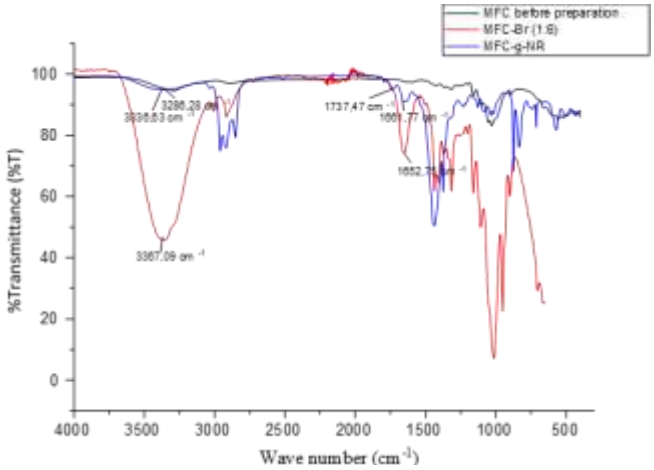


Figure 3. FTIR spectra of MFC before and after synthesis of graft copolymers with natural rubber

1.8. *Physical properties of the composite.*

The addition coupling agent into natural rubber/MFC composites affected the physical and mechanical properties of the composites. The results of physical properties testing for all vulcanized composites can be seen in Table 2.



Figure 4. Visualization of composite A-D (from left to right)

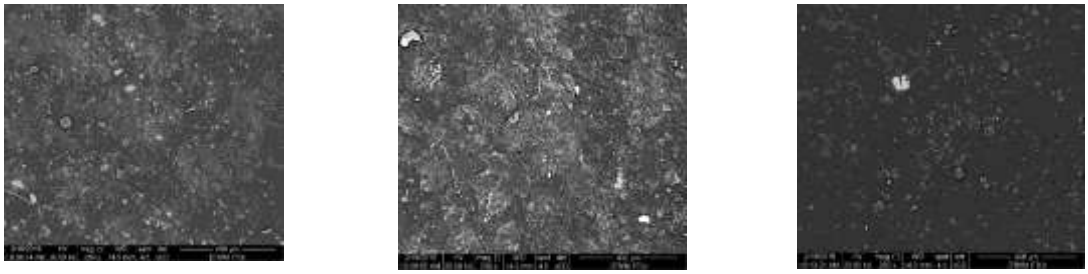


Figure 5. SEM micrograph of composite A, B, and C (from left to right)

Table 2. Physical properties of natural rubber/MFC composite with varied kinds of coupling agent

Physical Properties	Vulcanized			
	A	B	C	D
Hardness (Shore A)	75	67	65	63
Tensile strength (MPa)	4.4	4.3	2.4	5.1
Elongation at break (%)	350	520	420	560
Tear strength (MPa)	35.8	27.3	22.6	27
Compressien set, temp. 27±2 °C (%)	9.89	12.64	43.23	13.64
Compression set, temp. -5±2 °C (%)	2.61	5.08	23.14	7.52
Rebound resilience (%)	69	58	51	64

1.9. Effect on hardness

The addition of combinations coupling agent, hexamine/resorcinol and silane, increases the hardness up to 12 shores A compared to D composites, which did not use coupling agent. Meanwhile the addition of a single coupling agent, silane, increases the hardness by 4 shore A and the addition of NR-***g***-MFC increases the hardness by 2 shore A. This can be caused by the coupling agent that increasing the interaction of natural rubber-filler (NR-MFC interaction) so that the composite structure becomes compact and solid as a result of increased composite hardness.

1.10. Effect on tensile strength

Composites without coupling agent (composite D) provide better tensile strength compared to other composites that using coupling agent. This can be caused the coupling agent used is not suitable with the NR/MFC composite so that the addition of the material weakens the NR-MFC interaction so that the elasticity of the NR/MFC composite decreases.

1.11. Effect on elongation at break

Composites without coupling agent (composite D) provide better elongation at break than other composites that using coupling agent. The decrease in elongation at break can be caused by the function of coupling agent to increase NR-MFC interaction so that the intermolecular interactions of natural rubber decrease. It caused decreasing in the elasticity of natural rubber, so the composites with coupling agent become easier to break than composite without coupling agent.

1.12. Effect on tear strength

Composite A, which uses a combination coupling agent, hexamine/resorcinol and silane, gives better tear strength than other composites. The increase in tear strength can be caused by the addition of coupling agent to strengthen the NR-MFC interaction, thus increasing the strength of the NR/MFC composite. Composite B, which uses a single coupling agent, silane, has better tear strength compared to composite D (without coupling agent). However, the tear strength of composite C using NR-***g***-MFC as coupling agent is lower than other composites. It can be caused that NR-***g***-MFC is not suitable with NR/MFC composites so that the addition of material weakens the NR-MFC interaction so that the strength of NR/MFC composite decreases.

1.13. Effect on compression set

Composite A, which uses a combination coupling agent, hexamine/resorcinol and silane, provides better compression set than other composites. The greater the compression set value shows that after compressed, rubber elasticity is decreased [13]. Composite B, which uses a single coupling agent, silane, provides better compression set than composite D (without coupling agent). Whereas composite C, which using NR-***g***-MFC as coupling agent, has the worst compression set than other composites. This can be caused the NR-***g***-MFC is not suitable with NR/MFC composites so that the filler-filler interaction of the MFC used is greater than NR-MFC interaction. This shows that the intermolecular interaction of MFC is stronger than the NR-MFC interaction so that when the composite is compressed in high pressure at certain temperature and time, its elasticity will drastically decrease.

3.10. Effect on rebound resilience

Composite C, which uses NR-***g***-MFC as coupling agent, provides better rebound resilience than other composites. This can be caused by the addition of NR-***g***-MFC increasing intermolecular interactions of natural rubber so that the elasticity of composites is better than other composites. The lower the value of rebound resilience indicates that the composite is more resistant to impact.

4. Conclusions

The uses of NR-***g***-MFC as a coupling agent for NR/MFC composite could increase the dispersibility of MFC into natural rubber matrix in process compounding. On the other hand, the addition of NR-***g***-MFC decrease almost all physical properties except rebound resilience. To optimize the function of NR-***g***-MFC as coupling agent, the temperature of mixing should increase so the reaction of the coupling agent with natural rubber and MFC will be optimum.

Acknowledgment

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Carbon emission modelling in container terminal operations planning using a system dynamics approach

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Abstract. This paper discusses the model development of carbon emission cost in container terminal operations planning using a system dynamics approach. Operational planning in a container terminal consists of planning a vessel at berth process, containers loading and unloading processes by quay cranes, containers transportation process by container trucks, containers loading and unloading processes by yard cranes, and containers receiving and delivery processes by container trailers. In each stage, the process will produce carbon gas emissions. A system dynamics simulation model was applied to determine the optimal allocation of the number of used material handling equipment based on the number of handled containers to minimize the total carbon emissions in a container terminal operations planning. The design of a system dynamics simulation model considers the uncertainty in the vessel arrival time and the number of containers that should be handled on each moored vessel at the berth. The system dynamics model had been applied to a numerical example for resulting the optimal solutions of planning decisions at container terminal operations.

1. Introduction

In recent years, container terminal industries have been under great pressure to meet economic and environmental standards. The level of energy consumption and resulting emissions in this industry significantly increases the energy consumption rate and costs. Nevertheless, few container terminal industries have implemented performance measurement and strategy of energy efficiency. Container terminal performance needs to be improved to create industries that are not only competitive and productive, but also need to be more sustainable. As a consequence, performance measurement efforts that must be beyond the measurement of traditional efficiency and productivity are emerging challenges. In terms of energy consumption, there is a strong relationship between sustainability, efficiency, competitiveness and port profitability. The relationship of sustainability with the efficiency of energy consumption and port performance has not been fully understood, nor has been analyzed in detail [1].

Energy consumption level is one of the important factors in port operations and economic activities related to ports. Increased energy costs need to be responded by port authorities and container terminal operators by finding ways or strategies to reduce fuel expenditure. With the growth of global container trade and port infrastructure development, ports have become significant energy consumers.

An analysis of energy consumption requires a detailed understanding of the portion of energy expenditure at container terminal operations expressed by different sizes and types of containers, so that it can determine what operating area consumes energy [2].

The remainder of this paper is structured in the following manner. Section 2 reviews the relevant literature with the main focus on energy consumptions and carbon emissions resulting from container terminal operations. A detailed description of the problem studied herein is described in Section 3. In Section 0, the model development using system dynamics approach is presented for minimizing the total carbon emissions in container terminal operations. Section 5 presents and discusses the results of simulation model and, finally, in the last section summarizes findings and outlines potential future research directions.

2. Literature review

Although the literature related to energy consumption in container terminal operations is quite limited, several research work on energy consumption in specific types of container handling equipment had been conducted by Yun et al. [3], Yang and Chang [4], Acciaro et al. [5] and Geerlings and Duin [6]. However, in general, there has been no systemic view research of the beyond impact of energy consumption on technological advancements in container terminals. Yun et al.'s work was one of findings reported on the impact of electric rubber-tired gantries on green port performance [3]. Yang and Chang's research indicates that bulbar-powered RTGs equipped with online braking can reduce energy consumption by up to 60% [4].

Sim has made energy activity clusters as follow: vertical operations (quay cranes), horizontal operations (e.g. reach-stacker (RS) cranes, rubber-tired gantry (RTG) cranes, rail-mounted gantry (RMG) cranes, etc.), lighting, buildings and cooling (reefers). Usage time is another important factor when it comes to measuring energy consumption and setting indicators for energy efficiency because of: (1) ship calling patterns, all which can trigger significant variations and peaks in energy consumption; (2) variations in the dwell time of different container types (e.g. import and export containers); and (3) the seasonality of certain types of traffic (e.g. reefers) [7]. Geerlings and Duin have classified the energy consumption per type of cargo handling equipment in terminals as shown in the following Table 1 [6].

Table 1. Energy consumption per type of equipment.

Energy	Type of equipment	Fixed consumption per container move	Variable consumption
Electric	Quay Crane [a]	6.00 kWh	
	Barge Crane [a]	4.00 kWh	
	Rail Crane [a]	5.00 kWh	
	Automated Stacking Crane [a]	5.00 kWh	
	Rail Mounted Stacking Crane [b]	7.25 kWh	
	Platform [b]	5.00 kWh	
Diesel	Automated Guided Vehicle [a]	1.10 liter	1.80 liter/km
	Straddle Carrier [a]	0.80 liter	3.50 liter/km
	Terminal Tractor [a]		4.00 liter/km
	Multi Trailer System [a]		4.20 liter/km
	Reach Stacker/Top Lifter [a]		5.00 liter/km

[a] Based on a TNO project by Oonk

[b] Based on a comparison with the ASC on the ECT Delta Terminal, in which the reach of the equipment (stack length) is taken into consideration

Carbon emissions at container terminals are produced by direct and indirect carbon emissions based on fuel consumption or electrical energy [3]. Equipment operated using fuel, such as container trucks and yard cranes, consumes fuel energy while operating such that it will produce direct carbon emissions. Equipment operated by using electricity, such as OPS, will produce indirect carbon emissions, which

means that emissions are generated outside the seaport. Carbon emissions either directly or indirectly produced by each equipment (Figure 1.) can be calculated according to ISO 14064-1: 2006 standard [8] and IPCC 2006 [9], which are determined by the amount of energy consumption and the coefficient of emissions carbon from that energy, as given in Eq (1).

$$W = F.C_{energy} \quad (1)$$

where W represents the carbon emissions; F represents the energy consumption, which can be diesel (kg), LNG (kg), or electric (kWh); C_{energy} is the carbon emission coefficient of the energy, which can be obtained from IPCC 2006 [9] and the energy statistics department in corresponding region. The CO_2 emission coefficient of electricity for the port is 1073.65 lbs CO_2/MWh (1 lb =0.45359 kg), namely 0.7369 kg/kWh [10]. Therefore, once the energy consumptions are formulated, the carbon emissions can be obtained.

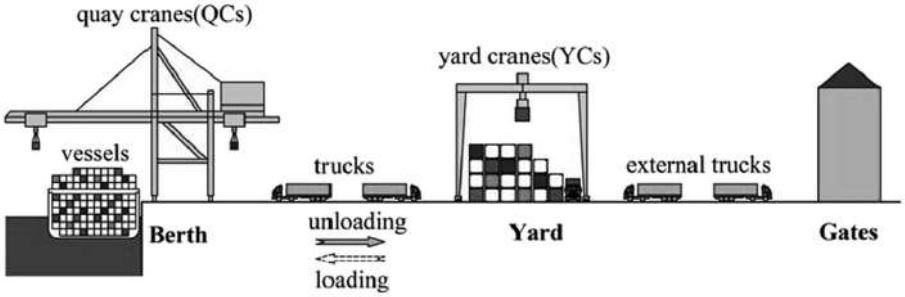


Figure 1. The equipment in container terminals [3].

The energy consumption level of ships can be divided into three components, namely: (1) energy consumption when the ship sails in the waterway, (2) energy consumption when the ship is waiting at the port, and (3) energy consumption when the ship is berthing at seaport. Based on Korean Environmental Industry and Technology Institute, 2016 in [7]. This paper used emission density values published by a South Korean organization as a basis for estimating carbon emissions produced in South Korea (KLCI DB, 2016). The carbon density values of the major vessel and equipment activities are shown in Table 2.

Table 2. The carbon emission density of major vessel and equipment activities.

Activity	CO_2-e (kg/TEU)
Container ship maneuver	1.99000
Container ship at berth	0.02324
Quay crane	1.39000
Yard truck	0.04287
Yard crane	0.06873
Container trailer	0.38645

2.1. CO_2 emission calculation for vessels

The vessel emissions at the hoteling phase are calculated using the following equation from Hu et al. [11]

$$E_{vessel} = \sum_p PO.t_s.LF.EF_p.FCF_p.C_y \quad (2)$$

Where: E_{vessel} is the total vessel emission while hoteling in kg of CO_2;

PO is the rated power (kW) of the auxiliary engine of the vessel,

t_s is the makespan or completion time in which the engine is used (hours),

LF is the load factor of the engine while the vessel is moored;

EF_p is the emissions factor kg CO_2/kWh for each pollutant p considered,

FCF_p is the fuel correction factor for each emission factor, to replicate changes in the fuel properties over time

C_y is the number of cylinders of the auxiliary engines of the vessel.

2.2. CO_2 emission calculation for QCs

A QC is an electrical machine that does not emit CO_2 directly, but the electricity used, was previously generated through a process with CO_2 emissions. According to Geerlings and Van Duin [6] the QCs' energy consumption is considered fixed per handled container, with a fixed value of 6 kWh/container. Thus, the CO_2 emission during the crane operation can be calculated as:

$$E_{cranes} = \sum_k C_s . W_k . EFC_k \quad (3)$$

Where: E_{cranes} is the total crane emission in kg of CO_2 during the loading/unloading process,
C_s is the fixed energy consumption for a QC, in kWh/container,
W_k is the amount of containers handled by each QC *k*,
EFC_k is the emission factor per electric QCs, in kg of CO_2/kWh;
k changes from 1 to *n*, which is the total number QCs used.

In this paper, the system dynamics simulation model is applied to help decision makers in solving the complex systems problem to minimize the total carbon emissions in container terminals in spatial and multi-temporal integration. The steps needed for system dynamics modeling and simulating of complex systems based on systems thinking are: (1). Identify the problem. (2). Develop a dynamic hypothesis explaining the cause of the problem. (3). Create a basic structure of a causal graph. (4). Augment the causal graph with more information. (5). Convert the augmented causal graph to a system dynamics flow graph. (6). Translate a system dynamics stock-flow graph into Powersim programs and equations [12].

3. Problem description

Based on real data at the port, the number of vessel calls can be 10 calls/week up to 60 calls/week. Quay cranes can process loading and unloading containers from and to vessels between 25 to 35 TEUs/h. The yard tractor moves at an average speed of 25 km/h and the handling capacity of each block is 25 TEUs/h. The number of loading containers may differ a lot between vessels of different sizes to simulate real conditions in container ports. The number of loading containers for one service call can reach 3600 TEUs and not less than 400 TEUs. For various types of loading tasks, mooring productivity may be different.

In this paper, the sets of parameter used in the system dynamics simulation model are as follow: the vessel arrival rate is Uniform Discrete distribution, UD [3,15] vessel calls/day at container terminals that have berth capacity of 20 vessels. The number of handled containers per vessel by Normal distribution with mean of 500 TEUs and standard deviation of 150 TEUs. Quay crane productivity rate Uniform Discrete distribution, UD [500,600] TEUs/day. While the amount of carbon emission density of vessel and equipment activities in kg/TEU is shown in Table 2, with the proportion of carbon emissions of the idle quay crane is about 3% of the carbon emission of quay crane in operating.

4. Model development

Total carbon emissions at container terminals are generated from the arrival of ships and the operation of all cargo handling equipment. In the process of arrival of ships at container terminals, carbon emissions are generated from the transport vessel and loading unloading vessel. Whereas carbon emissions from cargo handling equipment consist of quay crane processing, idle quay cranes, container truck transport and crane processing yards. Vessel arrival rate at berth is uncertain and is limited by berth capacity and the number of vessels still awaiting service on berth. While the vessel rate depends on the number of vessels in berth and container handling rate by quay cranes and the number of containers per vessel. The container handling rate by quay cranes is influenced by the number of containers that must be served and the number of quay cranes assigned to service each vessel. The number of quay cranes assigned to service each ship depends on the quay crane productivity rate and the number of quay cranes available at the container terminal. The number of containers in the storage container yard is affected by the capacity of container trucks and the capacity of yard cranes available. The relationship between variables in system dynamics in container terminals

is illustrated in the Causal Loop Diagram as shown in Figure 2 and Stock and Flow Diagram in Figure 3.

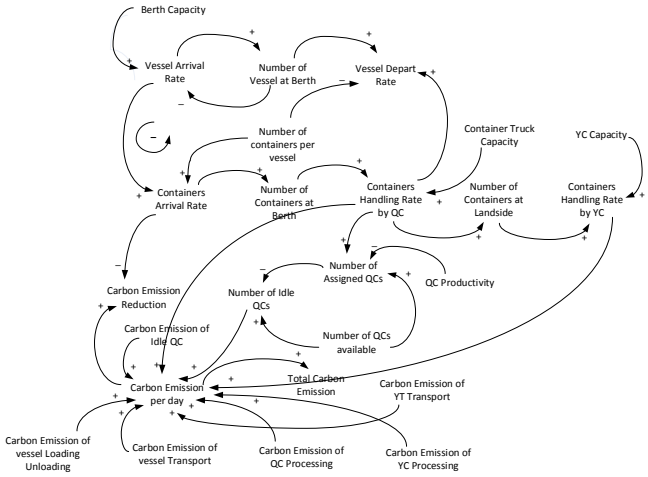


Figure 2. Causal Loop Diagram for system dynamics model of carbon emissions at container terminal.

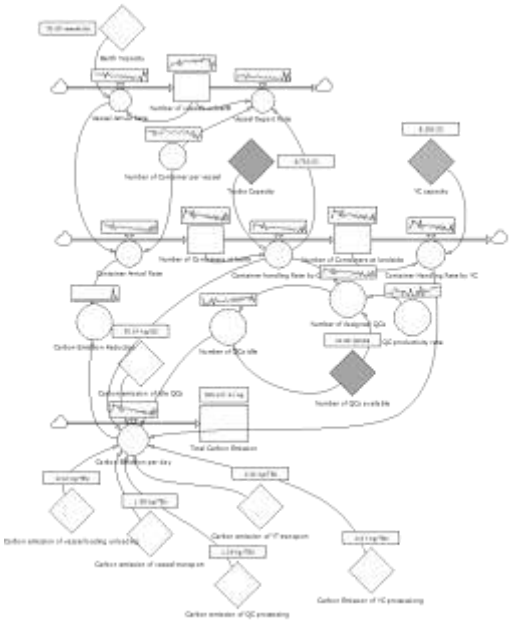


Figure 3. Stock and flow graph for system dynamics model of carbon emissions at container

List of equations for each variable in the system dynamics model for minimizing the total carbon emissions is shown in Figure 4 below.

Name	Unit	Definition
Berth Capacity	vessel/da	20<<vessel/da>>
Carbon emission of idle QCs	kg/QC	30.24<<kg/QC>>
Carbon emission of QC processing	kg/TEU	1.39<<kg/TEU>>
Carbon emission of vessel loading unloading	kg/TEU	0.02324<<kg/TEU>>
Carbon emission of vessel transport	kg/TEU	1.99<<kg/TEU>>
Carbon Emission of YC processiong	kg/TEU	0.06873<<kg/TEU>>
Carbon emission of YT transport	kg/TEU	0.39645<<kg/TEU>>
Carbon Emission per day	kg/da	('Carbon emission of vessel loading unloading'+'Carbon emission of vessel transport'+'Carbon emission of QC processing')*'Container handling Rate by QC'+('Carbon emission of YT transport'+'Carbon Emission of YC processiong')*'Container Handling Rate by YC'+'Carbon emission of idle QCs'*'Number of QCs idle'
Carbon Emission Reduction	kg/TEU	'Carbon Emission per day'/'Container Arrival Rate'
Container Arrival Rate	TEU/da	'Vessel Arrival Rate'*'Number of Container per vessel'
Container handling Rate by QC	TEU/da	MIN('Trucks Capacity','Number of Containers at berth'/TIMESTEP)
Container Handling Rate by YC	TEU/da	MIN('Number of Containers at landside'/TIMESTEP,'YC capacity')
Number of Assigned QCs	QC/da	CEIL(MIN('Container handling Rate by QC'/'QC productivity rate'/TIMESTEP,'Number of QCs available'),1<<QC/da>>,0<<QC/da>>)
Number of Container per vessel	TEU/vessel	ROUND(NORMAL(500<<TEU/vessel>>,150<<TEU/vessel>>,0.5),1<<TEU/vessel>>)
Number of Containers at berth	TEU	2000
Number of Containers at landside	TEU	3000<<TEU>>
Number of QCs available	QC/da	12<<QC/da>>
Number of QCs idle	QC/da	'Number of QCs available'-'Number of Assigned QCs'
Number of vessels at berth	vessel	3
QC productivity rate	TEU/(da*QC)	ROUND(RANDOM(500<<TEU/da/QC>>,600<<TEU/da/QC>>,0.5),1<<TEU/da/QC>>)
Total Carbon Emission	kg	0<<kg>>
Trucks Capacity	TEU/da	8700<<TEU/da>>
Vessel Arrival Rate	vessel/da	MIN('Berth Capacity'-'Number of vessels at berth'/TIMESTEP,ROUND(RANDOM(8<<vessel/da>>,15<<vessel/da>>,0.5),1<<vessel/da>>))
Vessel Depart Rate	vessel/da	FLOOR(MIN('Number of vessels at berth'/TIMESTEP,'Container handling Rate by QC'/'Number of Container per vessel'),1<<vessel/da>>,0<<vessel/da>>)

Figure 4. List of equations for system dynamics model of carbon emissions at container terminal.

5. Results and discussion

The system dynamics simulation model has run for 30 days to evaluate carbon emissions per day (Figure 5). Based on the available berth capacity, the minimum total carbon emission for 30 days is

393.42 tonnes that obtained by the optimal number of quay cranes is 12 QCs, capacity of container trucks is 8700 TEUs and yard cranes capacity of 8300 TEUs.

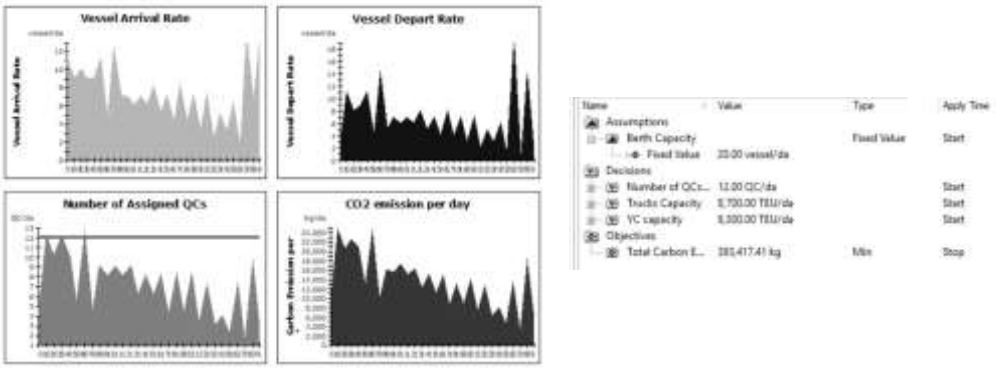


Figure 5. Simulation results of system dynamics model of carbon emissions at container terminal.

6. Conclusions

In this paper, an optimization model has been developed to minimize total carbon emissions in container terminal operations under the uncertainty environment by using a system dynamics simulation model approach. The minimum of total carbon emissions depends on the optimal number of assigned quay cranes for each vessel, the capacity of available container truck and yard cranes in the container terminal. For further research, a total carbon emission model can be developed with taking into account the technological advances in cargo handling equipment.

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The effect of soygurt fortification with black rice bran extract anthocyanin in hyperlipidemia wistar rats *(Rattus norvegicus)*

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Abstract. The main causes of hyperlipidemia include the consumption of a high-fat diet, which results in atherosclerosis and heart disease. Prevention of hyperlipidemia can be done by consuming foods rich in antioxidants, such as anthocyanins contained in black rice bran. This study aimed to evaluate the effect of anti hyperlipidemia on soygurt enriched with black rice bran extract in Wistar *(Rattus norvegicus)* rats. This research was conducted *in vivo*. Research materials include soygurt and black rice bran extract. The research stages included preparation of animal lab, 28 male Wistar rats, 3 weeks old; feed AIN-93G (G) and AIN-93M (M); adaptation a week; depletion period for 5 weeks, until hyperlipidemia with total cholesterol levels ± 200 mg/ml and total triglycerides ≥ 150 mg/dl. Separation into 4 diet treatment groups, namely without a standard diet, M diet + demineralized water (P = placebo); M diet + soygurt dried (K = control), M diet + 50 mg black rice bran extract enriched in soygurt (S-50), and M diet + 100 mg black rice bran extract enriched in soygurt (S -100) for 5 weeks. Taken blood from retroorbital flexus, euthanization, and surgery. Analyses were changed in total cholesterol levels, total triglyceride levels. Statistic analysis was performed by analysis of one-way variants (One Way Anova) with Minitab 17 at a significance level of 5%. If there are significant differences, then proceed with the Tukey's test ($p \leq 0.05$). The results showed that the S-100 group was able to reduce total cholesterol and triglyceride levels after the end of treatment at 95.13 mg/dl and 69.55 mg/dl. Changes in total cholesterol levels during the study, namely at the early until the induction increased by 57.19% and the induction to the end decreased by -48.19% had a positive effect on the treatment of S-50 and S-100 reducing total cholesterol levels. Whereas for the total triglyceride levels during the study, at the early until the induction increased by 46.51% and the induction to the end decreased by -48.42%, a positive effect of the treatment of S-50 and S-100 decreased total triglyceride levels.

1. Introduction

Hyperlipidemia is a disorder of lipid metabolism characterized by increased levels of cholesterol, LDL *(Low-Density Lipoprotein)* and decreases HDL (High-Density Lipoprotein). Factors triggering such conditions include a family history of dyslipidemia, hyperlipidemia, overweight, lack of physical activity, alcohol consumption, smoking, and diabetes. Besides a diet that is high in cholesterol such as cow brain, egg yolks, seafood, and red meat also can trigger the onset of hyperlipidemia [1].

Research conducted by the Agency for Health Research and Development, in 2013, stated that there are people in Indonesia over the age of 15 years had higher levels of total cholesterol, triglycerides, and LDL above normal, and 60.3% of them had levels of LDL *near-optimal* and

borderline high (100-159 mg/dl) [2]. Some researches suggest that there is a strong correlation between high LDL levels with the formation of atherosclerosis [3].

One effective way to overcome hyperlipidemia is to consume foods that contain lots of antioxidants because its content can neutralize free radicals that cause disease caused by conditions such as hyperlipidemia, atherosclerosis [4].

Black rice has the content of antioxidants, especially anthocyanin, amounting to 10.70 ± 0.03 mg/g [5] (Kong and Lee, 2010). Black rice bran contains phenols, high anthocyanin. Brown rice and black rice diet can improve blood antioxidant levels and reduce the formation of atherosclerotic plaques in rabbit's hyperlipidemia [6]. A Brazilian study showed that administration of a diet containing black rice cultivar IAC600 can control the lipidemia condition in rats [7].

Soy milk is processed soy beverages containing high nutritional value, wherein the protein content reaches 3.5-4.0%. Besides the price is cheaper than cow's milk, soy milk also has other advantages, such as cholesterol-free, lactose-free so consumed by people who are allergic to cow's milk (lactose intolerance). But people generally prefer cow's milk because of their unpleasant odors (beany flavor) in soy milk. One way to minimize these unpleasant odors is further processing into yogurt, known as soygurt. The culture used in the manufacture of soygurt in this study are Lactobacillus bulgaricus and Streptococcus thermophillus.

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2. Research Methods

2.1. Materials and Methods Research

The materials used were black rice that milled and taken black rice bran. The chemicals used included: HCl, acetic acid, the mice feed and AIN AIN-93G and 93M (American Institute of Nutrition) [8]. kits for the determination of cholesterol and triglyceride levels, deionized water. For this study used several types of equipment, among others were, glass tools, analytical scales, oven, water bath shaker, muffle furnace, UV-VIS spectrometer, vortex, centrifuge (4ºC), rotary evaporator, freeze dryer. The animal lab used were male Wistar rats types aged 3 weeks.

2.2 *The course of study*

Before making the feed for the animal, a preparation to extract rice bran black by way of bran of black rice is extracted with a solution of acetic acid 3% in demineralized water, shaker at 40 ° C for 60 minutes and then stored at 4 ° C for 24 hours was carried out. Then do the filtering, in a rotary evaporator for 4 hours at 40°C and in the freeze dryer. Manufacture soygurt using bacteria L. bulgaricus and S. thermophillus. Furthermore, making the feed treatment conducted under standard feed and AIN AIN-93G and 93M.

Before treatment, the animal lab first underwent a period of adaptation for 7 days and was fed at libitum. At the beginning of the treatment performed on the analysis of mouse blood plasma for total cholesterol and triglyceride levels, to determine the condition of hyperlipidemia or not. Rats that have undergone hyperlipidemia was then divided into 4 groups @ 7 tail, and maintained for 5 weeks in individual cages, with the provision of the basal diet and drink deionized water ad libitum. During this period, they were given soygurt drinks enriched with anthocyanin extracts of black rice bran as force-feeding. Analysis of cholesterol and triglyceride levels was carried out at the beginning, during and at the end period of the study Of the 28 tails carried division of the group into four dietary treatment groups, i.e. without a standard diet, a diet M + demineralised water (P = placebo); diet M + soygurt dried (K = control), M + soygurt dried enriched rice bran black extract levels of 50 mg (S-50), and a standard feed AIN-93M + soygurt dried enriched rice bran black extract levels of 100 mg (S -100) for 5 weeks. Blood sampling performed by retro-orbital flexus and then do analysis.

Data were analyzed by analysis of variance single-lane (One Way Anova) with Minitab 16 at a significance level of 5%. If there was a significant difference, then followed by Tukey's test.

3. Results and Discussion

3.1. *Development Rat Weight*

The development of body weight every week during the study can be seen in Figure 1.

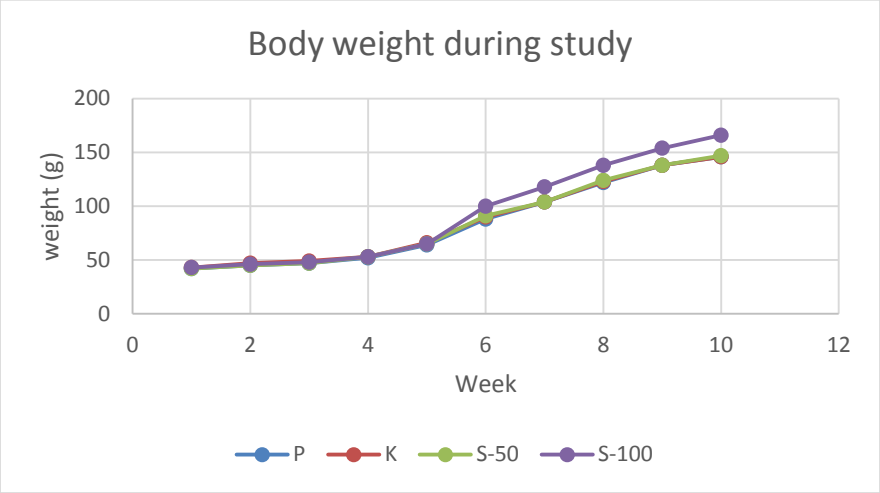


Figure 1. The development of body weight every week

The development of rat body weight every week during the study through week 10 (Figure 1), showing an increase in weight every week in all groups of rats, significantly occur after the maintenance of up to 8 weeks.

Based on statistical analysis with ANOVA method RAL against the growth of body weight of rats showed no significant difference ($p \leq 0,05$). Thus we can say that diet and long maintenance treatment did not significantly affect the growth of body weight of rats. Rats that were fed with food containing S-100 experienced higher growth than then ones treated with standard food. And there was a tendency of the consumer to have the highest growth. This suggests that the protein contained in soygurt played a role in the growth of mice. Zhao [13], earning rats fed a diet of food containing soybean products that have a weight higher than the growth casein diet.

3.2. *Plasma Cholesterol Levels*

The development of cholesterol levels during the study, until the 10th week during the study period is shown in Figure 2.

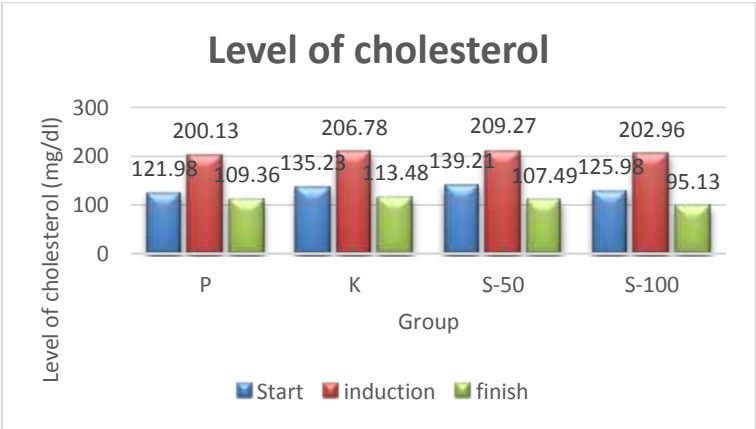


Figure 2. Levels of cholesterol at the start, induction, and end of the study

The intervention of diet with enriched feed to the treatment of black rice bran extract anthocyanin on soygurt effect on cholesterol levels of mice hyperlipidemia, characterized by a decrease ranging from 95.13 to 113.48 mg/dl. It is evident from Figure 2, which shows that at the end of the study mice S-100 group experienced a significant reduction in cholesterol levels compared to other groups. The conditions show that anthocyanin contained in the extract significantly help to decrease cholesterol levels in rats hyperlipidemia. The results are consistent with the results of the study stating that granting diet with black rice aleuronic anthocyanin containing 5 g/100 g of feed given for 16 weeks, was able to inhibit the formation of atherosclerosis lesion rats deficient in apolipoprotein. Wounds that are not inhibited will lead to the accumulation of cholesterol and plaque formation. Besides it reduces oxidative stress and inflammation [9]. Reduction of plaque formation was also examined by Ling et al. (2002) which are on the outer layer of black rice diet as much as 5 g/100 g of feed given to the rabbits that have been given a high cholesterol diet for 2 months.

3.3. *Changes in Plasma Cholesterol Levels*
Changes in plasma cholesterol levels can be seen in Figure 3.

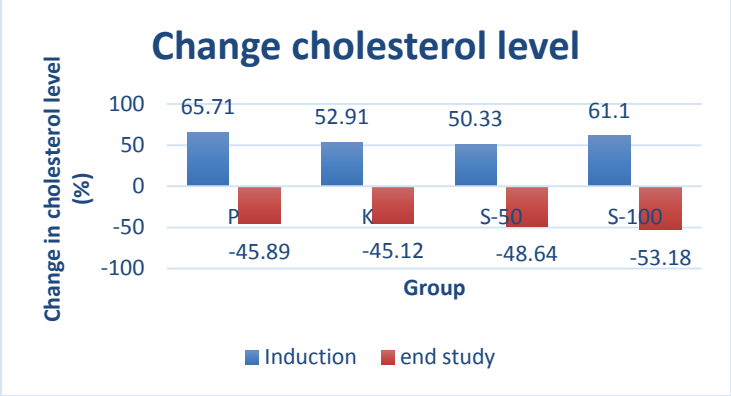


Figure 3. Changes in cholesterol levels at baseline, induction and at the end of the study

Percentage changes in plasma cholesterol levels showed that the levels increase at the beginning until the induction of 50.33 to 65.71%. While the induction treatment fitter diet decreased levels of 48.64 to 53.13%. This indicates that the induction treatment of S-50 and S-100 can lower cholesterol levels compared to other treatments.

3.4. *Plasma triglycerides*
Overview of the development of triglyceride levels is presented in Figure 4.

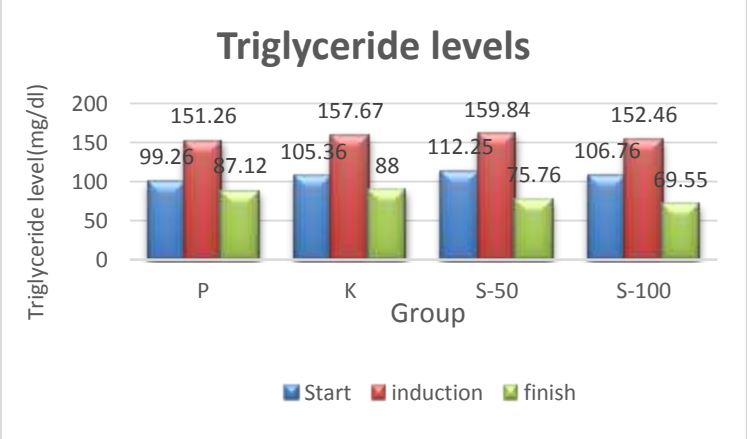


Figure 4. Triglyceride levels at baseline, induction and at the end of the study

Figure 4 shows that at the end of the study the S-100 experienced a significant decrease in triglyceride levels compared to other groups. Treatment enrichment anthocyanin black rice bran extract on soygurt effect on rat triglyceride levels hyperlipidemia, characterized by the decline, total triglyceride levels with levels ranging from 69.55 to 88 mg/dl. Triglyceride levels associated with LDL in the human body. Triglycerides enter the blood plasma in two forms namely chylomicron formed from intestinal absorption after eating fatty foods, and hepatic VLDL formed with the help of insulin. Triglycerides outside the liver will be hydrolyzed by the enzyme lipoprotein lipase. The rest will be metabolized into LDL [10].

3.5. *Changes in Plasma Triglyceride Levels*

Changes in plasma cholesterol levels can be seen in Figure 5.

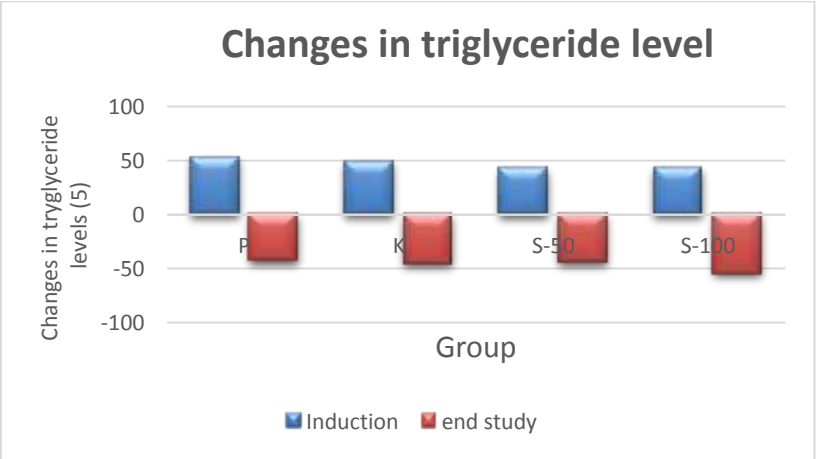


Figure 5. Changes in triglyceride levels at baseline, induction and at the end of the study

The percentage change in plasma triglyceride levels showed that levels increase at the start until the induction of 42.40 to 52.39%. While the induction treatment fitter diet decreased levels of 42.40 to 54.38%. This indicates that the induction treatment of S-50 and S-100 can lower triglyceride levels compared to other treatments.

Hyperlipidemia (high cholesterol and triglycerides) caused by the consumption of fat, can also be caused due to the consumption of carbohydrates. Digestion of carbohydrates to produce monosaccharides glucose main will be stored in the liver in the form of glycogen. To produce energy, glycogen is broken down into glucose and subsequently produce pyruvate and acetyl-CoA through glycolysis and eventually form CO_2, H_2O, and ATP. If ATP is not used, then the acetyl-CoA would not enter the citric acid cycle but will be used to form the fatty acid through esterification with glycerol and result in triglycerides [11]. Triglycerides enter the blood plasma in two forms namely chylomicron formed from intestinal absorption after eating fatty foods, and hepatic VLDL formed with the help of insulin. Triglycerides outside the liver will be hydrolyzed by the enzyme lipoprotein lipase. The rest will be metabolized into LDL [10]. LDL excessive hyperlipidemia conditions can cause constriction of blood vessels through the formation of plaque on the walls of blood vessels. LDL oxidation by free radicals of oxygen causes LDL easily sticks to the walls of blood vessels and cause of plaque and can cause endothelial dysfunction [12]. Antioxidants are known to prevent the oxidation of LDL and increase HDL.

4. **Conclusion**

The results showed that group S-100 can lower total cholesterol and triglycerides after the end of treatment respectively amounted to 95.13 mg/dl and 69.55 mg/dl. Changes in total cholesterol levels during the study in the beginning until the induction rose by 57.19% and induction to the end fell by -

48.19% positive effect of the treatment of S-50 and S-100 lowers total cholesterol levels. As for the total triglyceride levels during the study in the beginning until the induction rose by 46.51% and induction to the end fell by -48.42% positive effect of the treatment of S-50 and S-100 lowering the total triglyceride levels.

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Container storage tariff policy analysis using combining game theory and system dynamics approach

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Abstract. This paper examines the storage tariff setting policy. The main purpose of this paper is to give consideration to optimal tariffs based on alternative strategies that reduce dwelling time. The main problem is the basic tariff for container storage in Container Yard is too cheap. This low-cost tariff of the storage container is used by customers so that containers are piled too long in Container Yard and cause dwelling time to be high. This has an impact on the congestion effect and the decline in utilities in the container terminal. This problem has complexity and suitability with System Dynamics. The linkage system between one cause and another cause will be modeled with System Dynamics so that the estimated output of container flows can be obtained. Furthermore, with the Non-Cooperative Game approach, a payoff matrix table will be obtained which contains the total profit obtained by the container terminal management and the total cost incurred by the customer. The main factors considered in the payoff matrix are the estimated container flows, the container storage tariff and the length of time accumulated in Container Yard. Finally, the optimal tariff from both sides was found (Nash Equilibrium), from the point view of terminal container management and customer. This will help terminal management to make the right decision.

1. Introduction

The port has an important role to support an operational of supply chain system. It can be considered as a part of supply chain systems and several entities involved such as terminal management, shipper, consignee, carrier and forwarder. The port can also be seen as a gate of the flow of goods in and out. The problem that is almost experienced in every container terminal is limited storage space and stagnation. The limited storage space of the container has caused a bottleneck of the container that can be handled by the container terminal.

Martin et al (1) state that in general, terminal operators do not derive large profits from storage charges because their main activity is container transhipment between different modes of transportation, but they would like to satisfy certain targets by introducing storage pricing, as follows : (a) to prevent customers storing containers in container yards for a long periods, (b) to ensure the efficiency of terminal performance and greater profits from the storage area, (c) to provide additional services to customers which are currently in high demand, especially for users who do not have warehouse facilities. The storage duration of the container can be considered as one of performance indicators on container terminal. In case the longer dwelling time indicate the lower performance of the container terminal (2).

The policy to determine the tariff of container storage had been widely discussed by the researchers. That are: Castilho and Daganzo (3) had to focus their main objective only to maximize the benefits obtained by terminal management. Then Kim and Kim (4) introduced a storage tariff policy with progressive rates, where progressive tariffs are used as a penalty rate imposed on customers. So customers are not using the container yard facility too long. The last research, Qiu and Lam (5) used the game theory approach with the Stackelberg game model. The main objective is to maximize the benefits of terminal management while minimizing the expenditure of customer costs in container yards. The use of exact methods to determine container storage tariff has a weakness where the mathematical approach used usually has limitations in modeling the relationship of one variable to other variables. Even though in the real world, the determination of container storage tariff has many links between one variable to other variables.

The model that has many interrelationships between one variable and other variables can be solved using a simulation approach. The simulation approach has the advantage that the model used can be probabilistic, accommodate variables that have interdependence with other variables and systems that have complexity. In this paper, researcher use a system dynamics simulation approach to fill the payoff matrix from non-cooperative game theory approach. The system dynamics approach is a field of study of the structure and behaviour of socio technical systems to guide effective decision making, learning, and policy in a world full of dynamic complexity (6). While the use of the game theory approach has the same characteristics where the game consists of two to several people or groups have a strategy that is made to maximize their own profits or minimize the opponent's profits (7).

In this case, the researcher aims to develop a strategy where there is a balance between two players, the container terminal management and customers. So, container terminal management can have strategic considerations before making the right managerial decisions.

2. Literature study

2.1 Game Theory

Game theory is a branch of applied mathematics that is used in the social sciences, most notably in economics, as well as in biology (particularly evolutionary biology and ecology), engineering, political science, international relations, computer science, social psychology, philosophy and management. Game theory attempts to mathematically capture behaviour in strategic situations, or games, in which individual's success in making choices depends on the choices of others (8). The theory breaks naturally into two parts. There is non-cooperative theory which the players, if they may communicate, may not form binding agreements. An example of this situation is the interaction between companies in an industry in the environment where antimonopoly laws make it illegal for companies to reach agreement on prices or production quotas or other form of behaviour. On the other hand, in the cooperative theory the player are allowed to form binding agreements, and so there is strong incentive to work together to receive the largest total payoff (9).

Based on the problem solving strategy, game theory is also divided into pure and mix strategy. The example shows how each player can choose a strategy for rock, paper and scissors. The value in the matrix is the payoff or consequences of each decision making. In this game, each of the two players can choose either rock, paper, scissors. If both players choose the same action, there is no winner and the utilities are zero. Otherwise, each of the actions wins over one of the other actions and loses to other remaining action. Whereas when viewed from the payoff matrix in the form of zero sum games, the type of game that describes the amount of profit received by player 1 will amount to the loss felt by player 2 and vice versa (10).

Non-zero sum games are types of games that are not totally counted because some result shave a net result that is greater or less than zero. The most famous example is the case of prisoner dilemma shows on Figure 1. Non zero-sum games case, where prisoners have the choice to confess or evade when asked by the police. In this game, player 1 can see that no matter which column player II chooses, he will be better off if he chooses row 2. For if player I chooses row 2 rather than row 1, he wins 4 rather than 3 if player II chooses column 1, and he wins 1 rather than 0 if she chooses column

2. In other words, player I's second strategy of choosing the second row strictly dominates the strategy of choosing the first. On the other hand, the game is symmetric. Player II's second column strictly dominates her first. However, if both players use their dominant strategies, each player receives 1, whereas if both players use their dominated strategies, each player receives 3 (9).

	cooperate	defect
cooperate	(3, 3)	(0, 4)
defect	(4, 0)	(1, 1)

Figure 1. Non zero-sum *games case*

2.2 System Dynamics

The system dynamic concept was developed by Forrester in the 1950s in the form of Industrial Dynamics books. The term Industrial Dynamics then changes to a system dynamics to suppress the use of this methodology in fields other than business (11). In a system dynamics, the system is conceptualized as physical state variables and information (stock) that can accumulate, run out and or increase by variable rates (flow), all of which interact through closed loops of cause and effect (feedback loops).

The use of a system dynamics approach is more precisely modeled on the problem as follows:

1) Has dynamic properties (changes with time)
2) The structure of the model contains at least one feedback structure

System dynamics can also be used in reviewing a policy regarding price. In a previous study of pricing in electricity transmission services (12), the simulation results showed that price determination has a positive effect in managing transmission congestion, transmission expansion and selecting cargo locations. Price points are very sensitive to operational conditions and network characteristics. It can also encourage electricity providers and user to avoid the cost of expensive transmission congestion and dramatic electricity price fluctuations.

In addition, in a recent study of the determination of Real-Time Charge (RCP) price on Electric Vehicle (EV) (13), the models made were quite extensive including EV power consumption, a generator sets, cost pricing, user response, evaluation of benefits of all stakeholders interest and net life cycle of the electric charging station. This paper proves that increasing RCP will increase profits on charging service operators. This can happen if and only if the number of EV is large enough. While the increase in the number of EV is quite large, it only occurs if the government holds a gradual subsidy to users of EV. Besides being able to increase profits from charging EV service operators, it can also increase savings on non-renewable energy and reduce emissions.

3. System under discussion

Dwelling time is the length of the average container time in the container yard of a container terminal (14). The consignee's pattern of container collection in the delivery process is also erratic, causing variability in container stacking time in the Container Yard.

Martin (1) proposes a mathematical model for the optimal tariff scheme on Container Yard assuming container arrivals by sea are stochastic (the number of containers unloaded per ship type is a random variable) and several vessels for two different purposes namely maximizing terminal operator profits and minimizing the cost of the whole system. The rate for storing containers based on flat-rate time can be seen in Figure 4 as follows:

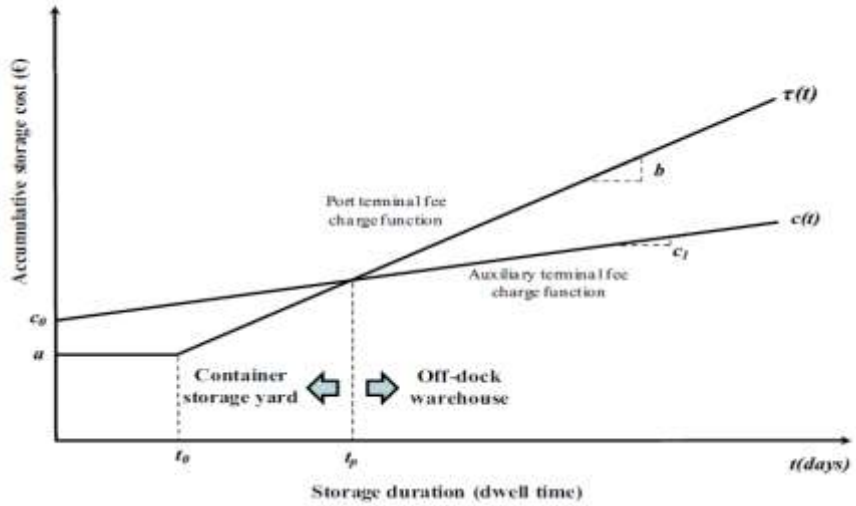


Figure 2. Container storage tariff scheme at container terminal (1)

where :

α	: zero or non-zero flat rate
b	: storage rates that are proportional to time
t0	: flat rate duration (in days)
t	: the length of time the container is in the terminal area
c(t)	: total customer expenditure at time t
tp	: threshold time

In Figure 2. Container storage tariff scheme at container terminal (1) assumes that customers minimize their own storage costs, assumptions taken from Kim and Kim (4) and the customer does not reschedule the time taken to take the container according to storage costs. Based on the price structure, the threshold time will divide into two categories :

1) Customer who has a delivery time (shorter than the time limit)
2) Customer with delivery times greater than the time limit

For the last category that must be minimized because it would be better to use their own warehouse facilities because the storage costs would be lower and not cause congestion effect in the container terminal.

4. Container storage system causal loop model and payoff matrix

4.1 Container storage system causal loop model

Dwelling time and container terminal utilities are influenced by many factors including economic and social factors. The causal loop model can be seen in Figure 3. Causal Loop Diagram of Container Yard, which is divided into 3 sub-factors. The main factors include activities at container terminals that influence each other. The second factor is what activities will directly affect the total revenue of container terminal management. The last factor is any activity that will affect the total expenditure of the customer in the storage of temporary containers.

In the causal loop model, the length of accumulation in temporary facilities will be the main key of container terminal utilities. The length of accumulation in temporary facilities will be the decision of the customer where the higher the cost of warehouses outside compared to the rate of accumulation in temporary facilities, the longer the accumulation time will be. The length of container stacking will directly affect the capacity of containers that can be accommodated at container terminals. If the national container flow is in peak season, then there will certainly be congestion in the container

terminal area. Congestion will have an impact on container terminal utilities and waiting times on ships that will dock.

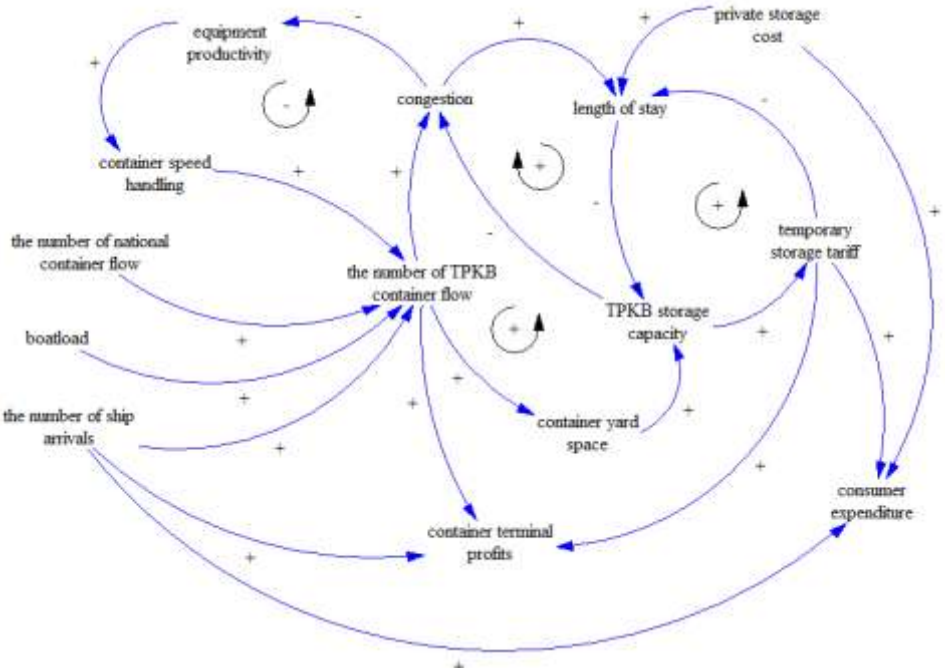


Figure 3. Causal Loop Diagram of Container Yard

In this paper, the strategy for determining stacking rates will provide additional benefits to the temporary container storage activities for container terminal management. In addition, the number of ship arrivals and incoming container flows will also add to the benefits of container terminal management. On the other hand, customers will consider the difference between the container stacking rates at container terminal facilities and the cost of storing containers in their own warehouses.

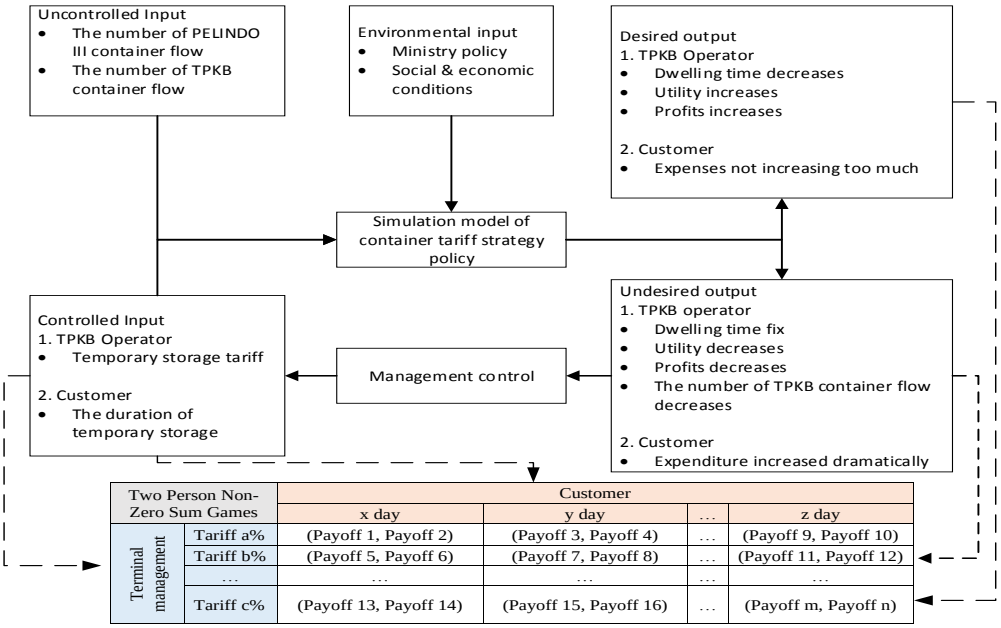


Figure 4. Input-output diagram relation to payoff matrix

In Figure 4. Input-output diagram relation to payoff matrix, policy analysis regarding storage tariff with a system dynamic approach. With the simulation of the container tariff strategy model the strategy is expected to result in a decrease dwelling time, increased utility and increased profits.

5. Future Work

Validation of the causal loop model is currently underway with a case study of the Banjarmasin container terminal. The purpose of the validation of the causal loop model is to ensure all factors and valid and reasonable factor relationships. The model of the causal loop will be updated and modified based on recommendations and feedback received from the results of validation. In the end the researcher will help decision makers to understand the advantages and expenses of the game results related to the increase in basic rates for container storage, dwelling time and container terminal utilities.

The advantage of this model is the model can capture the effect of increasing tariff on equipment utilities, container terminal revenue and the flow of goods in container terminal. In previous studies only considered the effect of increasing rates on dwelling time. While the lack of this model is the model has not considered inflation and the value of profits from the flow of goods in container terminal.

6. Conclusion

Validation of the causal loop model is currently underway with a case study of the Banjarmasin container terminal. The model of the causal loop will be updated and modified based on recommendations and feedback received from the results of the validation. In this case, the results of the validated model will be used to simulate the scenarios that are in the two-person non-zero sum game. In the end, the researcher will help decision makers to understand the advantages and expenses of the game results related to the increase in basic rates for container storage, dwelling time and container terminal utilities. So, container terminal management can have strategic considerations before making final managerial decisions.

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Formulation and characterization of chitosan-alginate freeze dried matrices loaded with oleoresin extract of red ginger

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Abstract. A simple method of encapsulation of bioactive compounds that does not involve washing, heating, and degradation of active substance is desired. The encapsulation of red ginger oleoresin within chitosan-alginate matrices is developed using freeze drying method in order to achieve higher encapsulation efficiency and loading capacity in the matrices. In this research, oleoresin of red ginger is used as the bioactive compound which has proven to contain antioxidants from phenolic compounds that suppress tumor growth and inhibit carcinogenesis. The encapsulated bioactive substance inside chitosan-alginate matrices is aimed to be released in the colon. The chitosan-alginate matrices were prepared also with various content of oleoresin. X-ray diffraction patterns showed that crystalline peaks vanished in chitosan-alginate matrices which shows its compatibility. IR spectra indicates that oleoresin was entrapped inside the matrices. Matrix with weight ratio of chitosan:alginate 1:0.5 showed low release of phenolic compounds in simulated gastric fluids and high release in simulated intestinal and colonic fluid. Freeze drying method was proven to produce a high yield and loading percentage matrices. This indicates that the formulation of chitosan with alginate has the potential to be used as extended release system for oral delivery of red ginger oleoresin in colon.

1. Introduction

Zingiber officinale, generally known as ginger, originated from South-East Asian and introduced to many parts of the globe, has been cultivated for thousands of years as a spice and also for medicinal purposes. The rhizome of this plant has been used as a medicine in Asian, Indian, and Arabic herbal traditions since ancient times also as herbal medicine for the treatment of arthritis, rheumatological conditions and muscular discomfort [1, 2]. Ginger is also used in inflammatory conditions as its components shows anti-inflammatory activities *in vitro*. Some phenolic substances present in ginger, in general, have strong anti-inflammatory and anti-oxidative properties. It also exerts substantial anti-carcinogenic and anti-mutagenic activities [3, 4, 5]. It has been found that ginger supplementation suppresses colon carcinogenesis in the presence of procarcinogen [6].

Encapsulation of active compounds in matrices or microparticles with various polymers has been widely known for its use in protecting and acting as carriers of drug or active substance. Chitosan is a common polymer used and known as a biodegradable, biocompatible and non-toxic biopolymer [7, 8, 9] which has a good mucoadhesivity [10]. Alginate is another common biopolymer in oral drug delivery known for its stability in acidic conditions of the stomach [11]. The combination of chitosan and alginate have been previously used in oral controlled drug delivery formulations [12, 13].

In this research, the active compounds of ginger oleoresin were loaded into chitosan-alginate matrices using the freeze drying or also called lyophilization method, which converts a solution into a solid by taking out water

molecules through the process of sublimation and desorption in vacuum condition [14]. Since the preparation of loaded matrices preferably does not involve processes that might degrade the active substance [15], freeze drying may become a potential method for matrix formulation.

This research developed the ginger oleoresin loaded in chitosan-alginate matrices using freeze drying method with variation of alginate and oleoresin content in the matrices. The matrices have been evaluated for its release characteristics in the *in vitro* assay using simulated gastrointestinal fluids. The total phenolic content, loading capacity and the morphology of matrices were also evaluated. The results were expected obtaining the right formulation of oleoresin loaded chitosan-alginate matrices that can be used to transport the active compounds in ginger oleoresin for medicinal treatment in colon-targeted area via oral administration.

2. Materials and methods

2.1. Materials

Fresh red ginger (*Zingiber officinale var. Rubrum*) was purchased from a local market in East Jakarta, Indonesia. The chitosan of MW of 80-120 kDa, particle size of 200-300 mesh, viscosity of 100-200 mPas, was purchased from Chemultiguna, Indramayu, Indonesia. Other chemicals and reagents were procured from Sigma-Aldrich, Inc., and Merck.

2.2. Formulation of chitosan-alginate freeze-dried matrices

The red ginger oleoresin extract were obtained from maceration of dry rhizome powder in ethanol for seven days. The chitosan-alginate matrices were prepared with six variations, i.e. one blank matrix without oleoresin extract and five matrices with variation of alginate and extract composition. All of the matrices were prepared using the freeze drying method [16,17]. 50 ml chitosan solution of 2.5% acetic acid (v/v) was mixed with Oleoresin extract. The mixture was stirred using four-blade impeller at 1500 rpm for 10 minutes. 2% solution of Tween 80 was added drop by drop to the mixture and stirred for 5 minutes. The alginate solution of 0.1 g/12.5 mL was added into the chitosan mixture emulsion and stirred for 20 minutes. The frozen emulsion was lyophilized using EYELA FDU-2100 freeze dryer. The formed matrices were grinded into powder with size <100 μm.

2.3. Matrix morphology test

Powder X-Ray Diffraction (XRD) of chitosan, alginate, and all samples of freeze dried matrices were obtained using SHIMADZU XRD 7000 MAXIMA-X with Cu tube. All samples were analyzed between 2θ angles of 10° and 80° using the voltage of 40 kV, current of 30 mA, and time per step of 1 second. The crystalline or amorphous character of chitosan, alginate, and obtained matrices were determined through the diffractogram. The Fourier Transform Infra-Red (FTIR) analysis was done to validate the presence of oleoresin entrapped in the matrix based on the functional group readings shown by the Infra-Red spectra. Thermo Scientific Nicolet iS5 with wavelength ranging from 4000 to 400 cm^{-1} was used for FTIR test.

2.4. Total Phenolic Content, Yield and Loading capacity of matrices

The yield and loading capacity of the matrices were quantified based on the mass of dried matrices and the oleoresin extract used using the following formulas:

$$\text{Yield (\%)} = \frac{\text{Mass of dried matrix (mg)}}{\text{Total mass of materials used for matrix (mg)}} \times 100\% \quad (1)$$

$$\text{Loading Capacity (\%)} = \frac{\text{Mass of oleoresin used in matrix (mg)}}{\text{Total mass of matrix (mg)}} \times 100\% \quad (2)$$

2.5. In-vitro drug release test in simulated gastrointestinal fluids

The release profile of phenolic compound from oleoresin-loaded chitosan-alginate matrices was obtained from sequential series release testing method using dialysis membrane tube in simulated gastrointestinal fluids. Three release media were used; *simulated gastric fluid* (SGF; pH 1.2), *simulated intestinal fluid* (SIF; pH 7.4) and *simulated colonic fluid* (SCF; pH 6.8). 20 mg of matrix particles were immersed in 60 mL of simulated fluids and incubated at 37°C. A sample volume of 5 mL of each fluid media were taken periodically in 2, 4, 6, 8, and 24 hours, for analyzing the total phenolic content. The determination of total phenolic content (TPC) was based on the test using Folin-ciocalteu's reagent method which was reported as gallic acid equivalent using UV-

spectrophotometry analysis [18]. The profile release was obtained by plotting the total phenolic content as a function of time in simulated gastrointestinal fluids.

3. Result and discussion

3.1. Formulation of matrices, yield, and loading capacity

Six different matrices had been made, five of which varied in the ratio of oleoresin extract to chitosan or alginate to chitosan, and the other was an empty matrix or matrix with no oleoresin extract. All compositions contained a fixed amount of chitosan, but the ratio of alginate to chitosan and the ratio of oleoresin to chitosan varied from 0.1: 1 to 1: 1. Data obtained from the matrices is shown in table 1. The matrix yields are quite high, with a value of 81, 5% to 95.7% using equation (1). However, there is no trend between the matrix yield and the increasing amount of alginate or amount of oleoresin extract in the matrix composition. Regardless of the loss of material mass occurred during the matrix preparation process, the matrix yields indicate that the freeze-drying method is a good method for producing chitosan-alginate matrix.

Table 1. Matrices formulation, Yield and Loading Capacity

Matrix	Chitosan:Alginate:Oleoresin weight Ratio	Yield (%)	Theoretical Loading Capacity (%)
A1E0	1:0.1:0	91.91	0
A1E1	1:0.1:0.1	86.59	6.54
A5E1	1:0.5:0.1	81.51	5.33
A10E1	1:1:0.1	92.65	3.50
A5E3	1:0.5:0.3	95.76	11.59
A5E5	1:0.5:0.5	94.01	17.79

The theoretical loading capacity of the matrix was calculated based on the quantitative data of the materials used in the formulation of matrices using equation (2). The results show that the loading capacity increases when the amount of oleoresin extract used increases in the matrices with a fixed amount of alginates such as in A1E1, A5E3, and A5E5. While the trend of loading capacity is decreasing with increasing amount of alginate in the matrices with a fixed amount of oleoresin extracts, as seen in matrices of A1E1, A5E1, and A10E1. The equation (2) did not take account of material mass loss during the matrix preparation process. A high concentration of alginate in the matrix can induce the formation of a narrow structure due to cohesive interactions between polymers. This structure can decrease the free spaces in the matrix which will cause less oleoresin extract to be absorbed into the chitosan-alginate matrix [19].

3.2. Characteristics and morphology of matrices

X-ray Diffraction test was done to determine the structure and morphology of the matrices. Freeze dried matrices can either be crystalline or amorphous [17]. The samples tested were matrices of A5E1 and A5E3 matrices, which have ratio of alginate to oleoresin extract of 0.5:0.1 and 0.5:0.3, respectively. Pure chitosan and alginate material were also tested. All samples were analyzed with angle range of 2Θ from 10^0 to 80^0, with voltage of 40 kV and 30 mA current. The diffraction patterns of the samples were shown in figure 1.

It was reported that two crystalline peaks with the 2θ angle of 20.45° and 29.49° were present in pure chitosan and one crystalline peak with a 2θ angle of 20.47° was present in pure alginate, which makes the structure of both materials as semi-crystalline. As for A5E1, and A5E3 matrices, there were no crystalline peak present in the same region of 2θ angle, which concludes that freeze dried matrices were amorphous structures. The decrease in crystallinity was explained by the compatibility of chitosan and alginate complex formed due to the presence of hydrogen bond between amino groups and hydroxyl groups [20, 21].

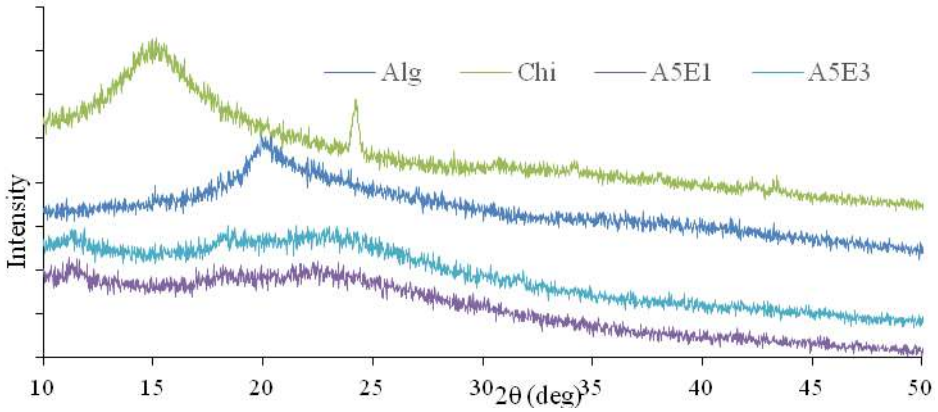


Figure 1. XRD graphs of chitosan (C), alginate (A), and matrices A5E1 and A5E3 (formulation is shown in table 1)

The morphology of the matrix was further analyzed using Scanning Electron Microscopy (SEM) analysis. Wrinkled and rough surfaces are present on the images of prepared matrices (figure 2). Cavities are observed on the surfaces of the matrices. It appears that the surfaces of matrices are the combination of both chitosan and alginate. Cavities were obtained due to the formation of spaces that were previously ice crystals which were rapidly sublimated during the freeze-drying process [14, 22]. The cavities in A10E1 matrix appear to be larger than the cavities in A5E1 matrix, this can be caused by larger amount of ice crystals sublimated from A10E1 matrix due to the larger amount of alginates in A10E1 than the alginates in A5E1 matrices.

Table 1 shows the loading capacities of A5E1 matrix is smaller than that of A5E3 matrix. It seems there is a relationship between higher loading capacity with larger cavities as it is shown in SEM images of matrices in figure 2. The larger amount of oleoresin extract in matrix, such as in A5E3, the larger droplets size of emulsion formed. Therefore, after the freeze-drying process, the cavity size of the A5E3 matrix was larger than the cavity size of the A5E1 matrix.

The results of samples analysis using Fourier Transform Infra-Red spectroscopy or FTIR is shown in figure 3. Matrices of A5E5, A5D3 and A5E1 have the same alginate and different oleoresin, while A1E1, A5E1, and A10E1 have the same oleoresin and the different amount of alginate. The assay was done in the range of wavenumber 4000 to 400 cm^{-1}. The specific broad peaks of chitosan-alginate matrix are on the wavenumber ranged 3244-3433 cm^{-1} corresponding to the stretching vibration peaks of hydroxyl groups (O-H) and amine (N-H). The peaks at 1520 and 1385 cm^{-1} are belong to stretching of carbonyl (C=O) group and bending of secondary amide (-N-H), respectively, as the consequence of interaction between chitosan and alginate. The peak at 1107 cm^{-1} is due to the stretching vibration of -C-O-C groups in chitosan and alginate. The vibration of hydroxyl (OH) phenolic groups in oleoresin is shown in peak at wavenumber of 595 cm^{-1}. Similar peaks of absorption of chitosan-alginate matrices and ginger oleoresin are reported by other researchers [12, 23, 24]

Figure 3 shows the effect of alginates in the matrices. For the matrices with the same alginates they have two peaks around 1520-1385 cm^{-1} and they have almost similar height of peaks. However, when the alginate increased the height of both peaks reduced. This might corresponds with the interaction occurred in the matrices between chitosan and alginate, which encapsulate the ginger oleoresin

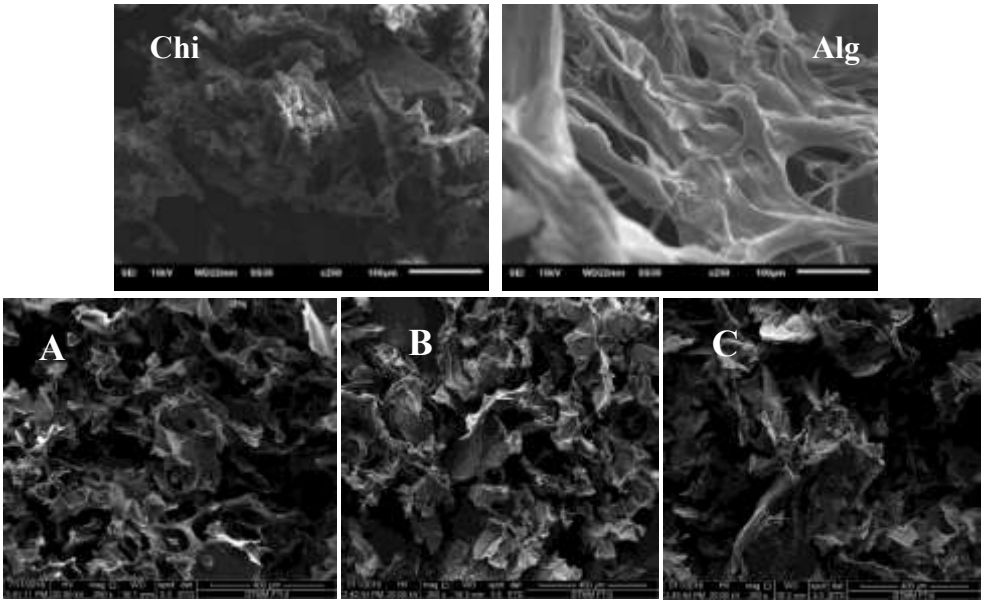


Figure 2. SEM images of chitosan (Chi), alginate (Alg), and matrices A5E1 (A), A10E1 (B), and A5E3 (C). Note: ratio of chitosan:alginate:oleoresin is shown in Table 1.

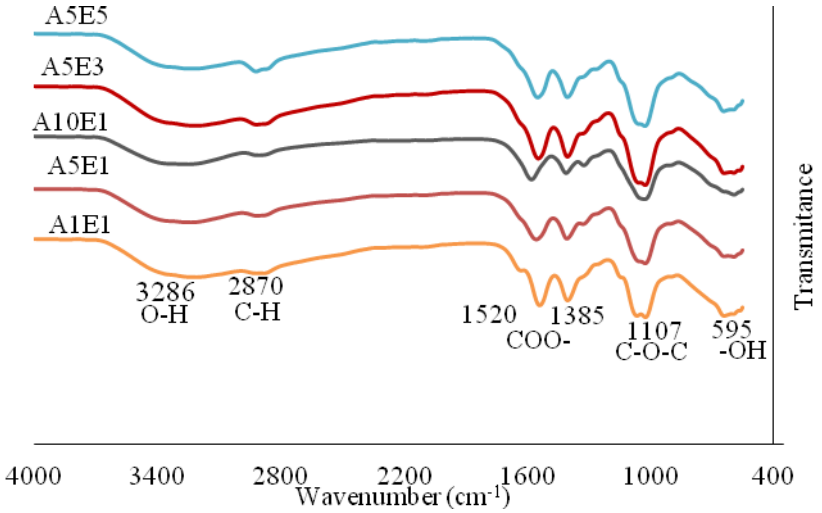


Figure 3. FTIR spectra of matrices (formulation is shown in Table 1)

3.3. In-vitro release study

In vitro release profile of matrices are shown in figure 4 and 5. The cumulative release percentage was determined based on the value of total phenolic content calculated for each release sample in simulated gastrointestinal fluids. For the first three hours, the matrix was placed in the SGF with a pH of 1.2. The fluid was then changed into SIF for the next 4 hours with a pH of 7.4 and then the matrix was placed in the SCF with a pH of 6.8 for 17 hours. None of the formulated matrices reached 100% of cumulative release, meaning that the produced chitosan-alginate matrix may have sustained the release of oleoresin effectively.

As can be seen in figure 4, matrices A5E1 and A10E1 have cumulative release below 20% in the first two hours which shows that alginate was functional to suppress the release of drug in low pH solution and extend the release in higher pH conditions. Matrix A5E1 has the least release percentage of 8.5% in the first 2 hours in SGF of pH 1.2. It is known that alginate was precipitated into alginic acid, which is not soluble in low pH, so it prevents erosion [25]. In neutral pH, such as in SIF and SCF, matrix with alginate content experiences swelling

and creates a gel which is followed by disintegration and release of drug [26]. Therefore, It was known that alginate is proven to suppress the release of oleoresin in low pH and increase the release in higher pH.

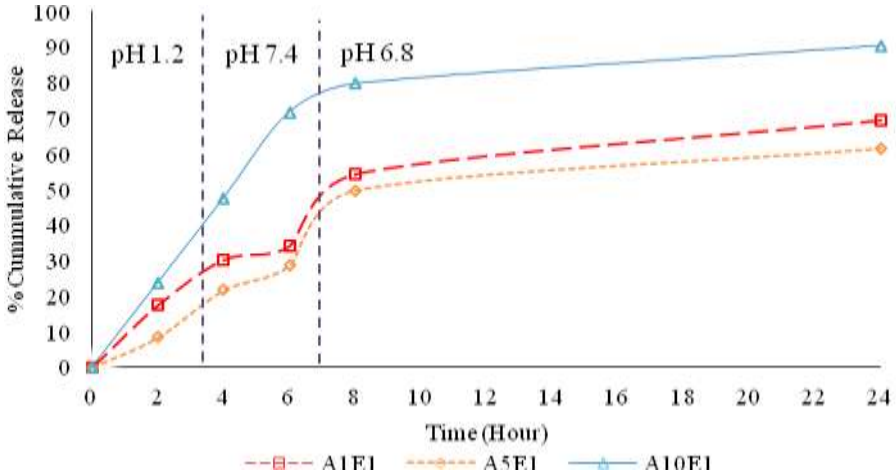


Figure 4. Oleoresin release profile from chitosan/alginate matrices. Effect of alginate in matrix chitosan:alginate:oleoresin= A1E1(1:0.1:0.1), A5E1 (1:0.5:0.1), A10E1 (1:1:0.1) in SGF (0-3 hour), SIF (4-7 hour), and SCF (8-24 hour)

The profile release of oleoresin from matrix A10E1 was quite different from the profile release of two other matrices. It seems that concentration of alginate in composition A10E1, where weight ratio of chitosan:alginate was 1:1, was too high. So, when the alginic acid present in high concentration erosion happens rather quickly due to its high solubility in high pH. This may be the cause of the high percentage of release of oleoresin extract in matrix A10E1. This phenomenon can also happen because in high pH the carboxyl groups of alginate are more ionized, and the electrostatic repulsion between ionized groups increases swelling rate [27]. The swelling of polymer was followed by water uptake phenomena by the matrix, that induced a higher rate of drug diffusion in those conditions [28]. Therefore, the chitosan-alginate composition of matrix with weight ratio of chitosan to alginate of 1:0.5 was selected to be further studied by varying the oleoresin extract content due to its minimum release of oleoresin in acidic conditions.

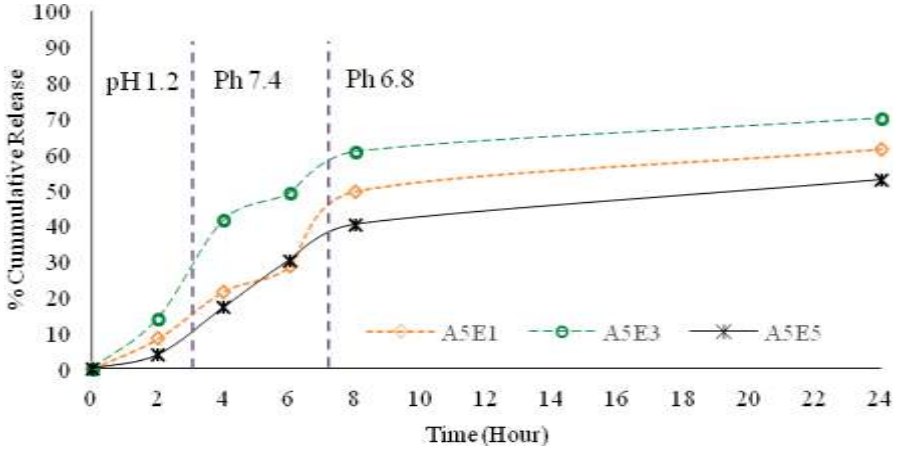


Figure 5. Oleoresin release profile from chitosan/alginate matrices. Effect of oleoresin in matrix chitosan:alginate:oleoresin= A5E1(1:0.5:0.1), A5E3 (1:0.5:0.3), A5E5 (1:0.5:0.5) in SGF (0-3 hour), SIF (4-7 hour), and SCF (8-24 hour)

Figure 5 shows that matrix A5E3 with higher oleoresin loaded than A5E1 had higher release in all media solution. The release of oleoresin in matrix A5E5 which had higher oleoresin extract loaded was surprisingly the lowest. It was predicted that high amount of oleoresin molecules in the mixture was not encapsulated completely inside the matrix using the freeze drying process, hence the content of oleoresin extract loaded in the matrix was

actually low. It seems that loading the oleoresin extract in chitosan-alginate matrix more than 1:0.3 weight ratio of chitosan to oleoresin will end in the low release of oleoresin.

The profile release of chitosan-alginate matrix loaded with oleoresin extract in simulated gastrointestinal fluids shows that the composition of matrix affects the release characteristics of oleoresin. The composition of matrix with weight ratio of chitosan:alginate:oleoresin in 1:0.5:0.3 had low release in SGF of pH 1.2 and extended release up to 70% in SCF of pH 6.8 after 24 h. By varying the composition of matrix and oleoresin extract loading, the release of oleoresin can be targeted in the colon or in other sites in gastrointestinal tract.

4. Conclusion

Freeze dried chitosan-alginate matrices have a relatively high yield and loading percentage. An average yield of 90% and a loading of oleoresin up to almost 18% was reached by the varying the composition of matrices in this research. Diffraction patterns of matrices showed that lyophilization process decreases the crystallinity of chitosan-alginate making the matrices an amorph. SEM images shows cavities and wrinkled surfaces as a result of water crystals that was sublimated during the freeze drying process. The FTIR spectroscopy analysis showed specific peaks of various functional group for each matrix that proved oleoresin was entrapped inside the matrix. The *in vitro* release profile of oleoresin from chitosan-alginate matrix showed the dependency of pH conditions. The presence of alginate in the matrix suppresses the release of oleoresin in acidic conditions but increase the release in higher pH conditions. Certain composition of matrix, such as weight ratio of chitosan:alginate:oleoresin of 1:0.5:0.3, resulted in low release of oleoresin in low pH and high release in neutral or higher pH condition. Therefore, the formulation of chitosan-alginate matrix can be designed to be used as a carrier for extended release of oleoresin extract to the sites in the colon via oral administration.

Acknowledgement

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Preparation and characterization of polyvinyl alcohol-chitosan-tripolyphosphate hydrogel for extended release of anti-tubercolosis drugs

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Abstract. The preparation and characterization of polyvinyl alcohol (PVA) and chitosan-tripolyphosphate hydrogels in order to obtain extended anti-TB drug release system for osteoarticular tuberculosis was reported. This study aimed to obtain the formulation of hydrogel matrix loaded with anti-TB drugs and the characteristics of the matrix as well as the release profile of drugs. The hydrogel matrix was made by the solvent casting-evaporation method. The morphological assay using Scanning Electron Microscopy (SEM), and X-Ray Diffraction (XRD) showed that PVA and chitosan formed a homogeneous mixture with slightly waved surface indicated a pretty high crosslinking density. The chitosan reduces the efficiency of drug loading and reduces the rate of drug release. The profile release of the four drugs indicated that formulation of 80% PVA-20% chitosan hydrogel matrix had the highest drug release rate at short period of time in phosphate buffer solution (PBS) of pH 7.4. The maximum drug loading efficiency was obtained in a matrix formulation contain only PVA, while the addition of sodium tripolyphosphate increased the drug loading efficiency and also reduced the amount of drug released. The hydrogel matrix formulation of PVA-chitosan-tripolyphosphate showed its potential to be used as an extended delivery system for anti-TB drugs

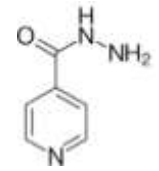
1. Introduction

Tuberculosis (TBC) is an infectious disease caused by Mycobacterium tuberculosis. It is reported that this disease can affect various organs, such as lung, pericardium, meninges, and also backbone [1,2]. World Health Organization reported that Tuberculosis was the biggest case caused by single infecting agent, where 10.4 million people had been infected, and 1.7 million of them were dead. Indonesia is the second rank for the highest number of TBC-infected people, where 1 million people are infected in 2016 and the number is still growing each year [3].

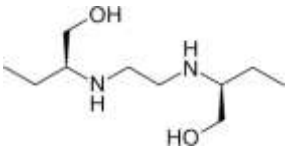
One of the most common types of TBC is osteoarticular tuberculosis, an extrapulmonary tuberculosis affecting bones, including backbones. Current treatment method is by surgery to remove the infected site, and continued by oral drug consumption of isoniazid, rifampicin, ethambutol, and pyrazinamide for two months, then consumption if isoniazid and rifampicin for four more months [4]. The molecular structure of isoniazid (INH), pyrazinamide (PZA), ethambutol (ETH), and rifampicin

(RFP) was shown in Figure 1. This treatment is aimed to kill active and dormant bacteria in the patients' body.

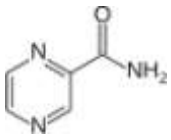
Unfortunately, this pattern of drug consumption could produce patients' discomfort, potentially drug resistant bacteria, as well as, negative side effects on patients' liver.



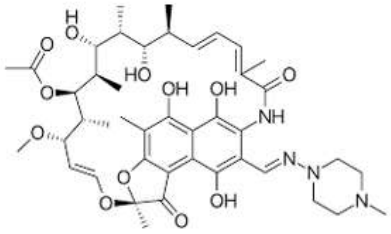
Isoniazid (INH)



Ethambutol (ETH)



Pyrazinamide (PZA)



Rifampicin (RFP)

Figure 1. Molecular structure of anti-tuberculosis drugs.

Several things that had been mentioned above triggered the development of a controlled drug release system, a system in which drugs are accumulated in a depot to be later released slowly in infected site. TBC treatment using a slow drug release system has several advantages, such as drug dosage can be decreased, side effect to the patients' liver can be reduced, and drug consumption frequency can be drastically reduced. Because of these advantages, several drug delivery systems had been developed, one of them is by Xue et.al [5] that showed encapsulation of TB drugs using poly-lactide co-glycolic acid (PLGA). The drug release can be extended to 25 days from the initial 3 days before encapsulation. Other researchers [6] did research on alginate-PLGA core-shell for slowing the drug release. The result shows that only 0,4% of the drug is released in 25 days. This research was able to reach longer release time, but the amount of drug released is feared to be too low. In the recent research, a formulation using hydrogel is attempted to be developed to encapsulate TB drugs, to have high encapsulation efficiency, but can also release drugs at a longer time with the appropriate amount.

Hydrogel is a three dimensional polymeric material that can retain water and biological fluids in a large amount so it can swell, but would not dissolve in water [7]. Hydrogel has several advantages than other drug delivery system, such as its ability to retain water and biological fluid in large amount, very biocompatible, and relatively deformable to get a certain drug release profile. Hydrogel can adjust its structure to adapt to various physical or chemical obstacles, making hydrogel very suitable for drug delivery system.

One of relatively common hydrogel is polyvinyl alcohol (PVA), a biodegradable, hydrophilic, non-toxic, and biocompatible synthetic polymer. PVA is vastly used for biomedical application [8] and has a relatively high drug encapsulation efficiency of hydrophilic drugs [9]. Unfortunately, release of bioactive compounds from PVA hydrogel is considerably fast. A research of Rogojanu el al. [10] showed that 50% of salicylic acid released in only 10 hours. While a research from Takamura et al [11] demonstrated that 45% of flurbiprofen was released in 3 h.

Salicylic acid and flurbiprofen have similar structure to tuberculosis drug, where all of those drugs have a carbonyl functional group in their structure. Based on this, it is predicted that the anti-

tuberculosis drug will also be released quickly from the PVA hydrogel. Therefore, PVA needs to be combined with other substances that can slow the drug release, such as chitosan. Wang [12] reported using the PVA- chitosan matrix to release BSA (bovine serum albumin), and with the addition of chitosan the matrix slowed the drug release to 60% of the total at 25 h. It is also known that chitosan with the presence of sodium trypolyphophate (STPP) can form crosslinking. [13]. Therefore, in this research, the previous made of PVA-chitosan matrix was immersed in the STTP solution in order to form cross linking with chitosan. The aim was to formulate PVA hydrogel matrices with a high encapsulation efficiency and slow release of anti-TB drug, so it can be used as a base implant material for spinal tuberculosis treatment.

2. Methods

2.1. Material

The Chemicals used in this research were polyvinyl alcohol (PVA) (with degree of hydrolysis 99%), Chitosan with MW of 15 – 75 kDa (deacetylation of 84%), acetic acid, and sodium tripolyphosphate (STPP). The anti-tuberculosis drugs of isoniazide (INH), pyrazinamide (PZA), ethambutol (ETH), and rifampicin (RFP) were given by PT. Phapros. The phosphate buffer solution (PBS) of NaH2PO4-NaHPO4 with a pH of 7.4 and a mixture of acetonitrile with 20 mM NaH_2PO_4 solution of pH 6.8 was used as mobile phase in the HPLC analysis.

2.2. Preparation of PVA-CS-Drugs-TPP hydrogels matrices

A casting or solvent evaporation was used in preparation of the matrices. Chitosan was dissolved in 2% acetic acid solution to obtain 4% chitosan solution. Then 4% PVA solution was prepared by heating distilled water to 90oC, then gradually added the PVA by continuous stirring for 1 – 2 hours or until PVA was completely dissolved. The PVA solution was mixed thoroughly with chitosan solution at room temperature. The mass ratios of PVA to chitosan in the mixture were, 100:0, 80:20, 60:40, and 40:60 as shown in table 1. Mixture of tuberculosis drugs (INH, PZA, ETH, and RFP) was added to the mixture of chitosan-PVA. The PVA-chitosan-drugs mixture was agitated using a sonicator until they become a homogenous mixture. The mixture was then allowed to stand at room temperature to naturally remove the bubble obtained from agitation. The mixture was poured into 5 cm petri dishes (+ 20 ml), and then evaporated in an incubator at 37 (C until a constant weight was obtained. The hydrogels obtained, then were removed from petri dishes to undergo the crosslinking process. Crosslinking occurred by immersing the hydrogels in 2% or 4% STPP solution for 30 minutes. The crosslinked hydrogels were removed and placed in the incubator at 37 °C until the weight was constant.

It is reported earlier that combining PVA with chitosan for preparing scaffold was occurring due to the formation of hydrogen bonding between hydroxyl groups of PVA and chitosan [14]. By immersing the matrix of PVA-CS-Drugs into a solution of STTP, the matrix seemed hardened because of the formation of networking between the amine group in chitosan and the hydroxyl group of STPP [15]. The schematic formation of hydrogel matrix between PVA, chitosan and STPP that was loaded with anti-TBC drugs is shown in figure 2.

Table 1. Hydrogels Sample Variation

Code	PVA : chitosan	STPP concentration
100A	100 : 0	2%
100B	100 : 0	4%
80A	80 : 20	2%
80B	80 : 20	4%
60A	60 : 40	2%
60B	60 : 40	4%
40A	40 :60	2%
40B	40 : 60	4%

Note: 100, 80, 60 and 40 is the mass percentage of PVA in the hydrogel, while the percentage of chitosan is 100 – mass

percentage of PVA. A indicates the concentration of STPP of 2%, while B of 4%.

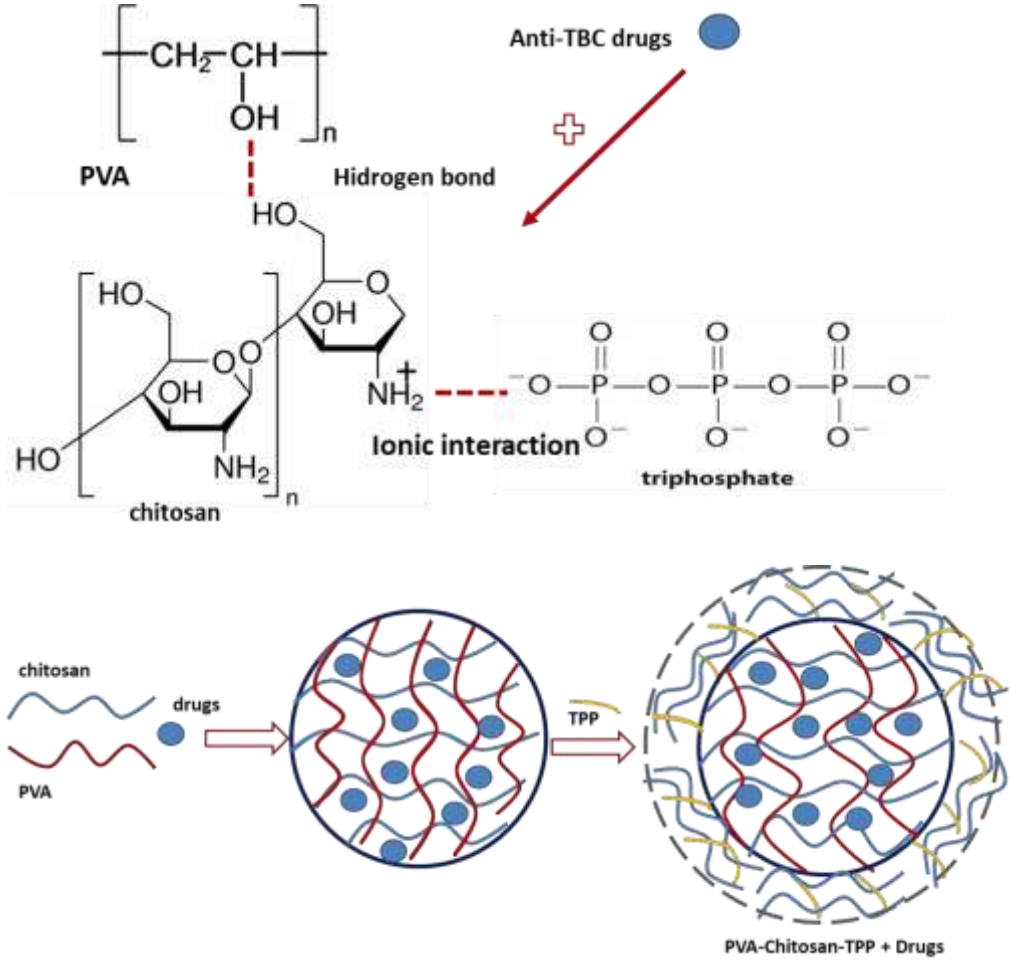


Figure 2. Schematic preparation of hydrogel matrix from PVA/chitosan/TPP loaded with anti-TBC drugs.

2.3. Morphology of hydrogels

The surface morphology of hydrogel matrices was determined using the scanning electron microscope (SEM) of SEI JEOL-JSM 6510LA with the secondary electron image mode of 20kV acceleration voltage and 500-10,000× magnification. X-Ray Diffraction (XRD) pattern of hydrogel matrices was obtained using SHIMADZU XRD 7000 MAXIMA-X with Cu tube. All samples were analyzed between 2θ angles of 10°C and 80°C using the voltage of 40 kV, current of 30 mA, and time per step of 1 second. The crystalline or amorphous character of PVA-Chitosan hydrogel matrices was determined through the diffractogram.

2.4. Drug encapsulation efficiency

The drug encapsulation efficiency was determined based on mass of drugs encapsulated in the matrices and mass of drugs dissolved in the STTP solution during the crosslinking process. The STPP solution after the crosslinking process was collected for analyzing the non-encapsulated drug using High performance liquid chromatography (HPLC) analysis. The drug encapsulation efficiency was calculated using the following equation:

$$\%Drug\ encapsulation\ efficiency = \frac{initial\ drug\ weight - drug\ loss\ to\ STPP}{Initial\ drug\ weight} \times 100\% \quad (1)$$

2.5. In vitro drug release test

In vitro drug release test was conducted in PBS of pH 7.4. The drug-matrix samples of 15 mg were placed in dialysis membrane containing 20 ml of PBS. Dialysis membrane was immersed in test tube containing 40 ml of PBS. The test tube was placed in a water bath at 37 °C and stirred at 250 rpm. For assaying the drug released, the PBS solution samples (4 ml) were withdrawn at 15 min, 30 min, 1 h, 2 h, 4 h 7 h, 12 h, 24 h and 72 h. The same volume of the fresh PBS solution was added to keep a constant volume. The drugs (isoniazid, pyrazinamide, and ethambutol) content in the sample solution was assayed using HPLC-UV detector with mobile phase A that composed of 8% acetonitrile and 92% 20 mM NaH2PO4 solution of pH 6.8 at 250 nm wavelength. While mobile phase B that composed of 50% acetonitrile and 50% 20 mM NaH2PO4 pH6.8 was used for rifampicin at a wavelength of 333 nm.

3. Results and Discussion

3.1. Drug encapsulation efficiency

The concentration of drugs in the STTP solution after the crosslinking process was assayed using HPLC analysis. The drug encapsulation efficiency was determined using equation (1) and the results were shown in table 2.

Table 2. Drug Encapsulation Efficiency

Sample	Encapsulation Efficiency (%)			
	Isoniazid INH)	Pyrazinamide (PZA)	Ethambutol (ETH)	Rifampicin (RFP)
100A	98.6	57.7	62.9	99.6
100B	98.4	40.8	78.8	99.3
80A	99.7	28.1	45.0	99.9
80B	99.3	24.5	37.9	99.9
60A	98.8	29.7	55.2	99.9
60B	98.9	35.1	53.9	99.9
40A	97.8	27.2	49.1	99.8
40B	97.4	18.1	54.0	99.8

The results showed that rifampicin had the highest encapsulation efficiency followed by isoniazid, ethambutol, and pyrazinamide, respectively. Hydrogen bonds are formed between carbonyl (C = O) from drugs and protonated amines ($NH3^+$) from hydrogels (Takahashi et al., 2005). This bond will hold the drug in the hydrogel matrix, and prevent it from escaping. INH and PZA have one carbonyl group, the RFP has three carbonyl groups, and ETH does not have a carbonyl group. This explains why rifampicin has the highest encapsulation efficiency. The encapsulation efficiency of PZA was lower than that of ETH, although ETH did not possess a carbonyl group. Retention of ETH in the matrix may be due to its large molecular size compared to three other drugs.

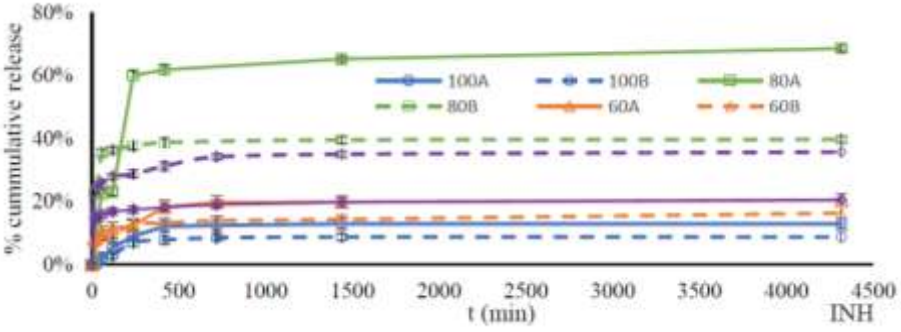
Table 2 shows the trend of encapsulation efficiency decreases when the content of chitosan in the matrix increases, especially for PZA and ETH. This can be explained because the more chitosan in the hydrogel matrix the more amine groups from chitosan can form bonds with STPP, and the more encapsulated drugs. The relationship between chitosan content and encapsulation efficiency was not significant for INH and RFP. The effect of STTP concentration during the PVA-CS linking process on efficiency encapsulation was also not significant. It seems that drug encapsulation occurred earlier when PVA interacted with chitosan, forming space to hold drug molecules. The chitosan interaction with TPP ions as linking agents formed an aggregation of chitosan that resulted in a hard material after solvent evaporation.

3.2. Drug release profile

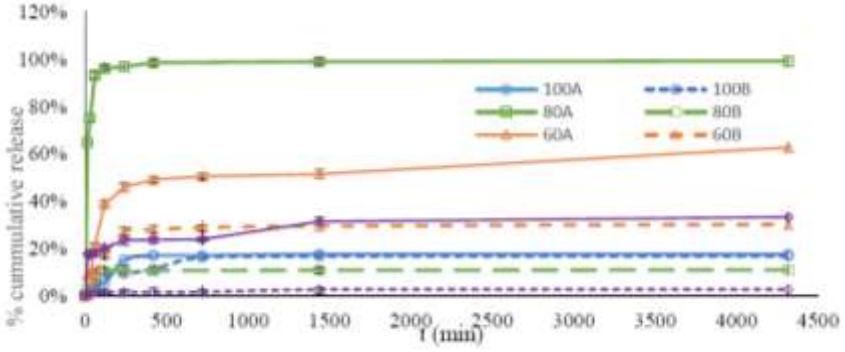
The samples taken at certain period of time were assayed for the drug content and plotted as shown in figure 3 for isoniazid (INH), pyrazinamide (PZA), ethambutol (ETH), and rifampicin (RFP) drugs. Different drug showed different release profile in buffer solution of pH 7.4. Fig. 3A shows the release profile of INH. It took only about 4h to release the INH up to about 70% when the matrix contained 20% chitosan in it. Similar release profile of PZA is shown in figure 3B. The matrix with a composition of 80% PVA and 20% chitosan caused the release of PZA from matrices up to 100% at about 60 min. Based on the molecular structure of INH and PZA (figure 1), which both have aromatic amines and are relatively small size, the release profiles indicate that the drugs are easy to be captured by hydrogel PVA-chitosan. However, they are easy to be released when the matrix swollen after a short period of time, 60 min, in buffer solution. Since chitosan form bonds with OH^- groups from PVA or with C = O groups from the drug, therefore the more chitosan content in the formulation, the stronger the drugs is bounded.

The delayed or extended release was shown when ETH was loaded into the matrices (figure 3C). The release of ETH was only about 20% until 1 h. The ETH release was up to 70% at 7 h (420 min) when using STPP solution of 2%. The release was extended up to 24 h (1440 min) when STPP solution of 4% was used. The molecular structure of ETH (figure 1) showed the presence of aliphatic amine and two hydroxyl groups. It seems these polar functional groups tend to interact stronger with the amine and hydroxyl groups belong to PVA and chitosan. The networking formed between chitosan and STPP made the release of ETH become more restricted.

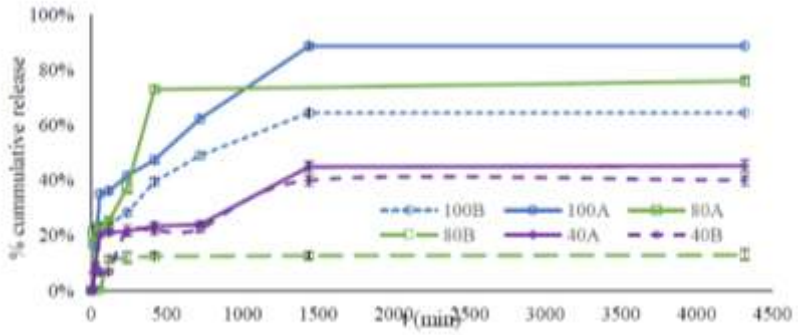
The release profile of RFP in buffer solution was quite different from the other three drugs (figure 3D). It was only about 45% released at 4 h when matrices contained chitosan of 20% and 40%. Unlike the others, the release of RFP in a matrix of 100% PVA was linear from the beginning and reached about 45 % at 24 h. Lower concentration of STPP solution showed lower release of RFP at 24 h. The molecular structure and the size of RFP are much different than the others (figure1). Based on the size it is likely that less of RFP can be entrapped in the hydrogel of PVA-chitosan (figure 2). Other than its big size, the RFP is not soluble in aqueous solution. Therefore, after evaporation of the solvent, it seems that RFP cannot all occupy the void in the networking of PVA and Chitosan. So, there is not much RFP can be trapped inside the hydrogels.



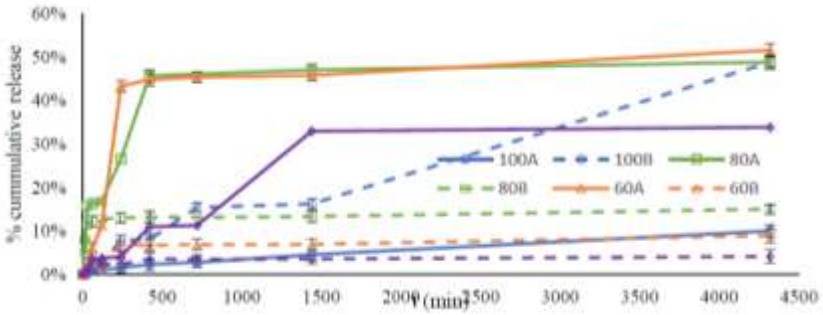
A. Isoniazid (INH).



B. Pyrazinamide (PZA).



C. Ethambutol (ETH).

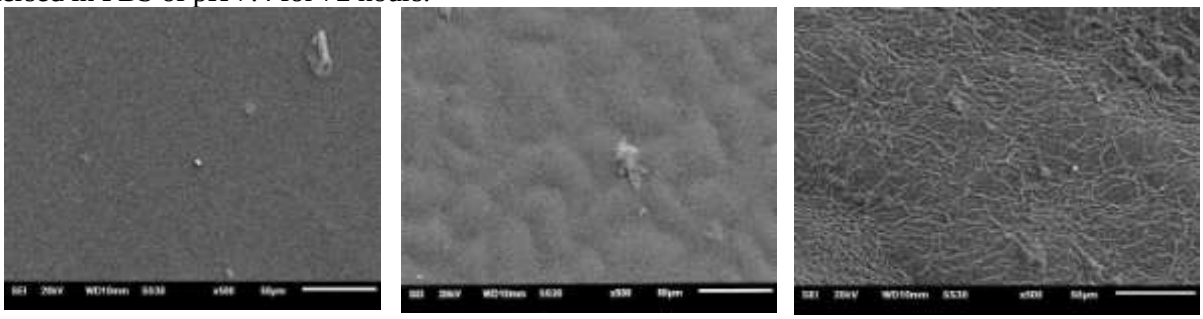


D. Rifampicin (RFP).

Figure 3. Drug release profile in PVA matrices with various percentages of chitosan

3.3. The morphology test of hydrogel matrix

SEM scanning with 500x magnification shows the surface morphology of PVA/chitosan hydrogel at various compositions. Figure 4 of 100A is a matrix sample made with 100% PVA and 0% chitosan in a 2% STPP solution. Figure 4 of 40B-new is a sample made of 40 % PVA and 60% chitosan in a 4% STPP solution. Figure 4 of 40B-72 is a similar sample with previous one, but is analyzed after it is immersed in PBS of pH 7.4 for 72 hours.



100A 40B-New 40B-72

Figure 4. Scanning Electron Microscopy from matrices of 100A, 40B new, and 40B after 72 h, using a 500x magnification

Sample 100A (PVA only) shows a smooth and an even surface of the matrix. This shows that PVA matrix was able to form homogenous mixture and completely dissolved in water. PVA thin film has a good structural integrity, smooth, even, and no crack [16]. Sample 40B-new (40% PVA, 60% chitosan in 4% STPP) shows a homogenous surface but slightly waved than sample 100A. This shows that PVA and chitosan were compatible, resulting in a slightly waved surface of the matrix. Sample 40B-72 (60% chitosan in 4% STPP after 72 hours release test) shows an uneven and rough surface, due to degradation and erosion of polymer in release media solution.

The powder XRD pattern is shown in figure 5. The PVA matrix shows a very high peek at $2\theta = 20^{o}$ (red color) but when chitosan is added, the peak significantly weakened (blue and green). The addition of chitosan in the hydrogel matrices reduced the crystallinity of PVA matrices. This might indicate that amine group or hydroxyl group in chitosan form bonds with hydroxyl group of PVA, which support the prediction that there is a good interaction between PVA and chitosan. A wider peak in XRD pattern was related to crystal size, where wider peak is a result from imperfect crystals [17].

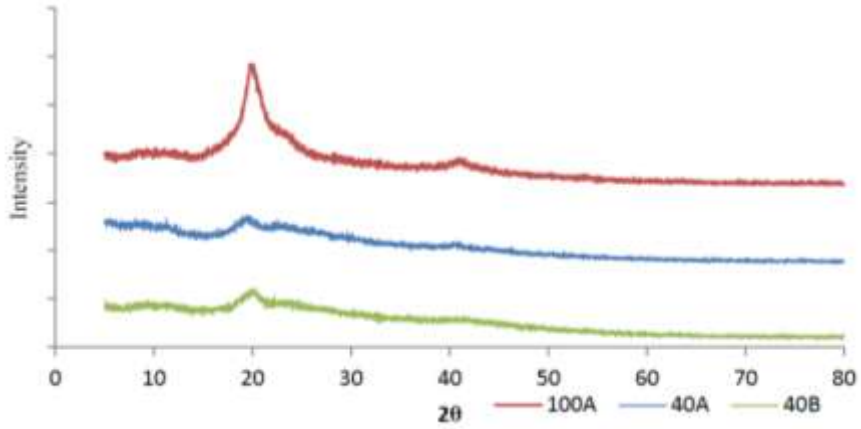


Figure 5. XRD pattern for samples 100A, 40A, dan 40B

4. Conclusion

The drug efficiency encapsulation was not affected significantly by the addition of STPP solution to the PVA-chitosan hydrogel matrices. The addition of STPP as linking agents formed hard hydrogel matrices. Addition of chitosan to PVA hydrogels formulation decrease drug encapsulation efficiency. The drug efficiency encapsulation for INH and RFP seems not affected by the composition of chitosan in the PVA matrices. However, for PZA and ETH the addition of chitosan slightly reduces the drug efficiency encapsulation. The drug release increases when chitosan is added up to 20%. However when the chitosan is higher than 20%, the drug release reduces, this might be due the denser of matrix encapsulating the drugs. The best formulation that gives the highest drug encapsulation efficiency is the hydrogel matrices that contain no chitosan, whereas to get high drug release, the 2% concentration of STPP is better than 4%. Based on the results, the formulation of PVA-chitosan hydrogel matrix with STPP as linking agent has the potential to be used as a carrier for extended release of anti-tuberculosis drugs. However, the release characteristic of each drug should be evaluated further in order to obtain longer release time of drug.

Acknowledgement

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Effects of initial concentration, adsorbent mass, pH and temperature to personal care products waste removal with activated carbon as adsorbent

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Abstract. Before being discharged into the water, waste from the personal care products (PCP) industry needs to be treated using the adsorption process. In this study, activated carbon is chosen as adsorbent because of its organophilic property, abundance, and continuous system. The experiment was carried out in batches using 3 variables of COD concentrations in PCP wastes in 250 ppm, 225 ppm, and 200 ppm with the adsorbent mass amount of 0.3 g/l, 0.35 g/l, and 0.4 g/l. In this experiment, the effects of initial COD concentration, adsorbent mass, pH, and temperature on the adsorption process, equilibrium models, mass coefficients, and thermodynamic analysis of adsorption will be analyzed. Equilibrium models of Distribution Coefficient, Freundlich, and Langmuir Model, are implemented in this experiment. From results of the study, the equilibrium system of PCP waste and activated carbon using Langmuir Equilibrium achieved a percent removal value of 69.03% at concentration of 200 ppm and the adsorbent mass of 0.4 g/l. For determining the mass transfer coefficient, an external adsorption model is used. The coefficient value of mass transfer coefficient (kc) with the trial method is 3.78x10-8 m/min, using numerical method with MATLAB is 7.6222x10-8 m/min, while using the analytical approach is 7.413x10-8 m/min.

1. Introduction

Demand of Indonesian market for personal care products (PCP) increases consistently every year for around 10-15% [1]. The higher the PCP products from industry and the higher community's consumption, the higher the waste will be formed, such as organic waste, pharmaceutical waste and nano-waste namely engineered nanomaterial (ENM). This waste flows to the environment from making process, wrapping, distributing, to personal care product consumption. This waste is also called pharmaceutical and personal care product (PPCP) waste.

There are several methods to reduce PPCP liquid waste level if after secondary treatment, the waste characteristic values still do not meet quality standards, one of them is with tertiary treatment. Quality standard for pharmaceutical liquid waste chemical oxygen demand (COD) level according to East Java Provincial Government Regulation Number 72 Year 2013 [2] is 75 mg/L.

Adsorption is commonly selected for tertiary treatment. Adsorption for liquid waste treatment becomes popular because it is more efficient and stable compared to biological method that also yields large amount of sludge [3]. Meanwhile, adsorption process is very efficient, easy to be design and operate, relatively affordable and not affected by toxicity like biological treatment [4]. Furthermore, percent removal of organic waste is estimated quite high, around 70-80% [5].

Material often used for conventional adsorption is activated carbon. Activated carbon is commonly used for adsorption because of its large surface area and it does not need adsorbent preparation. However, also because of its large surface area, activated carbon regeneration needs a high cost technique. Common regeneration method is thermal regeneration, but it can remove 5-10% carbon because carbon structure is damaged [6].

Research commonly used for investigating PCP waste adsorption process is generally performed using synthetic waste with synthetic compound concentration parameter. Because of the large amount of component in PCP waste, parameter used for investigating PCP waste adsorption process is COD. COD is amount of oxygen (mg O_2) needed to oxidize organic substances in 1 liter water sample. Until now, there is no research activity that investigates PCP waste adsorption process with COD as the main parameter, so that further research is needed to figure out PCP waste adsorption characteristic by those two types of adsorbent in order to obtain operation condition and adsorbent type which fits PCP waste treatment most.

2. Research Method

System process of this research is described in figure 1. The process consists of 7 steps which is initiated by PPCP waste characterization and ended with adsorption modelling. The modelling is based on finding the most optimum parameter to obtain maximum percent removal.



Figure 1. System process diagram of this research.

2.1. PCP waste characterization

Waste characterization includes initial total suspended solid (TSS) level test, initial 5-day biological oxygen demand (BOD_5) and initial COD. This procedure determines whether waste needs pretreatment before adsorption process or not, referring to East Java Provincial Government Regulation Number 72 Year 2013 [2] concerning pharmaceutical waste. Initial TSS level test uses gravimetry method. Initial BOD_5 level test uses reagents: phosphate buffer, $MgSO_4$, $CaCl_2$, $FeCl_3.6H_20$ and KI obtained from BDH. Initial COD test uses $K_2Cr_2O_7$ and $AgSO_4$ reagents obtained from e-Merck. Activated carbon for this experiment is obtained from Merck.

2.2. Maximum COD percent removal determination at various initial COD concentration of wastewater

Diluting waste at various concentration is carried out in order to figure out maximum COD percent removal can be reached at which concentration. Same adsorbent mass is used for all variables, which is 0.15 gr. Experiment data are sampled at 0, 1 3, 5, 10, 15, 20, 30, 40, 60, 80, 100 and 120-th minute and waste volume used in this experiment is 500 ml. Adsorption equilibrium data are obtained after 24 hours since adsorption process starts. Variables used in this experiment: 250 ppm, 225 ppm and 200 ppm.

2.3. Optimum adsorbent mass determination

After obtaining the initial concentration for maximum percent removal in previous step, the adsorbent mass for this experiment is varied until the maximum percent removal is reached. Experiment data are sampled at 0, 1 3, 5, 10, 15, 20, 30, 40, 60, 80, 100 and 120-th minute and waste volume used in this experiment is 500 ml. Adsorption equilibrium data are obtained after 24 hours since adsorption process starts. Variables used in this experiment: 0.15 gr, 0.175 gr and 0.2 gr.

2.4. Optimum pH determination

With previous initial concentration that makes up maximum percent removal, initial pH is measured. Then, pH is adjusted until reaching acidic pH (pH=4) and basic pH (pH=11). Adsorption process is performed using previous adsorbent mass which results maximum percent removal. Adsorption results which result maximum percent removal in acidic pH, neutral pH, and basic pH are then compared. Experiment data are sampled at 0, 1 3, 5, 10, 15, 20, 30, 40, 60, 80, 100 and 120-th minute and waste volume used in this experiment is 500 ml.

2.5. Optimum temperature determination

With previous initial concentration, adsorbent mass and pH that made up maximum percent removal, temperature is measured then varied to obtain optimum temperature that results maximum percent removal. Experiment data are sampled at 0, 1 3, 5, 10, 15, 20, 30, 40, 60, 80, 100 and 120-th minute and waste volume used in this experiment is 500 ml. Variables used in this experiment: 30 ^{o}C, 35 ^{o}C, 40 ^{o}C, 45 ^{o}C and 50 ^{o}C.

3. Results and Discussions

This research discusses PCP waste adsorption which is effluent secondary treatment, using activated carbon. Table 1 shows PCP waste characteristic data before entering adsorption process compared to the quality standards from government [2] concerning pharmaceutical waste.

Table 1. PCP waste characteristic

Parameter	Quality Standards [8]	Characteristic Used in Experiment
COD	**150 mg/L**	**860 mg/L**
BOD_5	**75 mg/L**	**72 mg/L**
TSS	**75 mg/L**	**8 mg/L**
pH	**6-9**	**7.9**

Activated carbon used in experiment is powder type activated carbon from Merck with surface area of 800 m^2/gr.

3.1. Initial COD concentration effect

Three pollutant concentration variables (250 ppm, 225 ppm and 200 ppm) are used to understand pollutant concentration effect in adsorption process in certain adsorbent mass values. This pollutant concentration range is selected based on pollutant concentration for tertiary treatment in industry which has to be the lowest pollutant concentration. Ideal adsorption process is performed in thin solution. Initially, wastewater is diluted with distilled water because PCP waste has COD concentration of 860 ppm. Activated carbon mass used here is 0.15 gr. Experiment data are sampled at 0, 1 3, 5, 10, 15, 20, 30, 40, 60, 80, 100 and 120-th minute. Figure 2 shows COD value change versus time with adsorbent mass of 0.15 gr in various initial concentration.

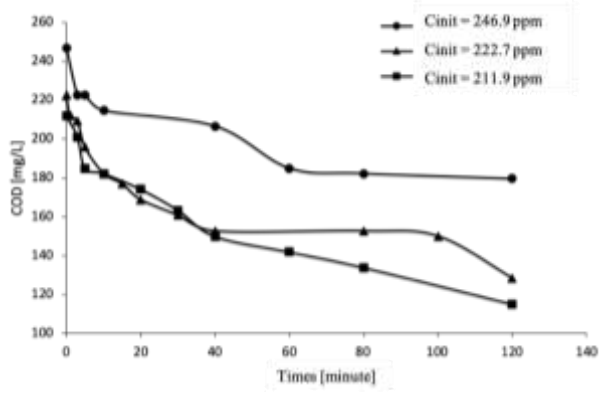


Figure 2. Profile of COD concentration versus time with adsorbent mass = 0.15 gr in various initial concentration.

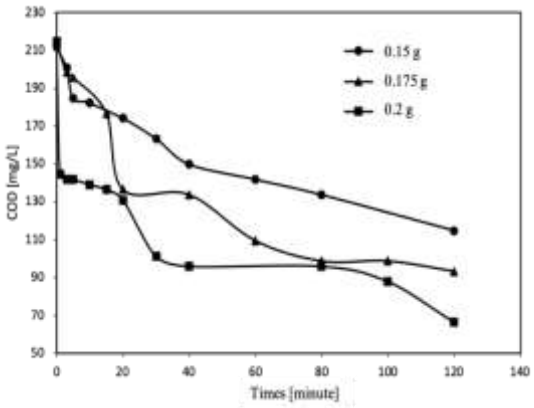


Figure 3. Profile of COD concentration versus time with initial COD concentration = 200 ppm in various initial adsorbent mass.

Table 2. COD percent removal data in various initial COD concentration

COD_0 [mg/L]	246.9	222.7	211.9
$COD_{2\text{-hour}}$	179.559	128.363	114.889
$COD_{,eq}$ [mg/L]	166.087	128.363	104.111
percent removal	32.738%	42.354%	50.867%

Table 3. COD percent removal data in various adsorbent mass

COD_0 [mg/L]	214.5897	214.5897	211.9
Adsorbent mass [gr]	0.2	0.175	0.15
COD_{2hour}	66.3867	93.3327	114.889
$COD_{,eq}$ [mg/L]	66.3867	85.2489	104.111
percent removal	69.0634%	60.2735%	50.867%

Table 2 shows COD percent removal data in various initial concentration (246.9 ppm, 222.7 ppm and 211.9 ppm). Meanwhile, for COD concentration of 250 ppm, after 2 hours of adsorption process, COD concentration becomes 179.559 ppm, where this result does not yet meet the quality standards from government [2].

In the lower concentration, steric hindrance because of inter particle bond happening in waste particle adsorption becomes smaller. Therefore, adsorption process becomes more optimum. Furthermore, adsorption process is ideally performed in gas and thin solution, so that if the solution concentration is lower, adsorption process is more optimum [7]. Therefore, for next adsorption process, initial COD concentration of 211.9 ppm is applied.

3.2. Adsorbent mass effect

In varied adsorbent mass experiment, three variables of adsorbent mass are used: 0.15 gr, 0.175 gr and 0.2 gr. Figure 3 shows COD value change versus time in initial COD concentration of 200 ppm with various adsorbent mass.

On Table 3, it can be seen that adsorption process optimum mass is obtained at mass of 0.2 gr, where the greater the adsorbent mass, the greater the active side for adsorbent adherence. Quality standard from government is met for all mass and in the next process, the adsorbent mass of 0.2 gr is used.

3.3. Isotherm and adsorption kinetics

From varied initial COD concentration and adsorbent mass experiment, isotherm for this experiment can be estimated from plotting curves as comparison among Langmuir, Freundlich and distribution coefficient isotherm.

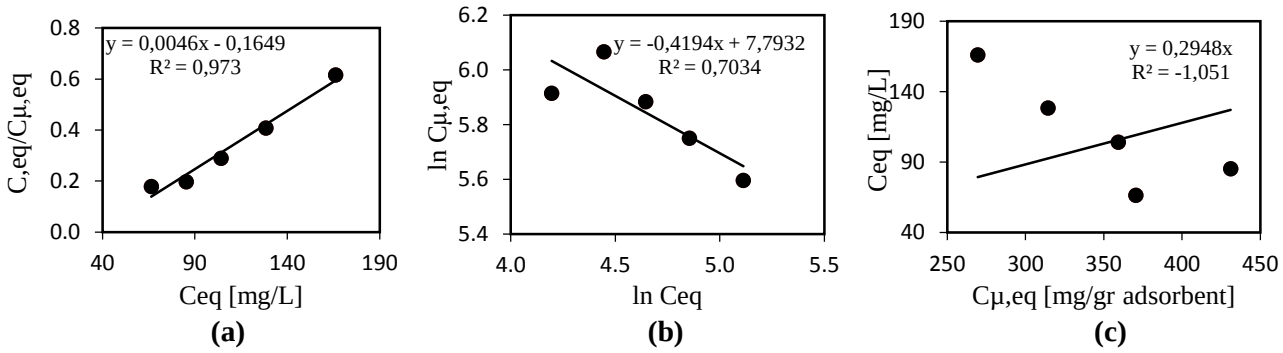


Figure 4. PCP waste adsorption process with activated carbon as adsorbent. **(a)** Langmuir isotherm plot; **(b)** Freundlich isotherm plot; **(c)** Distribution coefficient isotherm plot;

Table 4. PCP waste adsorption isotherm parameter table with activated carbon as adsorbent

ISOTHERM	PARAMETER	R^2
Langmuir	**K_L = -0.028 L/mg**	**0.973**
	$C_{\mu,max}$ = 217.391 mg/g	
Freundlich	**K_F = 2424.062 mg/g**	**0.703**
	n = -2.384	
Distribution Coefficient	**k_d = 0.295 g/L**	**-1.051**

On figure 4, it can be seen that the most suitable equilibrium for this research is Langmuir isotherm. It can be seen from table 4, Langmuir equilibrium has value of R^2 = 0,973. The value is the closest number to 1 if compared to R^2 values from Freundlich and distribution coefficient equilibrium. This fact shows that PCP waste adsorption process using activated carbon follows monolayer adsorption model as described in (1).

$$C_{\mu,eq} = \frac{C_{\mu,max} K_L C_{eq}}{1 + K_L C_{eq}} \quad (1)$$

Analytical approach COD is obtained by using equation (2).

$$\int_{Co}^{C} \frac{dC}{(C - C_{eq})} = -\frac{k_C \times A \times t}{V} \quad (2)$$

Analytical approach is an approach with exponential method resulting steep declining line then flattening at some point, while experiment data are declining with sloping trend. Therefore, trial method is carried out to find COD value from modelling that approximates experiment value more precisely. COD trial value approximates experiment data better than analytical approach.

In PCP waste adsorption experiment using activated carbon, various k_c values ranging from 5.175×10^{-8} to 11.57×10^{-8} with various adsorbent mass and initial concentration of PCP waste. Average k_c value obtained with analytical approach is 7.70×10^{-8}. Meanwhile, average k_c from trial method is 3.78×10^{-8}. Because the values are close one another, it can be concluded that k_c value is not affected by adsorbent mass and initial concentration of PCP waste.

3.4. Effects of pH

In varied pH adsorption process experiment, three variables of various pH are used, which are pH=4, pH=7.5 and pH=11. pH=4 is used for setting up acidic situation in adsorption process, while pH=11 is used for setting up basic situation in adsorption process. From there, a match between adsorbent and adsorbate in acidic, neutral and basic pH are evaluated. Neutral pH for this waste is 7.5. In this varied pH experiment, fixed initial concentration of 200 ppm and adsorbent mass of 0.2 gr are used. pH value that gives the biggest decrement of COD is 4 (acidic pH) which also means that pH value of 4 results the biggest percent removal of 74.086%. This proves that acidic pH is more suitable for activated carbon. Theoretically, CA possesses point of zero charge (PZC) in pH=5.4. When the pH of solution is

below PZC, CA will suffer from protonation, so that positive charge will also decrease. Therefore, CA will adsorb more anionic compounds. The original pH of the solution tends to be basic, which is 7.5, thus for increasing the percent removal, the pH of the solution should be acidized to less than 5.4.

3.5. Effects of temperature

In this experiment, adsorption process with 5 varied temperatures: 30, 35, 40, 45 and 50^0C is performed. It can be concluded that k_c value is affected by temperature. The higher the temperature, the higher the k_c value. This justifies that when temperature increases, mass component transfer of waste from water to adsorbent surface also increases. Because when temperature increases, molecule movement becomes faster, this causes the increase of probability of the contact between waste component and active side of adsorbent, so that more waste component that is adsorbed in active side of adsorbent. This makes the percent removal value increase when adsorption process temperature is higher.

4. Conclusion

In constant activated carbon mass, the biggest percent removal value is obtained in the lowest COD initial concentration of 211.9 ppm. In the fixed PCP waste concentration, the biggest percent removal value is obtained in the highest varied mass, which is 0.2 gr. The highest percent removal is reached when COD initial concentration is 200 ppm, adsorbent mass is 0.2 gr, pH of solution is 4 and temperature is 50^0C where percent removal value obtained is 73.69%. Mass transfer coefficient value (k_c) with trial method is 3.78×10^{-8} m/min. With computer-aided simulation, it is 7.6222×10^{-8} m/min, while with analytical approach, it is 7.413×10^{-8} m/min.

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Surface roughness analysis using sound signal in turning of mild steel

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Abstract. Among every other parameters of production process, surface roughness holds its ground as one of the most crucial factor for quality analysis. Good surface finish is a major criterion in almost every machining process. If the surfaces aren't smooth, many kinds of mechanical, thermal, frictional, vibrational problems may occur. So minimizing surface roughness should be top priority. Surface roughness depends on many factors. But it has a direct relation with the tool conditions and overhang length of the tool. With the variations of tool conditions and overhang length the machining sound level also varies. In this present work, an analysis has been made based on captured sound signal to correlate the surface roughness parameters with sound level at different tool and overhang length conditions. As the cutting tool wears out due to continuous usage, surface roughness also develops on the tool surface. It has been observed that with the increase of overhang length the sound generated level within the cutting zone varied and surface roughness in the job also varied due to the effect of vibration and friction. A correlation factor has been investigated with the sound level variation to analyze the surface roughness condition with different tool wear and overhang length.

1. Introduction:

Lathe machines are one of the most widely used metal shaping machines for cylindrical job pieces. For effective and multipurpose uses they are being used in almost every workshop. Many research works has already been conducted to improve the surface roughness of machined work-piece in turning operations using different types of process parameters, coolant, hot machining, cryogenic machining etc. G.M. Sayeed Ahmed et al [1] conducted an experiment using AISI 1050 material of different diameters of 20, 30, and 40 mm in which the surface roughness of the work piece was determined through experiments using constant cutting speed and feed rates with different depth of cuts (DOCs) and tool overhang lengths. Safeen Y. Kassab et al. [2] experimented to find relation between surface roughness and cutting tool vibration in lathe dry turning of medium carbon steel. They found that vibration of cutting tool depends strongly on cutting tool overhang length and with the increasing feed rate the surface roughness of work piece increase. H.H. Habeeb et al. [3] conducted machining of nickel based alloys 242 included using four different cutting tool materials under wet condition. Flank wear modes are noticed as acceptable results at lowest cutting depth with high cutting speed and moderate feed rate. Optimum surface roughness results were also recorded with decreasing of cutting depth. In a similar type of experiment by Anayet U. Patwari et al. [4] investigated the effects on overhang length on surface roughness, chip morphology to determine the suitability of over-hang length with coated carbide inserts so that with the proper selection of the overhang length the productivity will increase with the increased process parameters. Vladimir Aleksandrovich Rogov et. al. [5] used the Taguchi method to optimize the surface roughness with vibration in turning of Aluminum AA2040 under dry condition where Spindle speed, feed rate, depth of cut and tool

overhang were chosen as cutting parameters. Kong Lingguo et al.[6] in their study found that within a certain range, the cutting speeds increased will first make the amount of vibration and surface roughness increase, then decreased, and more than this range, the surface roughness goes up along with the vibration increase. The cutting edge of the worn tool acting like un-uniformly larger nose radius which produced better surface was found in an experiment by S. Thamizhmanii et al. [7]. In this present study, several experiments have been conducted with different types of tool wear and overhang length and generated sound were captured at different cutting conditions in turning process. The captured sound level was analyzed to correlate the surface profile with the sound level in machining process and find out the relationship with sound level, surface roughness, tool wear and overhang length for conventional turning processes.

2. Experimental Details:

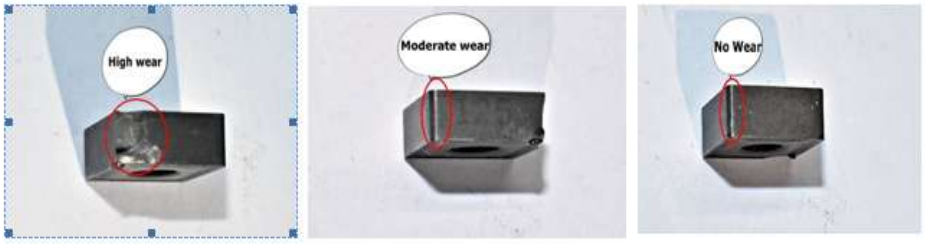
Many mild Steel bars of 200 mm length and 32 mm diameter were cut from the same bar using LET LHM-280 power saw machine for conducting lathe operation using Pinacho Mod. L-1/180 Lathe machine. Three same types of coated carbide insert have been used with different tool wear. In the experiment, one new insert, one moderate wear insert and large wear insert has been used for machining purposes. During machining audio recorder was used to capture the sound for sound analysis and an open source software was used for sound analysis which was captured by audio recorder. After the machining process, Profilometer was used for measuring surface roughness. A detail of the experimental setup is shown in Figure 1.



Figure1. Details of the Experimental setup used in this study.

For this experiment, same type of insert with different tool wear namely no wear-new insert, medium wear and high tool wear as shown in Figure 2 have been used for machining operation of different overhang length keeping all other process parameters constant. Conventional turning machining was done in the following manner:

- 1st work piece: High wear insert for 1st 10 mm, Moderate wear insert for 2nd 10 mm, no wear insert for 3rd 10 mm were used.
- 2nd work piece: No wear insert for 1st 10 mm, high wear insert for 2nd 10mm, moderate wear insert for 3rd 10 mm were used.
- 3rd work piece: Moderate wear insert for 1st 10 mm, no wear insert for 2nd 10mm, high wear insert for 3rd 10 mm were used.



(i) High Wear (ii) Moderate Wear (iii) No Wear

Figure 2. Different types of Insert used in this study

2.1 Experimental conditions:

This experiment was conducted by using lathe machine where 3 types of (no wear, moderate wear, high wear) coated carbide insert were used for machining. In both machining process following parameters were applied Cutting speed, Depth of cut, Feed rate was kept constant throughout the whole experiment while overhang length became variable.

Constant parameter: Cutting Speed: 875 rpm; Depth of Cut: 1 mm; Feed rate: 1 mm/rev;

Variable parameter: Overhang length: 160 mm, 170 mm, 180 mm.

3. Results and Discussions:

While measuring the surface roughness, different surface roughness was found using different insert for each work piece. Comparing work pieces, insert 3 (no wear insert) had the best surface finish at various overhang length as shown below.

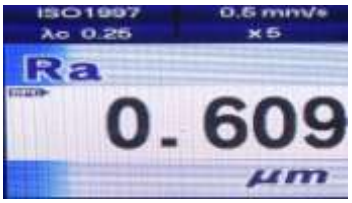
Surface Roughness **Surface Roughness Graph**

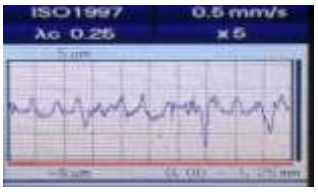
- For work piece 1: 160 mm Overhang, No wear insert





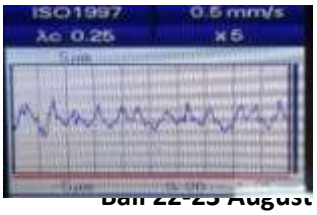
- For work piece 2: 180mm overhang, No wear insert





- For work piece 3: 170 mm overhang, No wear insert





In this experiment, using different insert for each job piece while varying the overhang length, it is found that 3rd insert (No wear) has the better surface finish for conventional machining. For job piece 1, in 160 mm overhang length for insert 3 (No wear) has the better surface finish of 0.360 micro-m. Similarly, for job piece 2 & 3 better surface finish is obtained using 3rd insert that has no wear for varying overhang length 180 mm & 170 mm as shown in Figure 3. It is clearly observed that with the increase of overhang length the surface roughness increased in case of no wear insert. In case of sound level analysis, it is also found that no wear insert generated less sound level compared to other two inserts. It is also observed that at overhang length 170 mm and 180 mm for moderate and high wear insert the surface roughness varied considering the frictional and vibration effect.

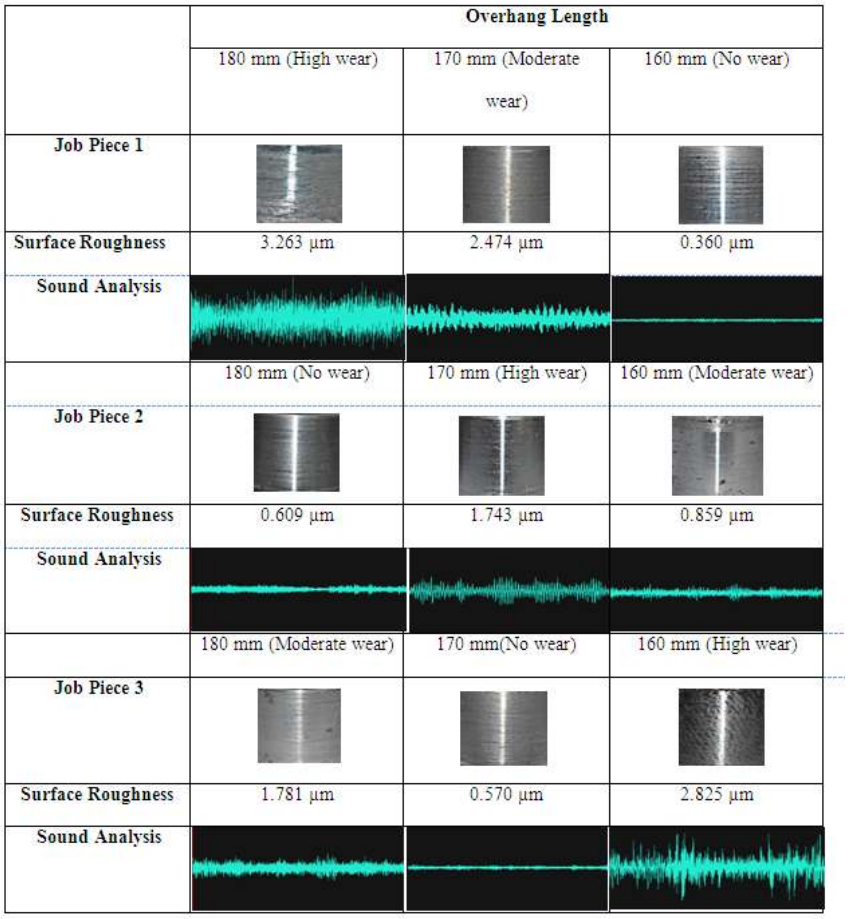


Figure 3. Surface profile with average roughness and sound level variation at different overhang length.

While machining the job piece, different types of chips were formed as shown in figure 4 using different insert for varying overhang length. For 1st job piece, using high wear insert for 180 mm overhang length discontinuous chip was formed which was black in color (because of high friction between tool and job piece). For 1st job piece, during machining discontinuous chips were formed for other insert (Moderate & No wear) for varying overhang length (170 mm & 160 mm). But the chips which were formed during machining became blueish (because of friction between tool and job piece it slightly burnt) for insert 2 (Moderate wear) and silver for insert 3(No wear).

For 2nd job piece continuous chip was formed using insert 3(No wear) where overhang length was 180 mm and using insert 1(High wear) with overhang length 170 mm formed continuous chips with build up edge due to excessive friction and vibrational effect between tool and jobpiece and it was coil type shape. For overhang length of 160 mm insert 2 (moderate wear) formed discontinuous chip which

was brownish in color. For job piece 3, continuous chips were formed using 2nd (Moderate wear) & 3rd insert (No wear) for varying overhang length at 170 mm.

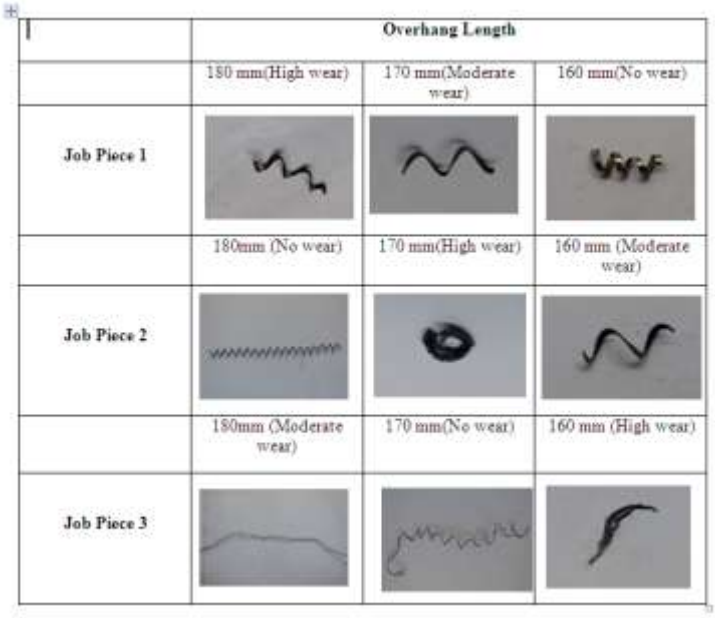


Figure 4. Different types of chip formed in machining processes.

But the chips which were formed during machining became bronze type color (because of friction between tool and job piece it slightly burnt) for insert 2 (Moderate wear) and silver for insert 3 (No wear). Beside this continuous chips with build up edge was formed using insert 1(High wear) (overhang length 160mm) due to excessive friction between tool and jobpiece.

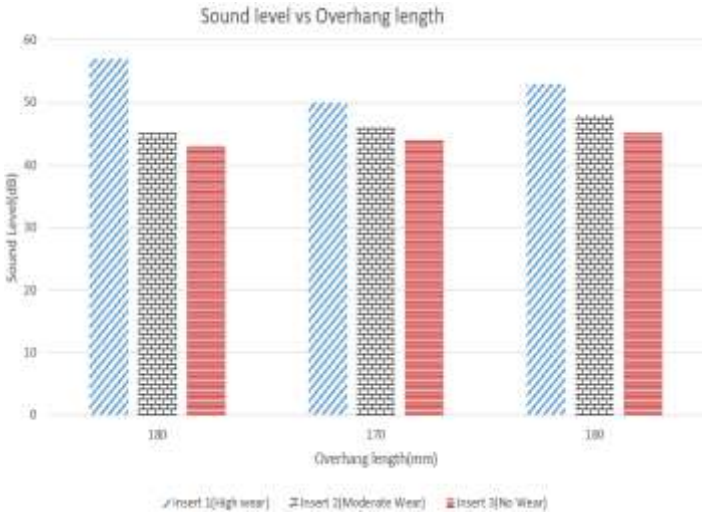


Figure 5. Sound level variation at different overhang length for different insert.

Figure 5 shows the visual demonstration of sound analysis vs. overhang length, where machining is done for this experiment under same feed rate, depth of cut and cutting speed but overhang length is variable for each insert. From this histogram, it can be seen that sound level is decreasing with decrease of overhang length. When overhang length is decreasing less vibration occurs, that's why sound level decreases and surface improvement is also achieved. Correlating figure 3 and figure 5, it is

found that for insert 1 (High wear) surface roughness first decreasing then increasing with the increase of overhang length and same tendency is reflected in sound level variation. For insert 2 (Moderate wear) surface roughness first increasing then decreasing with increase of overhang length. For insert 3 (No wear) surface roughness gradually decreases with the decrease of overhang length. Generally surface roughness decreases with decrease of overhang length. Similar tendency has also been reflected in captured sound level variation. According to the sound analysis, it is showed that maximum sound is recorded [57db] for overhang length 180 mm in case of high wear insert and minimum [43db] is found in case of no wear insert.

4. Conclusions

In this study, surface roughness has been compared with the sound level variation at different overhang length for three different types of insert. Generally, it has been observed that with the increase of overhang length the average surface roughness value is going to be increased. Overhang length variation results the cutting process stability and insert status reflects the frictional behaviour in between the tool and the work-piece. The performance of machining is related with the stated factors and sound captured during machining will be varied at various combinations of the process and system parameters. So, in this paper, an attempt was made to investigate and correlate the output response in terms of average surface roughness and generated sound signal during cutting process. Surface profile response, tool life, vibration may be predicted from the sound level variation.

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Environmental life cycle costing of boiler system: a case study

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Abstract. In this modern age, there is a need in creating not only a profitable business but also sustainable ones. This merger of sustainability and profitability calls for specific tools that could help businesses in advancing their business practices. Life Cycle Costing (LCC) is now one of the tools used for calculating both the economic and environmental impact of a chosen system, with the aid of Life Cycle Analysis (LCA) to delve more in-depth on the environmental side of the equation. PT XYZ uses Compressed Natural Gas (CNG) as the primary source of fuel for the burning of their boiler system. They would like to know the Eco costing of this current system as well as an alternative, diesel fuel. From the finding, it was found that the total LCC of CNG is costlier compared to diesel. This was due to the high environmental impact of delivering CNG gas back and forth using trucks. It was advised for the company to use diesel if they wanted to take the socially responsible decision. If the company were to decide on sticking to CNG, an alternative delivery system should be considered, such as building a piping network.

1. Introduction

In this modern age, there is a need in creating not only a profitable business but also sustainable ones. In 2015, the United Nations formulated the United Nations 17 Sustainable Development Goals (SDG) as a part in creating a shared vision for harmony and property for all nations (United Nations, 2015). The merger of sustainability and profitability calls for specific tools that could help businesses in advancing their business practices. Life Cycle Costing (LCC) is now one of the tools used for calculating both the economic and environmental impact of a chosen system, with the aid of Life Cycle Analysis (LCA) to delve more in-depth on the environmental side of the equation.

The extent of the applied field of LCA research has led to a proliferation of publications in various fields in recent years [1]. PT XYZ is a multinational company that creates and sells food products all over Asia. They own a few farms for raising poultry to supply their demand for meat and protein-based products all over Asia. With this, they produce their in-house feed for as nutrients for their poultry population. As with any agricultural product, both environmental and economic implications need to be analysed further. So far, the company uses Compressed Natural Gas (CNG) as the primary source of fuel for the burning of their boiler system. This boiler system is vital in creating steam that will later be used in softening chicken feed where they would later be formed into pallets. However, the company is trying to look for a greener and also a cheaper source of fuel that could replace CNG if possible, one of which is diesel fuel. Thus, this study will try to answer this conundrum by creating models that would suit the what-if scenario created.

2. Theoretical foundation

LCA is a method in determining the overall environmental impact in the creation of a range of products or services [2]. The phases of the product's life cycle could be calculated to create a holistic view of the impacts the product or service could bring. LCA method was built upon ISO 14040 and ISO 14044 standards [3]. The ReCiPe is the method used to analyse the impact of the inventory. This method was developed to create a normalising factor [4] and thus enabling the user to determine the impact selected categories. This as developed by combining Eco-Indicator 99 and CML-IA where Eco-Indicator 99 is more "problem-oriented" while CML-IA is "damage-oriented". During Impact Assessment phase, there will be two assessment options, which are ReCiPe Midpoint or ReCiPe Endpoint.

LCC is an accounting method that had been used to measure the cost paid during all stages of a product's life cycle [5]. Conventional LCC had been used by the Military as a tool for analysis of potential procurement and projects . Over the years, with the advancement in the socio-economic field, there comes a need for an analytic tool to analyse the socio-economic impact of a product or service of not only the product and service itself but also the indirect cost both upstream and downstream of the system. Therefore, LCC is now being modified to suit the LCA based system to suit this need, which was developed by Hunkeler et al. [6]. With the now developed LCC for LCA, its methodology will be altered to suit the specification of an LCA study, where their stages are identical. However, LCC will add additional costs, not in the LCA such as recovery costs and other capitals used in the system. A functional unit is also used in LCC as a standard of measure for the calculation [3].

3. Methodology

3.1 Goal setting

This study aims to find the solution to the problem identified regarding the lack of economic valuation of LCA on their chicken feed utility system by using the LCC method. This problem is specified to which fuel the boiler system should use according to the environmental LCC calculation (economically and environmentally.) The LCC conducted will not include calculation of development stage as they had past as well as the end of life costs due to lack of data present.

3.2 Data collection

The data collection phase is conducted by distributing internal questionnaire by the company itself. Additional information by interviews and checking past documents will be taken to fill any gaps needed for the company. Expert opinion and literature review will also give additional input when there is lack of real data in the field. Next, any literature data will also be input in the case of any missing data. This assumption will help bridge the gap of the unknown when needed or necessary, also as secondary data for certain confidential information.

3.3 Data processing

From the data collected, the values will be adjusted to suit the functional unit of the study, which is 1000 M3 of boiler water used in the boiler. From here, all input and outputs of the system will be recorded as well as their costs. Next, the adjustment for the functional unit is calculated by converting the input and output of the system to match the flow of the proposed functional unit. The cost per unit for each impact will be collected and then be converted to Indonesian Rupiah in 2019 by using inflation data from the past six years.

3.4 Data analysis

Data from the LCA will be the impact categories where there will be characterised and normalised score for each category. There will also be a network that indicates which process will cause the biggest contributor to the environment from the process compiled. Next, the LCC will also find the most expensive indirect impact as well as the raw materials and processes that cause the highest cost for the overall system along with maintenance and labour costs. This LCC study will not calculate development cost, indirect overhead, as well as end of life cost. This is due to either lack of data or lack of meaningful calculation, especially for development cost as they boiler system is already in

place and thus equal cost for each option since the boiler could use all three fuels with out changing the boiler itself.

The analysis of reviewing the calculation and analysing hotspots of economical cost in the utility of the production line for chicken feed as well as creating Net Present Value (NPV) calculations to see which fuel is the better option for PT XYZ and what they could do to lower their LCC cost. In calculations for the NPV, data from past inflations will be calculated to help determine NPV as well as Future Value (FV). The weighted average will be used to calculate the total inflation used to predict the change in cost for the boiler's life span. The model with the lowest cost will be the chosen model that will be recommended for the company.
Monte Carlo simulation is used to check the reliability of the weighted average tool created, by comparing the result of the simulation against the predicted outcome of the NPV or FV calculation. After that, possible solutions will be given to address the system to reduce the process which contributes to the highest indirect environmental impact cost so that the company could lower the environmental impact. The solution will be analysed on how they could lower their impact score and also how this change could be implemented. The suggested solution is expected to give insight to have a better sustainable utility system.

4. Analysis

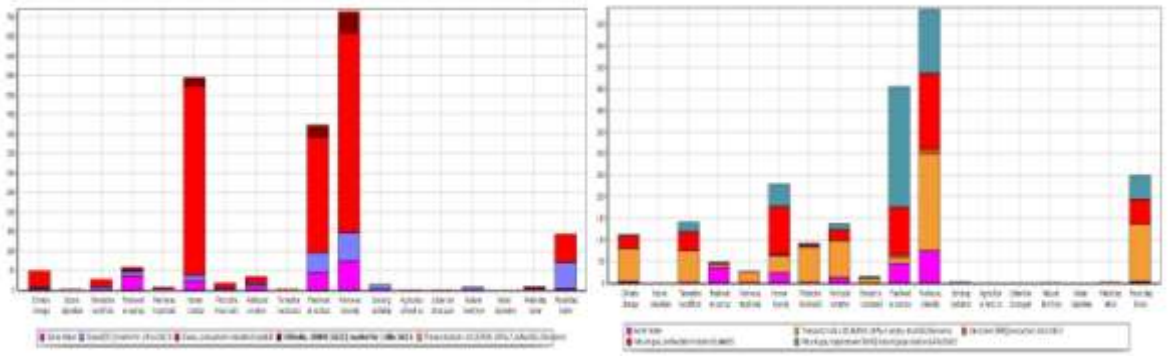
4.1 CNG result

The LCA result for CNG resulted in the characterised impacts below

Table 1. Impact category of CNG and diesel fuel in the boiler system

Impact category	Unit	CNG	Diesel
Climate change	kg CO_2 eq	769,096.38	338,323.02
Ozone depletion	kg CFC-11 eq	0.0036	0.04
Terrestrial acidification	kg SO_2 eq	5,343.50	1,072.10
Freshwater eutrophication	kg P eq	14.20	16.75
Marine eutrophication	kg N eq	205.09	57.01
Human toxicity	kg 1,4-DB eq	74,506.65	177,349.91
Photochemical oxidant formation	kg NMVOC	5,212.12	1074.53
Particulate matter formation	kg PM10 eq	1,917.37	485.73
Terrestrial ecotoxicity	kg 1,4-DB eq	85.17	7.27
Freshwater ecotoxicity	kg 1,4-DB eq	1,955.84	1,828.24
Marine ecotoxicity	kg 1,4-DB eq	1,559.97	1,762.91
Ionising radiation	kBq U235 eq	3,801.43	19,877.04
Agricultural land occupation	m^2a	276.54	702.25
Urban land occupation	m^2a	62.44	468.23
Natural land transformation	m^2	14.81	90.49
Water depletion	m^3	1,834.1224	2,188.3785
Metal depletion	kg Fe eq	1,326.5762	4,401.5393
Fossil depletion	kg oil eq	320,079.55	184,632.49

The table above indicates the quantity of impact for each impact category. The unit is each specific for the impact and all of the emission are not necessarily of the one account in the unit. For example, Climate change has 769096.38 kg CO2 eq, which means emissions of various gasses combined would have the equivalent impact of 769096.38 kg of CO2 gas released to the environment. These values can be broken down to each process in the chart below.



From the diagram above we can see for the most impact, Delivery (yellow) is the major cause of the pollution (except for Freshwater eutrophication, Human toxicity and Freshwater ecotoxicity), followed by CNG usage in the system. This indicates that delivery of CNG is the biggest contributor to the environment, and even outweighs the combustion of CNG. The same normalisation method and monetary calculation was applied to diesel. From this diagram it is visible that the effect of delivery here is very little compared with the combustion itself (Combustion in red while Delivery is yellow). This indicates that the usage of diesel engine itself is the biggest contributor to the environment for diesel system (Combustion in red while Diesel being in the system is in blue), followed by delivery and lastly the usage of boiler water.

4.2 Monetary implication for both scenarios

Now, from the data gathered, we can recreate a monthly cost using the actual data for using CNG as a fuel. Using Hunkelers' theory as a guide, maintenance and labour are put into the calculation as well. The indirect cost calculated is using 1000 m^3 of boiler water as a functional unit and thus by adjusting it to the real value of boiler water used in a month (873 m^3) we can find the cost of both diesel and CNG system per month. Considering the life span of an Industrial boiler is 15 years, we can, therefore, calculate the net present value for the total cost of running the industrial boiler for 15 years. This can be computed by predicting the inflation rate by using the weighted average method based on monthly data for the past six years in Indonesia, which yield 3.25%.

Table 2. Total cost

Type of Cost	CNG (IDR)	Diesel (IDR)
Direct Material	427,036,029.00	689,186,679.00
Direct Labour Cost	1,673,500.00	1,673,500.00
Indirect Environmental Cost	3,877,305,199.83	1,645,731,193.82
Maintenance	516,666.67	516,666.67
Total Monthly Cost	4,306,531,395.50	2,337,108,039.49
Life Cycle Cost for 15 Years	777,375,864,172.34	421,874,978,911.84

4.3 Analysis of results

The final decision depends on which side the company decide to go: the economic decision or socially responsible decision. The economic decision would be on focusing the real direct cost the company are facing, in which CNG usage would be cheaper. The socially responsible decision, however, is to use diesel as the duel of choice as it was shown that using environmental costing, the net present value on Environmental LCC for diesel was cheaper compared to CNG.

From this study, it is preferable for the company to choose the more sustainable decision on using diesel as the environmental fallout of using diesel as the fuel could save an estimate of IDR 355,500,885,260.50 of fallout cost to the environment and society. Though not necessarily a direct cost the company have to pay, creating a Corporate Social Responsibility (CSR) would be beneficial for the company in the long run, especially when dealing with foreign countries with stricter

sustainability laws compared to Indonesia. This could be beneficial if Indonesia would take up pollution tax as this would mean a lower tax for the company and also less money spent on environmental and societal recovery from the fallout of environmental impact.
However, the company could choose to stay on using CNG as the preferred fuel as the company needs to deal with the the direct cost in the present as it is urgent. In this case, the company should seek a deal with CNG provider closer to the factory where this would lower transport environmental impact since transport was the most significant contributor in the CNG system. Other improvements could be using Euro6 or higher vehicles as a mode of transport as higher Euro graded trucks would have lower emissions than the currently Euro4 standard Indonesia is using. Last, the company might want to try connecting industrial pipes from the central gas distributor as this eliminates transport. During the writing of this study, there were plans from the distributor to invest in piping. This is highly recommended as no more transport could lower the environmental impact of the system and thus considerably lowers the environmental costing for the CNG system.

5. Conclusions

5.1 Conclusion

CNG gas usage at the boiler system causes a total monthly environmental cost and direct cost of IDR 4,306,531,395.50 with the total life-cycle cost for 15 years of IDR 777,375,864,172.34. This cost comes mostly from these three categories: Particulate Matter Formation; Fossil Depletion; and Climate Change. Upon further analysis, it was found that the process of transporting the CNG was the most significant contributor to environmental impacts.
Diesel theoretical calculations came up with a total monthly indirect environmental cost and direct cost of IDR 2,337,108,039.49 along with the additional investment of IDR1,500,000.00 for a diesel pump. The total life-cycle cost for 15 years was calculated to be IDR 421,874,978,911.84. This cost comes mostly from these three categories: Particulate Matter Formation; Human Toxicity; and Fossil Depletion. When analysed further, the process that contributed most to the impacts was found to be the combustion of diesel in the boiler.

5.2 Managerial implication

There are two options that the company can take: a realistic approach or a socially responsible approach. First, the realistic approach based on a realistic perspective, the company could decide to focus on the cheaper direct cost, which will be CNG. This is under the consideration the direct cost that the company had to pay while the indirect environmental cost is only 'theoretical' cost. If this is the case, then the company should also consider reducing environmental impact by looking for ways to reduce the impact of transport of CNG. They could look into better-standardised trucks, perhaps Euro6, as an alternative to standard Indonesia is using right now. The company should also look into the construction of CNG piping from the supplier, which could remove the necessity to transport CNG using trucks.
Second, the socially responsible approach: from the study conducted it is clear that the company should look into minimising the environmental impact by using diesel as the fuel of choice as the fuel could save an estimate of Rp355,500,885,260.50 of fallout cost to the environment and society. This will not only help the communities surrounding the plant but also in profiling the company's CSR as a responsible and committed company in conserving the earth for future generations.

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The integration of social responsibility into business operation: case study of indonesian manufacturing industry

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Abstract. Prior studies argue that CSR should be integrated with business operations to get its benefits. However, empirical research on how CSR and business operations can be incorporated is still limited. This study aims to investigate how to integrate CSR and business operations and to identify the impact of such integration on company performance. Using a sample of 342 manufacturing companies in Java, Indonesia, PLS-SEM was employed to create a path model depicting the relationships between functional integration and company performance. The results showed that Cost, Quality, Supplier, and Employee, have significant positive relationships on company performance, while Innovation and Customers have no impact on company performance.

1. Introduction

Corporate Social Responsibility (CSR) can be defined as "… a concept where-by companies integrate social and environmental concerns in their business operations and their interaction with their stakeholders on a voluntary basis" [1]. CSR is the most frequently used term to point out the correlation between companies and society [2] and has become a concern for all businesses [3]. Several prior studies emphasize the incorporation of CSR into business operation to improve organizational performance financially and non-financially. But, not many research works on how companies attempt to integrate CSR activities into their business [4]. There are still shortcomings of particular concepts, mechanisms for integration activities, and study on specific objectives in the field of social responsibility [5]. Empirical studies on the integration of corporate sustainability into strategic management are still needed [6] because it is still unclear how CSR and business operation can be integrated as well as how such integration between them can affect company performance. Therefore, this study aims to investigate how CSR and business operations are integrated and to examine which impacts of such integration on the organisational performance.

2. Theoretical Background

The development of CSR practices depends on how they are integrated into current business practices [7, 8] which enables the companies to achieve not only significant social advantages but also meaningful business-related benefits [9]. CSR implementation can involve a 'built-in' and 'bolt-on' approach. The former is strategic through incorporating socially responsible behaviours into companies' operations, processes, and decision-making. The latter is more potential by embracing

social activities that extend beyond current business operations [10]. The former should involve mainstream functions, e.g., production, logistics, and quality control [11].

Some researchers highlight the necessity of incorporating CSR actions into the core activity of the value chain [12, 13, 14]. Companies should consider the social issues connected to the company's core activities, both the primary and supporting activities as a part of the value chain which consists of suppliers, customers, and specific tools [14]. Thus, they can evaluate which need to be enhanced to broaden the social agreement [12]. Prior studies address on four competitive priorities among manufacturing companies: low cost, quality, delivery performance (speed and reliability), and manufacturing flexibility [15, 16]. Another essential dimension is innovation [17] as one of the main drivers in the strategic orientation of a company [18]. Human Resource Management is also crucial in the integration process [19] by providing employees with the willingness, training, and motivation, necessary to apply CSR actions and initiatives [20].

Stakeholder theory claims that organisations have obligations not only to shareholders but also to stakeholders as groups and individuals who can affect, or are affected by, the achievement of a company's mission [21]. As the integration of CSR into business operation need to count in the stakeholders' concerns and objectives in the long-term perspective [22, 23], this study uses stakeholder theory to examine stakeholders' relationship in the functional integration. Through functional integration, CSR activities are incorporated into the business operation so that the companies ensure that their actions benefit them economically and socially [24, 25]. Therefore, we suggest the hypothesis that the functional integration of CSR and business operation has a positive impact on company performance. Partial Least Square Structural Equation Modelling (PLS-SEM) was employed to predict and explain measured constructs [26] to verify the hypothesis.

3. Research Methodology

3.1 Sample and Sampling Process

This study was conducted in the manufacturing industry in Java, Indonesia, since approximately 2.8 million manufacturers (64.29%) are located in Java. Furthermore, Java contributes over 70% of Indonesian national GDP [27]. The samples were selected from eight industrial estates in Java: (1) Surabaya Industrial Estate Rungkut, (2) Sidoarjo Industrial Estate Berbek, (3) Kawasan Industri Gresik, (4) Pasuruan Industrial Estate Rembang, (5) Ngoro Industrial Park (Mojokerto), (6) Kawasan Industri Wijayakusuma (Semarang), (7) Jakarta Industrial Estate Pulogadung, and (8) Kawasan Industri Jababeka (West Java). This study employed the purposive sampling (non-probability sampling) as the samples were selected from the Manufacturing Industrial Directory 2017 and tenant list of the relevant industrial estates based on the conformity with the sample criteria [28].

3.2 Data Collection

A survey using questionnaires was employed from June to September 2018 and administered both mail, e-mail, and online, as self-completion methods [29]. The questionnaires were addressed to senior managers because of their comprehensive understanding of the company strategy and practices related to CSR, and, therefore, would be competent to fill in the questionnaire. From 1,055 questionnaires distributed, 505 questionnaires were returned. After data screening, 342 cases with the response rate of 32.42% fitted the sample criteria and were used for further analysis.

4. Findings and Discussion

4.1. The Profile of Respondents

Details on company characteristics are provided as in Table 1, signifying that the sample represents a variety of manufacturing companies. Most companies are manufacturers of food and beverage (21.1%). The majority of companies (84.8%) have more than 100 employees, and half of the companies have been set up and operating in the range of 21 and 50 years. A three-quarter (73.7%) of the companies have private ownership, and most of them (67.5%) is in East Java.

Table 1. Company profile.

Variable	Frequency (n=342)	Percentage (%)	Variable	Frequency (n=342)	Percentage (%)
Main product			Number of employees		
Food and beverage	72	21.1	20 - 99	52	15.2
Tobacco	5	1.5	>100	290	84.8
Textile	11	3.2	Company's age (years)		
Leather and footwear	6	1.8	< 5	16	4.7
Goods from wood, handicraft	4	1.2	5-10	32	9.4
Paper	13	3.8	11-20	56	16.4
Coke and refined petroleum products	3	0.9	21-50	184	53.8
Chemicals and chemical products	44	12.9	> 50	54	15.8
Pharmaceuticals and medicinal chemical	7	2.0	Company's ownership		
Rubber and plastic products	34	9.9	Multinational	81	23.7
Basic metals	6	1.8	State-ownership	9	2.6
Non-metallic mineral products	23	6.7	Private	252	73.7
Fabricated metal products	39	11.4	Company's location		
Automotive	23	6.7	East Java	231	67.5
Computers, electronic and optical products	10	2.9	Centre Java	18	5.3
Repair and installation of machinery and equipment	5	1.5	West Java & Jakarta	93	27.2
Furniture	11	3.2			
Machinery and electrical equipment	20	5.8			
Other manufacturing	6	1.8			

4.2. Structural Equation Modelling (SEM) Analysis

Figure 1 presents the model of functional integration and company performance involving six constructs of functional integration, i.e., Cost, Innovation, Quality, Supplier, Customer, and Employee. To provide an understanding of CSR impacts on the company performance [30], organisational performances are measured through four constructs: financial performance (CFP) in strategic level, operational performance (COP) and social performance in tactical and operational level, including customer performance (CCP) and employee performance (CEP) [31].

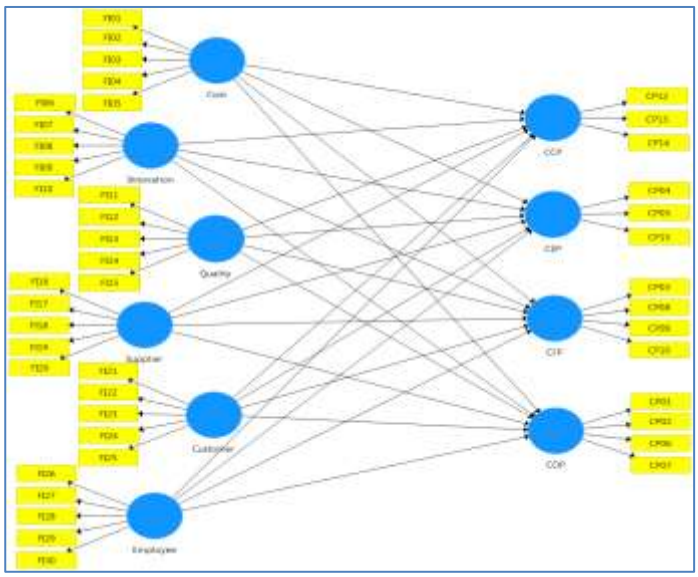


Figure 1. Model of Functional Integration and Company Performance.

Table 2. Indicators measurement.

Indicator	Loading	Indicator	Loading
FI01	0.771	FI23	0.830
FI02	0.766	FI24	0.731
FI03	0.804	FI25	0.818
FI04	0.805	FI26	0.811
FI05	0.781	FI27	0.860
FI06	0.721	FI28	0.787
FI07	0.851	FI29	0.877
FI08	0.848	FI30	0.818
FI09	0.789	CP12	0.873
FI10	0.776	CP13	0.860
FI11	0.810	CP14	0.842
FI12	0.832	CP04	0.848
FI13	0.845	CP05	0.886
FI14	0.814	CP15	0.835
FI15	0.834	CP03	0.786
FI16	0.756	CP08	0.855
FI17	0.754	CP09	0.891
FI18	0.844	CP10	0.773
FI19	0.767	CP01	0.759
FI20	0.791	CP02	0.821
FI21	0.810	CP06	0.812
FI22	0.795	CP07	0.827

4.2.1 Assessment of the Measurement Model. Table 2 displays the indicators measured using the 5-point scale from 1='strongly disagree' to 5='strongly agree'. In terms of company performance, subjective measures were used [32] by asking respondents to rate their company's performance relative to their competitors [33] over the most recent 3-year period using the 5-point scale from 1='much longer/much worse/much lower' to 5='much shorter/much better/much higher'. All of 44

indicators have loadings above 0.7 after eliminating two indicators of CCP and CEP with factor loadings below 0.7 [26]. As summarised in Table 3, all of ten constructs have Cronbach's alpha more than 0.8, composite reliability for all constructs is in the range of 0.89 and 0.92, exceeding the threshold value of 0.7 [28, 34], and AVE is greater than the threshold of 0.50. Results show that the heterotrait-monotrait ratio of correlations (HTMT) used to assess discriminant validity were significantly different from one [35] and below 0.90 [36]. Accordingly, internal consistency reliability, convergent validity, and discriminant validity have been established for the model.

Table 3. Constructs measurement

Construct	AVE	Cronbach's Alpha	Composite Reliability	R^2 value	Q^2 value
Cost	0.617	0.845	0.889		
Innovation	0.638	0.857	0.898		
Quality	0.684	0.885	0.915		
Supplier	0.613	0.842	0.888		
Customer	0.636	0.856	0.897		
Employee	0.691	0.888	0.918		
Customer Performance (CCP)	0.737	0.822	0.894	0.361	0.242
Employee Performance (CEP)	0.734	0.818	0.892	0.434	0.291
Financial Performance (CFP)	0.685	0.845	0.896	0.370	0.232
Operating Performance (COP)	0.648	0.819	0.880	0.389	0.230

4.2.2 Assessment of the Structural Model. The structural model assessment includes the collinearity, the significance, and relevance of the structural model relationship, the coefficient of determination (R^2), the effect size (f^2), and the predictive relevance (Q^2) [26]. The result shows that VIF values for all indicators are below 5, indicating no significant levels of collinearity detected among the indicators and the constructs [26]. Table 4 displays the path coefficient resulted from bootstrapping procedure with 5,000 boot-strap samples [26] at 500 observations in the original data with no sign changes option [37] with a significance level of 5% [34]. As shown in Table 4, 21 of 24 paths have a positive direct effect, and three of them show the negative direct effect. Eight positive direct effects are significant because their t-value are higher than the critical value at p-value 5%, this is, Cost → CCP, Cost → COP, Employee → CEP, Quality → CCP, Quality → CFP, Supplier → CCP, Supplier → CEP, and Supplier → CFP. Other three direct effects are significant at p-value 10%: Cost → CFP, Employee → CFP, and Quality → COP. Among the positive and significant paths, the most substantial direct effect is on Supplier → CEP (0.326), then Employee → CEP (0.291), and finally Cost → COP (0.269) as well as Quality → CCP (0.269). Based on those results, the hypothesis were accepted that the functional integration of CSR and business operation has positive and significant impacts on company performance. Table 3 exhibits that four constructs of company performance are weak to medium predictors with R^2 value from 0.361 to 0.434. Table 4 shows that six predictors have weak effect size (f^2) on company performance. As presented in Table 3, the Q^2 values are above 0, signifying that the exogenous constructs have excellent predictive relevance for all endogenous constructs [26].

Table 4. Path coefficient, T value, P value, and f^2 value.

Path	Path coefficient	T value	P value	f^2 value	Path	Path coefficient	T value	P value	f^2 value
Cost -> CCP	0.138	2.307	**0.021**	0.017	Innovation -> CCP	0.062	0.836	0.403	0.002
Cost -> CEP	0.093	1.422	0.155	0.009	Innovation -> CEP	-0.030	0.440	0.660	0.001
Cost -> CFP	0.121	1.831	0.067	0.014	Innovation -> CFP	0.102	1.438	0.150	0.006
Cost -> COP	0.269	4.225	**0.000**	0.069	Innovation -> COP	0.028	0.371	0.711	0.000
Customer -> CCP	0.030	0.390	0.697	0.000	Quality -> CCP	0.269	3.650	**0.000**	0.039
Customer -> CEP	-0.058	0.813	0.416	0.002	Quality -> CEP	0.134	1.552	0.121	0.011
Customer -> CFP	-0.073	0.923	0.356	0.003	Quality -> CFP	0.244	3.155	**0.002**	0.033
Customer -> COP	0.083	0.973	0.331	0.004	Quality -> COP	0.146	1.761	0.078	0.012
Employee -> CCP	0.033	0.374	0.709	0.001	Supplier -> CCP	0.179	2.151	**0.032**	0.018
Employee -> CEP	0.291	4.177	**0.000**	0.053	Supplier -> CEP	0.326	4.096	**0.000**	0.069
Employee -> CFP	0.155	1.945	0.052	0.013	Supplier -> CFP	0.169	2.165	**0.030**	0.017
Employee -> COP	0.103	1.231	0.218	0.006	Supplier -> COP	0.125	1.641	0.101	0.009

5. Conclusion

This study purposes to investigate how CSR and business operations are integrated and to examine the impacts of such integration on the company performance. The structural model assessment revealed that functional integration has significant positive results on company performance. Specifically, Cost has substantial impacts on the customer, operating, and financial performance, while Employee has effects employee and financial performance. Quality relates to the customer, operating, and financial performance significantly, and Supplier gives effects on the customer, employee, and financial performance. The findings from this study contribute to additional empirical evidence of the CSR integration and its impacts on company performance, particularly in the manufacturing industry.

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Solubility correlation of azobenzene derivatives in supercritical carbon dioxide: a short review

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Abstract. This short review highlights the solubility correlation of four azobenzene derivatives, which has similar chemical structures, available in the literature. At the same phase equilibrium (at the temperature of 353.15 K), the solubilities of four azobenzene derivatives in supercritical carbon dioxide followed in the order of Disperse Red 82 > Disperse Red 13 > Disperse Blue 79:1 > Disperse Red 1. Five different kinds of density based models were used to correlate the solubility data. Moreover, the solubilities of four azobenzene derivatives were also correlated thermodynamically by the model of the regular solution with the Flory–Huggins theory. It was found the Sung-Shim model (four parameters) has lowest a median AARD of 12.02 % of the solubility data over the entire conditions.

1. Introduction

Carbon dioxide has unique properties compared to other substances. It has unique properties of critical temperature (Tc = 304.15 K) and pressure (Pc = 7.383 MPa), respectively. Currently, in the textile industry, Supercritical carbon dioxide ($scCO_2$) dyeing process has been attention. This technology has many advantages compared to conventional dyeing technology because carbon dioxide is nontoxic, non-flammable, recyclable, dyestuffs can be reused, and no additional chemical is required in the process. In addition, consumption energy can be saved because unnecessary a drying process so dyeing time is short compared to the traditional dyeing technology. To the application and development of the Supercritical carbon dioxide ($scCO_2$) dyeing process require specific knowledge of the phase equilibrium between dyestuffs and the supercritical carbon dioxide as a solvent, and a number of authors have been discussed the dependence of solubility of dye in $scCO_2$ on both temperature and pressure, and have been presented in the literatures. Some investigators have found that the solubility of anthraquinones and azo derivatives are higher, static and dynamic methods have been used to measure the solubility of dyestuffs in supercritical carbon dioxide. We have measured and correlated the solubilities of anthraquinone derivatives in supercritical carbon containing the substituent groups —NO_2 , —OH, —NH_2 [1]-[4] because some of the dyestuffs used in dyeing processes are configurated by these functional groups. In this short review, we highlight the solubility correlation and investigated the effects of functional groups of four azobenzene derivatives, which has similar chemical structures that containing the substituent groups of —NO_2 available in the literature [5]- [6], namely, C.I. Disperse Red 1, C.I. Disperse Red 13, C.I. Disperse Red 82, and C.I. Disperse Blue 79:1. The solubility data obtained from the literature were correlated with the density based models, the Chrastil [7], the Sung–Shim [8], Bartle et al [9], Kumar-Johnston [10], and the Mendez-Santiago–Teja [11] models. Moreover, the solubilities of four azobenzene derivatives were also correlated thermodynamically by the model of regular solution with the Flory–Huggins theory [12].

2. Solubility of four azobenzene derivatives in supercritical carbon dioxide

In this study, we were used the solubility data available in the literature measured by Shinoda at al.[5] and Lin at al.[6]. Table 1 presents the Physical properties of C.I. Disperse Red 1, C.I. Disperse Red 13, C.I. Disperse Red 82, and C.I. Disperse Blue 79:1.

Table 1. The physical properties of C.I. Disperse Red 1 and C.I. Disperse Red 13, C.I. Disperse Red 82, and C.I. Disperse Blue 79:1.

	Red 1	*Red 13*	*Red 82*	*Blue 79:1*
CAS number	2872-52-8	3180-81-2	30124-94-8	3618-72-2
Mw	314.34	348.78	439.43	625.39
T_m / (K)	431.15[a]	406.15[a]	402.3[b]	422.15[c]
Δh_2^m / (kJ · mol^{-1})[d]	36.93	37.77	52.15	59.55
v_2^s / (m^3 · mol^{-1})[e]	$2.23 \cdot 10^{-4}$	$2.53 \cdot 10^{-4}$	$3.04 \cdot 10^{-4}$	$3.86 \cdot 10^{-4}$
T_c/ (K)[e]	946.28	951.96	901.49	952.37
P_c/ (MPa)[f]	2.025	1.924	1.3899	1.252
ω[f]	1.231	1.251	1.171	0.931

[a] Observed by Kozak et al.[13]
[b] Observed by Suesat et al. [14]
[c] Observed by Thiel et al.[15]
[d] Estimated by Jain et al. method [16]
[e] Estimated by Fedors method [17]
[f] Estimated by Edmister method [18]

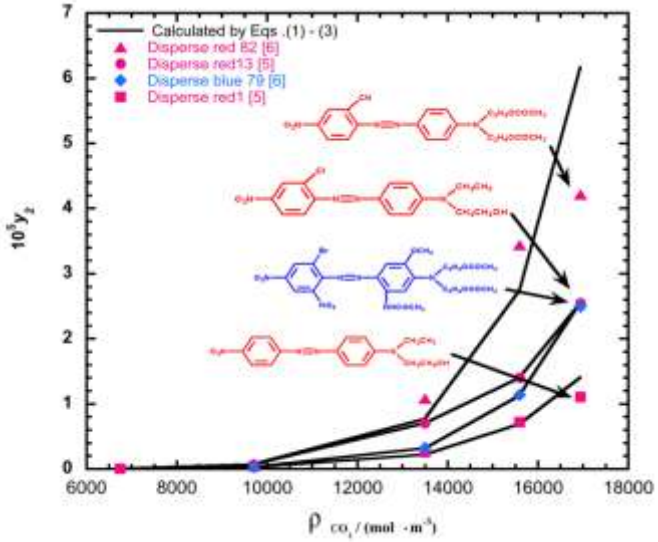


Figure 1. The solubility at temperature of 353.15 K of C.I. Disperse Red 82, C.I. Disperse Red 13, C.I. Disperse Blue 79:1, and C.I. Disperse Red 1 against density of CO_2 ρ /(mol·m^{-3}).

At the same equilibrium condition (the temperature of 353.15K) as shown in the figure 1. It found the C.I. Disperse Red 82 is the most soluble in the supercritical carbon dioxide over the entire pressure

range. The magnitudes of the solubilities of four azobenzene derivatives in supercritical carbon dioxide are in the order of Disperse Red 82 > Disperse Red 13 > Disperse Blue 79:1 > Disperse Red 1. the results showed that the additional —CN group on the Disperse Red 82 cause the solubility was much better in carbon dioxide than other structures. It was found that presence of —CN group significantly decreased the polarity of dye molecule so the solubility of dye was higher because supercritical carbon dioxide is nonpolar. In addition, the solubility of azobenzene derivatives in supercritical carbon dioxide were independent of the molecular weight as shown in the table 1, the molecular weight of Disperse Red 82 (439.43) was larger than that of Disperse red 13 (348.78).

3. Correlations

The solubility data obtained from literature were correlated using several types of semi-empirical equations, expressed in terms of pressure, temperature, and density of CO_2, proposed previously by the Chrastil [7], the Sung–Shim [8], Bartle et al. [9], Kumar-Johnston [10], and the Mendez-Santiago–Teja [11]. These equations have three or more parameters to be adjusted to the solubility values. Table 2 summarizes the density-based models and equations used. Figure 3 summarizes the average absolute relative deviation (*AARD*) for four azobenzene derivatives. It was found Sung-Shim model has lower average absolute relative deviation (*AARD*) than that of other models as illustrated in the figures 2-3. However, the correlation of Mendez-Santiago–Teja obtained the higher average absolute relative deviation (*AARD*), about 40 %. Table 3 shows the parameters of the Azobenzene derivatives system used and average absolute relative deviation (*AARD*) between the solubility data and calculated values. Furthermore, by assuming that no considerable solubility of the sc-CO_2 in the solid phase, the solubility of four azobenzene derivatives correlated by the thermodynamic model of solid-liquid equilibria. A detailed explanation of the calculation procedure of the thermodynamic criteria has been reported elsewhere [1]-[4]. We briefly explain the calculation procedure in this study. We used the regular solution model combined with the Flory – Huggins equation [2],[12]:

$$ln\, y_2 = \frac{\Delta h_2^m}{RT}\left(\frac{T}{T_m} - 1\right) - \frac{v_2}{RT}(\delta_1 - \delta_2)^2 - ln\left(\frac{v_2}{v_1}\right) - 1 + \frac{v_2}{v_1} \quad (1)$$

where T_m and Δh_2^m are the melting temperature and melting enthalpy of solid solute, respectively. The v_1 and v_2 are the molar volume of sc-CO_2 and solid solute. The solubility parameters of sc-CO_2 were calculated by the method of Giddings et al.[19]

$$\delta_1/(MPa)^{0.5} = 8.0325(Pc/MPa)^{0.5}\left(\frac{\rho_R}{2.66}\right) \quad (2)$$

The ρ_R (= ρ /ρ_c) is the reduced CO_2 density, ρ_c the critical density, and P_c is the critical pressure of CO_2. The solute solubility parameter was assumed to be dependent on CO_2 density, so can be expressed as:

$$\delta_2 = a + b\rho_{CO_2} \quad (3)$$

The average absolute relative deviation (AARD %) for the systems of N_D data points in this study can be calculated by:

$$AARD(\%) = \frac{100}{N_D}\sum_{n=1}^{N_D}\left|\frac{y_{2,n}^{exp} - y_{2,n}^{cal}}{y_{2,n}^{exp}}\right| \quad (4)$$

\

Table 2. Density-based models and equations used.

Models	Equations	Ref.
Mendez-Santiago – Teja	$\boldsymbol{T\ ln\ (y_2 P) = A + B\rho + CT}$	[11]
Chrastil	$\boldsymbol{ln\ y_2 = A + \frac{B}{T} + C\ ln\ \rho}$	[7]
Bartle et al.	$\boldsymbol{ln\left(\frac{y_2 P}{P_{ref}}\right) = A + B(\rho - \rho_{ref}) + \frac{C}{T}}$	[9]
	$\boldsymbol{ln\ y_2 = A + \frac{B}{T} + C\ \rho}$	[10]
Sung – Shim	$\boldsymbol{ln\ y_2 = A + \frac{B}{T} + \left(C + \frac{D}{T}\right) ln\ \rho}$	[8]

Table 3. Parameters of the Azobenzene derivatives system used and average absolute relative deviation (*AARD*) between the solubility data and calculated values.

System	Parameters				*AARD* /(%)
	A	*B*	*C*	*D*	
			Chrastil		
C.I. Disperse Red 1 + CO_2	-43.323	-9437.5	6.0339		20.09
C.I. Disperse Red 13 + CO_2	-46.76	-8203.7	6.1067		19.58
C.I. Disperse Red 82 + CO_2	-68.912	-4359.3	7.3209		18.06
C.I. Disperse Blue 79:1 + CO_2	-65.355	-5337.1	7.1501		13.38
			Mendez-Santiago – Teja		
C.I. Disperse Red 1 + CO_2	-14443	0.24584	35.114		59.96
C.I. Disperse Red 13 + CO_2	-13281	0.24884	32.454		54.92
C.I. Disperse Red 82 + CO_2	-9488.4	0.28638	20.967		33.19
C.I. Disperse Blue 79:1 + CO_2	-10457	0.28262	23.024		22.52
			Bartle et al.		
C.I. Disperse Red 1 + CO_2	26.167	-11391	0.015806		41.94
C.I. Disperse Red 13 + CO_2	23.501	-10179	0.015994		38.89
C.I. Disperse Red 82 + CO_2	12.409	-6016.3	0.017429		29.02
C.I. Disperse Blue 79:1 + CO_2	14.517	-7063.3	0.017204		14.19
			Kumar – Johnston		
C.I. Disperse Red 1 + CO_2	7.1483	-10008	0.00060037		40.71
C.I. Disperse Red 13 + CO_2	4.3513	-8796.7	0.00060866		39.19
C.I. Disperse Red 82 + CO_2	-7.4703	-4740.8	0.00067208		30.14
C.I. Disperse Blue 79:1 + CO_2	-5.2058	-5787.8	0.0006622		13.39
			Sung – Shim		
C.I. Disperse Red 1 + CO_2	21.718	-32853	-0.89301	2489.4	12.98
C.I. Disperse Red 13 + CO_2	26.789	-34682	-1.7264	2815.1	8.86
C.I. Disperse Red 82 + CO_2	19.446	-37588	-2.1001	3540.7	15.05
C.I. Disperse Blue 79:1 + CO_2	-10.905	-25814	1.3445	2181.9	11.20

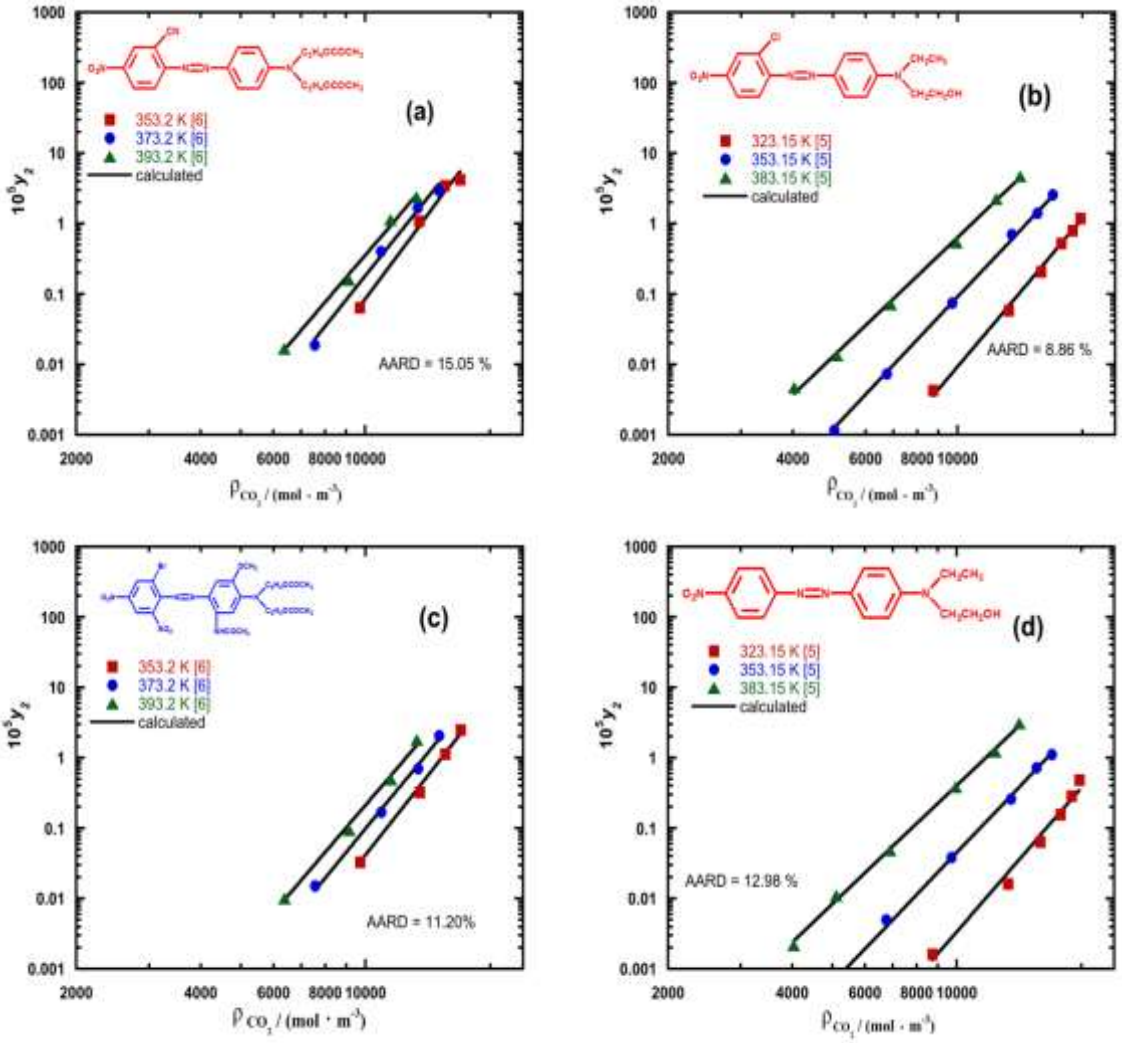


Figure 2. Plot of mole fraction $10^5 y_2$ against density of ρ CO_2 /(mol·m^{-3}) to correlate results for C.I. Disperse Red 82 (a), C.I. Disperse Red 13 (b), C.I. Disperse Blue 79:1 (c), and C.I. Disperse Red 1 (d) from Sung-Shim model

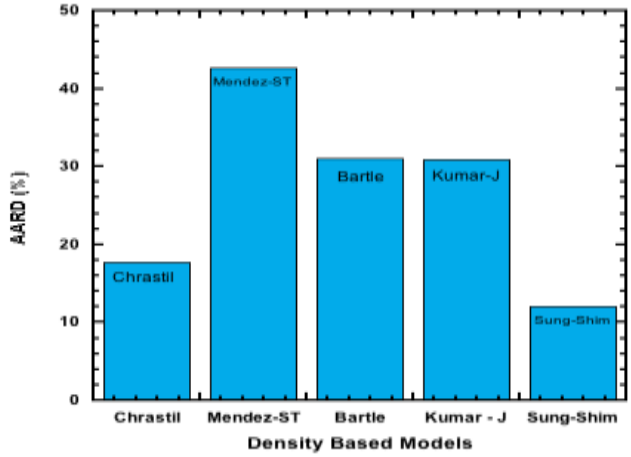


Figure 3. summarizes the average absolute relative deviation (*AARD*) for four azobenzene derivatives.

4. Conclusions

The solubility correlation of four azobenzene derivatives, which has similar chemical structures taken from available literature has been studied. At the same phase equilibrium (at the temperature of 353.15 K), the solubilities of four azobenzene derivatives in supercritical carbon dioxide followed in the order of Disperse Red 82 > Disperse Red 13 > Disperse Blue 79:1 > Disperse Red 1. Five different kinds of density based models were used to correlate the solubility data. Moreover, the solubilities of four azobenzene derivatives were also correlated thermodynamically by the model of the regular solution with the Flory–Huggins theory. It found the Sung-Shim model (four parameters) has lowest a median AARD of 12.02 % of the solubility data over the entire conditions.

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Xylanase production from combined *reutealis trisperma* with potato dextrose broth by *tricodherma reesei*: effect of pretreatment

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Abstract. Xylanase is an important enzyme in pulp and paper, food, feed, and textile industries. It is produced by fermentation process with *Tricodherma reesei* as fungi, which grows on several carbon sources such as cellulose and xylan. *Reutealis trisperma* (kemiri sunan) have been used for biodiesel production after being mechanically pressed. The solid waste, which is called *Reutealis trisperma* cake (RTC) contains carbon and nitrogen sources which are valuable to be used for xylanase production by *T. reesei*. Shake flask systems were used to grow *T. reesei* in medium consists of RTC and Potato Dextrose Broth (PDB). The systems were maintained at 28^{o}C, 200 rpm at initial pH of 6.0 for 84 hours. Two forms RTC used in this study were natural and alkaline pretreated. The RTC fermentations were performed for different concentration of PDB (15g/L and 20 g/L) and also for different concentration of RTC (13.33 g/L; 16.67 g/L and 20 g/L). Pretreated systems gave better yield of xylanase production compare to natural systems. Higher concentration of PDB for pretreated system was found to yield lower xylanase production. The highest xylanase activity (198.1 U/mL) was obtained in media containing 15 g/L PDB and 20 g/L pretreated RTC.

1. Introduction

Reutealis trisperma known as "Kemiri Sunan" is a shady tree which is often found in East and West Java. The seeds have been used for biodiesel production after being mechanically pressed to get non-edible oil [1]. The cake called *Reutealis trisperma* cake (RTC) consists of protein, carbohydrate (sugar), fat, moisture, ash, and others (Table 1). Since its protein and sugar content is quite high, we tried to use RTC as nitrogen and carbon sources in a media for *Trichoderma reesei* to produce xylanase. Xylan is a hemicellulose which is normally found in rice plant, wheat, and many other plants. Xylanase is an enzyme produced by fermentation process with liquid culture and has been used as pre-bleaching of kraft pulp to minimize use of harsh chemicals in the subsequent treatment stages of kraft pulp, to improve the ability for feed meal to be easily digested, modified agent for cereal based food, to covert lignocellulose and agricultural waste to fermented products [2][3][4]. Recently, the conversion of lignocellulosic agricultural waste to useful products has been very attractive. Agricultural wastes such as banana peels, rice straw, sugarcane bagasse, wheat bran and soybean hulls have been used as the substrate for xylanase enzyme production [5]. There is no study of using *Reutealis trisperma* pressed cake in xylanase production, hence our study gives new insight of using the cake in xylanase production. Since there is no xylanase yet produced in the country, xylanase is imported for domestic demand. The use of xylanase in pulp bleaching process reduces up to 30 % of chlorine used in the pulp bleaching, leading to 15-20% reduction of chlorine release in the effluent [6]. *Trichoderma reesei* is a mesophilic filamentous fungus which is used at industrial scale for the

production of enzymes hydrolyzing biomass such as cellulase and xylanase since it easily grows and well adapted at several substrates in fermentor cultivation condition [7]. *Trichoderma reesei* has two specific gen (*xyn1* and *xyn2*) that specific for xylan degradation and produce endo-β-1,4-xylanases from simple carbon source (xylan) [8][9]. Other fungi, *Aspergillus niger* is also known to produce some enzymes, such as carbohydrases and protease using biomass [10]. Fungal culture for enzyme production is affected from differences in nutrient composition. Fungal cultivation on pre-treated corn stover has been reported to perform better in enzyme production [11]. Thus, we used RTC in natural and pretreated forms. Both natural and pretreated RTC are used as additional carbon and nitrogen sources for Potato Dextrose Broth (PDB) in a growth media for *T. reesei* to produce xylanase. This research aims to study xylanase production by *T. reesei* using RTC and PDB and to compare xylanase activity in media contains several concentrations of PDB and pretreated RTC.

2. Materials and methods

2.1. Cake preparation

Reutealis trisperma cake (RTC) used in this research was obtained from Energi Baru Santosa Company, Gresik. Table 1 shows reported compositions of this material [12].

Table 1. Characteristic of RTC

	Content (%w/w)
Protein	34.03
Moisture	6.32
Carbohydrate	18.56
Fat	29.5
Ash	7.76
Others	3.83

Ground RTC (40 mesh) was heated in oven at 50^{o}C. The dried ground RTC is a natural RTC (NRTC), the pretreated RTC was subjected to alkaline solution pretreatment (Alk-RTC). For alkaline pretreatment, RTC was mixed with 0.6% (w/v) aqueous sodium hydroxide (NaOH) with 1: 30 (w/v) solid-liquids ratio. The mixture was heated at 50^{o}C and agitated at 160 rpm for 25 minutes. Finally, The Alk-RTC was washed and dried at 50^{o}C overnight until it reached constant weight. All chemicals used were analytical grade and purchased from Merck.

2.2. Media

Two different media was used in the experiment, Natural RTC (NRTC) with PDB and alkaline pretreated RTC (Alk-RTC) with PDB. Generally, a 24 g/L PBD was used to cultivate *T. reesei*. The sugar content in RTC (Table1) was used as basic calculation to calculate the combined use of RTC and PDB to be equivalent with 24 g/L PDB. A 20 g/L RTC which consists of 3.7 g/L sugar and 20 g/L PDB will give the sugar content equivalent to 24 g/L PDB. We started with 20 g/L RTC and 15 g/L PDB used in the initial experiment, the composition of PDB and RTC both Alk-treated and natural (untreated) were varied by scaling down 17-20% the amount of pressed cake to optimize media used for the systems. Both NRTC and Alk-RTC without PDB were used as control since we would like to investigate the effect of pressed cake for enzyme induction potential in shake flask systems. PDB was purchased from Sigma Aldrich. All media were adjusted to pH 6.0 prior to autoclave (TOMY,ES-315, Japan) sterilization at 121^{o}C for 15 minutes.

2.3. Culture conditions

Tricoderma reesei was obtained from Gadjah Mada University and stored on Potato Dextrose Agar (PDA) at 4^{o}C and subcultured monthly. *T. reesei* were inoculated into 20 mL culture bottle that contain Potato Dextrose Broth (PDB) for 3 days at 28^{o}C as pre-culture. After 3 days, pre-culture was added into shake flask systems which consisted of media that contained RTC and PDB at various

compositions. Culture was incubated for 84 hours in an orbital shaker operating at 200 rpm for 28°C with initial pH of 6.0. Daily samples were removed aseptically in a laminar flow hood for measurement of pH and enzyme activity. Sample was separated between the solid state and supernatant using centrifuge at 10,000 rpm for 10 minutes and clear supernatant was collected and used for enzyme assay. The analyses were done in duplicate and the mean value presented.

2.4. Enzyme assay

Xylanase activity was determined by a modified method from Bailey [13]. The method was best applied to properly diluted samples with xylanase activities in the range of 0.5-2 U/mL. A 1 wt% beechwood xylan (Sigma Aldrich, St. Louis, MO) was prepared in 200 mL 0.05 M sodium citrate buffer (pH 5.3). A 100 ⌈L enzyme broth was added to 25 mL test tube and then followed by 900 ⌈L of suspended xylan in buffer. For blanks, only suspended xylan was added to the test tube. The samples and blanks were incubated at 50°C for 5 minutes in a water bath. After 5 minutes, a 3 mL DNS reagent was added to the test tubes to terminate the enzyme reaction. A 100 µL enzyme-containing sample was added to the corresponding blank. The samples and blanks were boiled for 10 minutes to develop color and added with distilled water up to 25 mL. The absorbance values were measured using UV-Vis Spectrophotometer (Hewlett Packard 8453) at 560 nm. Xylanase activity is measured based on xylose release, which can be represented by following equation:

$$\boldsymbol{Xylanase}\left(\frac{\boldsymbol{U}}{\boldsymbol{mL}}\right)=\frac{\boldsymbol{xylose\ released(mg)}}{\boldsymbol{(5\ mins)(0.1\ mL\ enzyme\ sample)}}\times\frac{\boldsymbol{1\ mmol}}{\boldsymbol{150.13\ mg}}\times\frac{\boldsymbol{1000\ \mu mol}}{\boldsymbol{1\ mmol}}$$

$$=\boldsymbol{13.32\times xylose\ released\ (mg)} \quad (1)$$

3. Results and discussion

In this research, we used RTC as additional substrate to grow *Trichoderma reesei* for xylanase production. The variables used in this research both for NRTC and Alk-RTC were 13.33 g/L, 16.67 g/L and 20 g/L. The PDB concentrations were 15 g/L and 20 g/L.

3.1. Effect of natural and pretreated RTC on xylanase production

There were two systems used in the experiment, both NRTC with PDB and Alk-RTC with PDB. The PDB used was 15 g/L. The initial pH used for this study was 6.0. The xylanase activity profiles for all systems can be seen in Figure 1. The Alk-RTC gave higher production of xylanase compare to NRTC. The better performance of Alk-RTC in xylanase production may due to better access to protein in the cake since the alkaline treatment opens the cellulose structure for cell metabolism [14]. Higher concentration of Alk- RTC gave better xylanase activity during the fermentation period since the protein and carbon sources are available enough for cell to induce xylanase production. The NRTC system shows that higher concentration of NRTC resulted in lower xylanase activity which implied that NRTC prevented access to the protein for cell metabolism. With the exception of 20 g/L of pretreated RTC, most of the optimum production of xylanse occurred at second day. Though, it is a delay of optimum xylanase production on 20 g/L pretreated RTC, the xylanase produced in the system was higher than other pretreated RTC concentration which is due to more nitrogen and carbon sources in the pressed cake. After achieving the optimum production, the xylanase activity decreased which may be due to its interaction with other component in media which is known as fermentation product [15]. The decrease of xylanase activity can be indicated by significantly decrease of pH as shown in Figure 2.

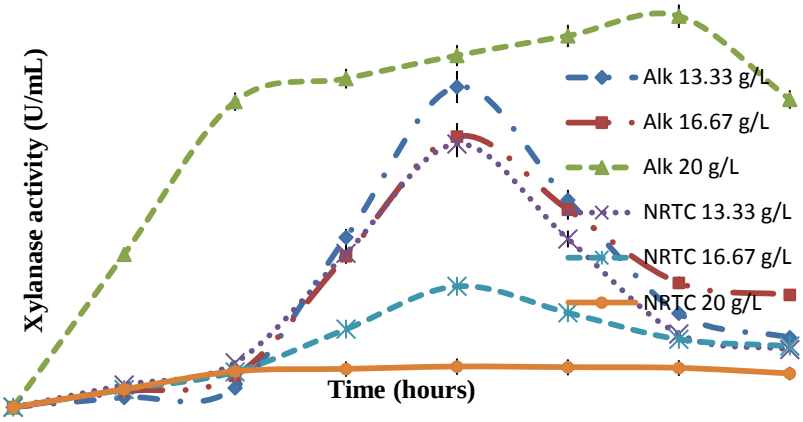


Figure 1. Profiles on xylanase activity for RTC in different concentration of RTC and 15 g/L PDB.

Table 2. Maximum xylanase activity at different concentration of RTC with 15 g/L PDB

RTC (g/L)	Xylanase activity (U/mL)	
	NRTC	Alk-RTC
13.33	133.378	162.28
16.67	61.262	137.12
20	20.534	198.13

Table 2 shows the maximum xylanase activity at different concentration of natural and pretreated RTC. It is clear that pretreated RTC gave a better xylanse activity compare to natural RTC. Natural RTC consists of lignin and cellulose which may hinder *T. reesei* to use the carbon and nitrogen sources in RTC. Having said that, the lower concentration of NRTC used in the production of xylanase may less inhibit xylanase induction, hence higher xylanase activity was found in the lower concentration of NRTC. However, in Alk-RTC (16.67 g/L and 20 g/L) the production of xylanase is 2 fold and approximately 10 fold compare to the same composition used of NRTC, which suggests adequate accessibility of the RTC's proteins and carbon sources to fungus. Other study reported the effect of natural and pretreated soybean hull in a fermentation process to produce xylanase enzyme showed that the enzyme production was largely unaffected by the presence of pretreated biomass or natural biomass [16].

3.2. Effect of alkaline-pretreated RTC and PDB concentrations in xylanase activity

Based on data from Table 2, we used 2 concentrations of Alk-RTC (13.33 g/L and 20 g/L) to compare the xylanse activity at different concentration of PDB (15 g/L and 20 g/L).

Table 3. Summary of evaluated fermentation system at different concentration alkaline pretreated (Alk) RTC and PDB

system	Carbon and nitrogen sources	Initial pH	Maximum xylanase activity (U/mL)
1	Alk 13.33 g/L , PDB 15 g/L	6.0	162.28 ± 0.97
2	Alk 20g/L , PDB 15 g/L	6.0	198.13 ± 0.03
3	Alk 13.33 g/L , PDB 20 g/L	6.0	151.19 ± 0.72
4	Alk 20g/L , PDB 20 g/L	6.0	157.93 ± 0.17
5	Alk 20 g/L as control	6.0	13.5 ± 5.1
6	NRTC 20 g/L as control	6.0	8.7 ± 0.64

Table 3 shows the best xylanase activity was achieved in a system with 20g/L Alk-RTC and 15 g/L PDB. Natural RTC and alkaline pretreated RTC were used as control. As has been mentioned in the above explanation, higher concentration pretreated RTC in systems with 15 g/L PDB will give higher xylanase activity. It seems that the lignin content in the cake has been degraded by alkali treatment, hence it give access for the cell to induce xylan. On the other hand, higher PDB concentration for both 13.33 g/L and 20 g/L of Alk- RTC gave similar maximum xylanase activities which were noted in system 3 and 4. The excess of PDB may hinder the production of xylanase which may be due to substrate inhibition. The data shows that natural RTC and pretreated RTC were able to induce xylanase production though the activity was low. The pretreated RTC gave better xylanase activity than natural RTC. It shows that alkaline pretreatment for RTC can give access for cell metabolism since the structure of lignin has been broken by the pretreatment process. There was more than 10 fold higher of xylanase activity in media using both Alk and PDB compare to Alk as control. It shows that carbon source in PDB enhanced the production of xylanase compare to Alk itself. Previous studies on xylanase production using *Trichoderma reesei* were conduct at various substrates. Xiong et al, have studied xylanase production by *T. reesei* RUT-30 which were grown at different pH medium with lactose as the main carbon source. The result showed highest xylanase activity (approximately 94.7± 4.8IU/mL) was achieved at pH 6 after 5 days of fermentation. Our result showed that Alk- RTC (20 g/L) combine with PDB (15 g/L) produced higher xylanase activity (approximately 198.13± 0.03 U/mL) compared to Xiong et.al [17].

3.3. pH profiles during fermentation process

The measurement of pH during fermentation process was obtained to indicate the growth of *Trichoderma reesei* which relates to the induction of xylanase. The decrease of pH means that *T. reesei* takes the TCA cycle to produce organic acid such as citric, oxalic and acetic acid [18]. However, the increase of pH shows that *T. reesei* takes protein to support its growth which may not go to TCA cycle which will end up with a little production of xylanase. The pH profile during fermentation process for alkaline-pretreated (Alk) RTC at various concentrations of RTC and PDB are shown in Figure 2.

(a) (b)

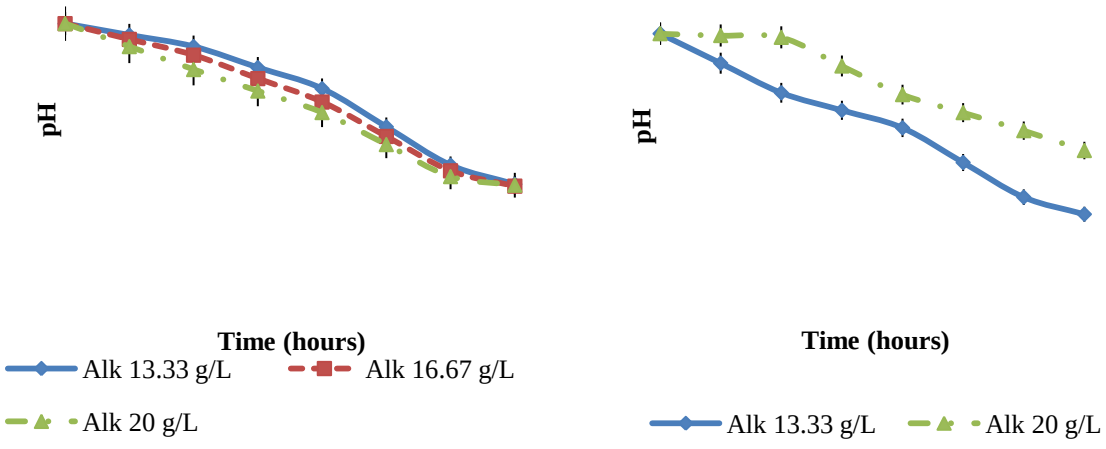


Figure 2. Profiles of pH during fermentation process for alkaline-pretreated (Alk) RTC at various concentration of RTC and PDB concentration (a) 15 g/L (b) 20 g/L

The initial pH used in this research was 6, this pH was taken regarding with previous research from Bailey et al. They found that the highest value of xylanase production was achieved when initial pH for fermentation in the pH range 6-7 [19]. From Figure 2, it can be seen that pH decreased during

fermentation process. It means that *T. reesei* grows through carbohydrate metabolism pathway TCA cycle. It produced organic acid, especially citric acid as their final product that slowly decreased pH in the reactor along with the time of fermentation [20]. Most of maximum xylanase activities were always achieved on 48 hours of fermentation (pH 5- 5.5). The xylanase production decreased significantly at pH below 4.5 after 72 hours of fermentation as can be seen in Figure 1 and Figure 2.

4. Conclusions

Shake flasks systems indicated that *Reutealis trisperma* cake (RTC) can be used as additional carbon and nitrogen sources for xylanase production. Pretreated RTC has been proved to give higher xylanase activity compare to natural RTC both in PDB 15 g/L. The maximum xylanase activity was performed at the system with 20 g/L pretreated RTC and 15 g/L PDB which was 198.13 ± 0.03 U/mL. The fungi were able to use RTC to induce xylan for xylanase production. The pH profile during the fermentation decreased along with the time of fermentation which presumably indicated the production of organic acid during *Trichoderma reesei* growth.

Acknowledgment

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Analysis of the potential of solar panel implementation towards green affordable housing development

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Abstract. Affordable housing is often associated with low-cost housing that pays lack of attention to the principle of green housing. It is due to having limited price which meet the decree of Minister of Public Works and Public Housing No.552/KPTS/M/2016. However, the application of solar panels in the affordable housing has potential of cost efficiency by replacing the cost of monthly electricity payment with the initial investment and maintenance cost of a solar panel network in the housing. The potential of electricity power in Parung Panjang housing is calculated by applying spatial analysis using GIS. Parung Panjang housing has the total area of 214,1 hectares. The results of spatial analysis showed that the potential of roofs that can be used for solar panel installation is 44,6 hectares. By managing that area and electricity payments, the potential for solar cost of energy is 929.14 IDR/kWh. It is lower than the cost of energy from State Electricity Company of 1,352 IDR/kWh. Besides, the implementation of solar energy in large residential area is more efficient than in a single house and small area.

1. Introduction

Indonesia is a tropical country which located around the equator line. Hence, Indonesia has a huge potential of renewable resources, yet it is still undeveloped, especially for solar renewable resource [4]. In fact, Indonesia is still less in utilizing renewable energy, where 96% of energy is from fossil fuel (18% gas, 30% coal, and 48% fuel) and only about 4% of energy is from renewable energy [2]. In this day, Indonesia has installed solar energy with capacity of 14,0 MWp. In the 2006 president decree, it is stated that Indonesia is planning to have 80 MWp by 2025 [1]. Therefore, this country needs to do a lot of researches about solar energy and implement the result soon. There were some researchers who have done researches that gave information about potential or implementation of solar renewable energy in various locations in Indonesia, for example; photovoltaic for hotels in Nusa Lembongan [3], solar panel in Haluoleo University [5], photovoltaic panel in Medan [6], and solar panel for households in Surabaya [8]. The previous research showed that the implementation of solar panel will provide long-term benefit in single building or small area [10]. This research will focus on the implementation of solar panel in a large residential area.

Perumnas Parung Panjang is a subsidized housing, where the middle-low resident class settled in this area must have a good level of resilience in their electricity needs and implement solar panel for renewable energy that will be profitable in the long term [3]. This research showed the potential of solar panel implementation in large affordable housing area to support green concept in housing. In

addition, if this research hypothesis is proven, that energy cost from sunlight is lower than energy cost from State Electricity Company, then the application of solar energy as a source of electricity will for sure help the middle-low resident to increase their economic level in the future.

2. Method

2.1 Study Area

The study area, especially Perumnas Parung Panjang Housing is located in Tangerang, West Java, Indonesia. It is located at 6.345879 ˚S, 106.569354 ˚E coordinates. The area is about 214 hectares, and it has around 6.000 households. The map of study area is shown in figure 1.



Figure 1. Study Area of Perumnas Parung Panjang.

2.2 Data Collection

The data consists of roof area and Global Horizontal Irradiation. The roof area data is obtained by digitalized used of Geographic Information System (GIS) from ArcMap 10.1, while Google earth image is used as the base-map of the digitalization. (figure 2). The Global Horizontal Irradiation data [7] (figure 3) and Photovoltaic Power Potential data (figure 4) are obtained from Solargis data.



Figure 2. Roof Area of Parung Panjang Housing.

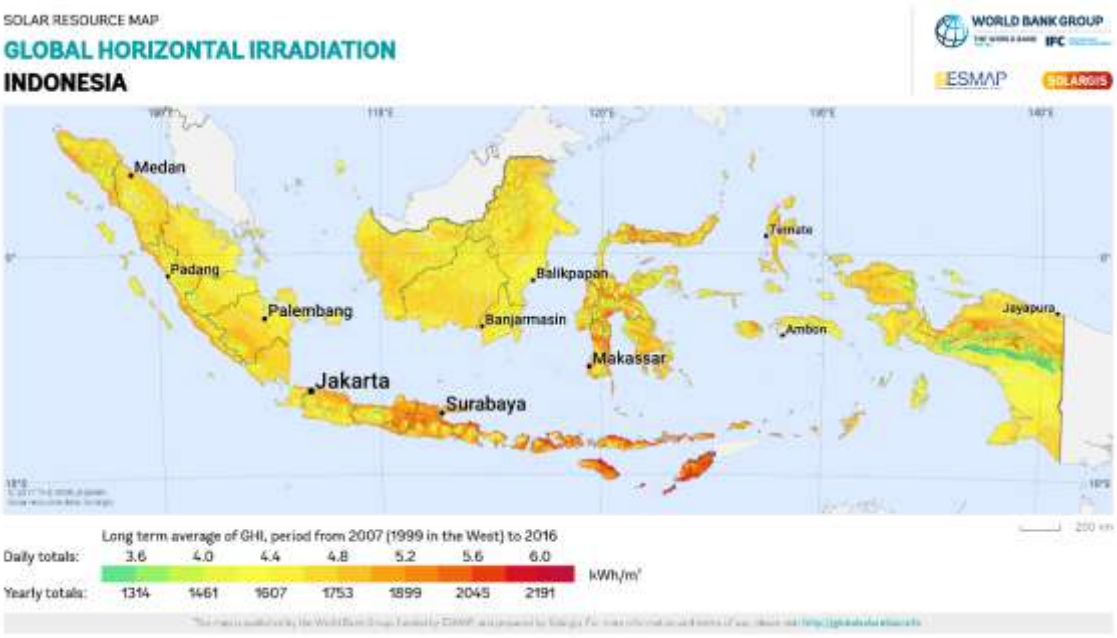


Figure 3. Global Horizontal Irradiation (GHI) of Indonesia.

2.3 Assesment of Solar Panel Potential in Housing

The research methodology for assessment of solar panel potential in housing is presented in figure 5.

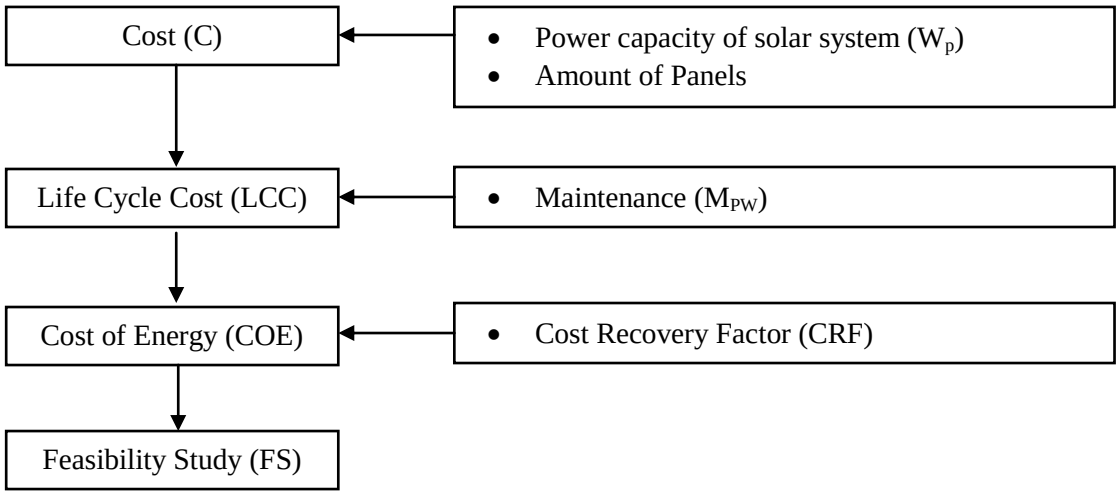


Figure 4. Flow Chart of Research Methodology.

3. Result and Discussion

3.1 Potential of Energy and Estimation of Cost

3.1.1 Power Capacity of Solar System. The power capacity of solar electricity system (W_p) is calculated by using the equation below. The area of PV panel array in Perumnas Parung Panjang housing is 446,224 m^2. η_{pv} is the PV panel array efficiency = 12%, Peak Sun Insulation (PSI) = 1,000 W/m^2 from figure 3 [7].

$$W_p = \text{Panel area} \times PSI \times \eta_{pv} = 446{,}224 \times 1000 \times 0.12 = 53{,}546{,}880\ W_p$$

The solar panel that will be used is BP3150M. This panel can produces 150 W_p.

$$53{,}546{,}880 / 150 = 356{,}979.2 \approx 356.980 \text{ panels}$$

Cost of solar panel (C) in housing is 1.11 USD every 5 – 10 W_p [9], but for this equation, 10W_p is used, which include sun panel, inverter, and balance of system.

$$C = W_p \times \text{Cost}/W_p = 53{,}546{,}880 \times 1.11 / 10 = 5{,}943{,}703.68 \text{ USD} \approx 80{,}239{,}999{,}680 \text{ IDR}$$

3.1.2 Life Cycle Cost. The Life Cycle Cost (LCC) is influenced by the long term cost of maintenance (M_{PW}) and cost of total initial investment (C). The investment is 8,023,999,968 IDR and the cost of maintenance per year is assumed at 1%. The discount rate (DR) is 11% and the expected development of life project is 25 years.

$$M_{PW} = \text{Inv}\ \frac{(1+DR)^T - 1}{DR(1+DR)^T}$$

$$M_{PW} = 802{,}399{,}997\ \frac{(1+0.11)^{25} - 1}{0.11(1+0.11)^{25}} = 6{,}557{,}607{,}892 \text{ IDR}$$

$$LCC = C + M_{PW} = 80{,}239{,}999{,}680 + 6{,}557{,}607{,}892 = 86{,}997{,}607{,}572 \text{ IDR}$$

3.1.3 Cost of Energy. Cost of Energy (COE) of solar electricity system is based on the Cost Recovery Factor (CRF), LCC and the annual energy production.

$$\mathbf{CRF} = \frac{DR(1+DR)^T}{(1+DR)^T - 1} = 0.1187$$

Cost of Energy (COE) is calculated by using the equation below, where the production of solar panel is 5 kWp.

$$\mathbf{COE} = \frac{LCC \times CRF}{annual\ kWh} = 929.14 \text{ IDR/kWh}$$

3.2 Economical Comparison

Cost of Energy (COE) estimation from State Electricity Company (Perusahaan Listrik Negara, PLN) is 1,352 IDR/kWh per March 2019. The projection of the equation showed that the COE of solar panel in Parung Panjang will be equal with COE of PLN if the project is developed in 9.275 years or 9 years 4 months based on table 1.

Table 1. Estimation cost of energy in year.

Year	Investment	LCC	CRF	COE
25	80,239,999,680	86,997,607,572	0.1187	929.14
20	80,239,999,680	86,629,774,136	0.1256	978.48
10	80,239,999,680	84,965,519,427	0.1698	1,297.66
9	80,239,999,680	84,682,926,602	0.1806	1,375.61
9.275	80,239,999,680	84,763,602,024	0.1774	1,352.36
8	80,239,999,680	84,369,248,567	0.1943	1,474.62

The results of this research provide information that the implementation of solar panels on a large residential area will give benefits, and it is in line with previous research on single building or small area [3,4,5]. However, the benefits of implementation of solar panels in large area are greater than on single building or cluster. In single building or small area, the COE of solar panel is always higher than COE of PLN, while in the large area, the COE of solar panel is less than COE of PLN. Thus, it will be more efficient to implement the solar panels in large area based on Table 2 [3,4,5,8].

Table 2. Comparison of COE of solar panels in various regions and scales in Indonesia.

Location	Scale	COE	Duration
Haluoleo University, Southeast Sulawesi	Campus area	0.3 USD/kWh x 14.495 = 4,348.5 IDR/kWh	25 years
Medan, North Sumatera	Single house	€ 0.09/kWh x 16,292.76 = 1,466.34 IDR/kWh	20 years
Nusa Lembongan, Bali	Single hotel	8,500 IDR/kWh	25 years
Surabaya, East Java	Single house	0.34 - 0.62 USD/kWh x 14.495 = 4,928.3 – 8,986.9 IDR/kWh	20 years
Perumnas Parung Panjang	Large residential Area	978.48 IDR/kWh 929.14 IDR/kWh	20 years 25 years
PLN (*Perusahaan Listrik Negara*/ State Electricity Company)	All Scale	1,352 IDR/kWh in March 2019	-

4. Conclusion

The COE of solar system in large residential area (case study: Perumnas Parung Panjang) is lower than the COE of PLN for more than 9.275 years of development time. Besides, COE of solar system in large residential area is lower than the cost of energy in single building or small area. Finally, the results showed that the solar energy can be an alternative source of electricity for housing, especially for large residential area, because it is more efficient in cost than diesel, gas, or coal from PLN.

Acknowledgments
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Integration of biogas technology into goat farming to achieve zero waste system: effect of substrate composition and concentration

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Abstract. Goat farming is one of the most applicable methods to earn extra money for many families in Indonesia. There were more than 35 million goats have been farmed throughout the country in 2015. Besides milk and meat, goat farming emits organic waste such as solid excreta and urine, which was estimated as much as 97 tones based on the aforementioned number of the goats. In addition, goat-based restaurant which are spread out in the country has also generated huge quantity of organic waste such leftover rice and vegetables. Those wastes were commonly collected and dumped in landfill area without proper pretreatment. In consequence, it caused bad odor, health-related problems, greenhouse gases emission and global warming. To mitigate these negative impacts, it was proposed to implement zero waste goat farming concept in which anaerobic digestion to produce biogas out of the organic waste was integrated. The challenge is inhibition of un-dissociated ammonia during the anaerobic digestion process due to higher content of protein these two waste. The objective of this research was to investigate the effect substrate composition and concentration of co-digestion of goat waste and restaurant waste. Effect of substrate composition of goat excreta-urine and leftover rice – vegetable from restaurant was evaluated on the value of 1:0, 1:1, in mesophilic anaerobic digestion (30℃, 1 atmosphere, initial pH of 7 or 8). While, effect of substrate VS concentration was evaluated at value of 0.253 to 10 g VS/l. The result show that digestion of the goat of waste was able to produce biogas yield at the lowest VS concentration. However, co-digestion with restaurant waste was shown to be lower biogas yield due to over-acidification at all substrate composition and concentration. Since there was no addition of buffer solution into anaerobic digestion culture, the culture was not able to recover during this over-acidification. The highest biogas yield was resulted from co-digestion at the ratio 1:0 as much as 98 ml STP/g VS (45% CH4). Implementation of anaerobic digestion into goat farming and restaurant waste could generate renewable energy and mitigate the environmental impacts.

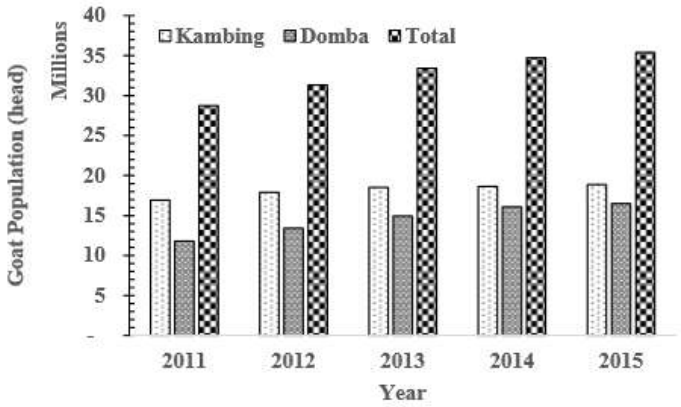


Figure 1. Population of goat throughout the time in Indonesia.

Table 1. Goat manure yield [3].

Goat Gender	Weight	Manure Yield		DM	N	P	K
		Wet season	Dry Season				
	(kg)	kg DM/ (head. Day)		(%)			
Male	22.5	0.36 (0.38)*	0.33(0.35)	94.6	2.81	0.42	0.93
Female	20	0.35 (0.37)	0.32(0.35)	94.6	2.78	0.43	0.93

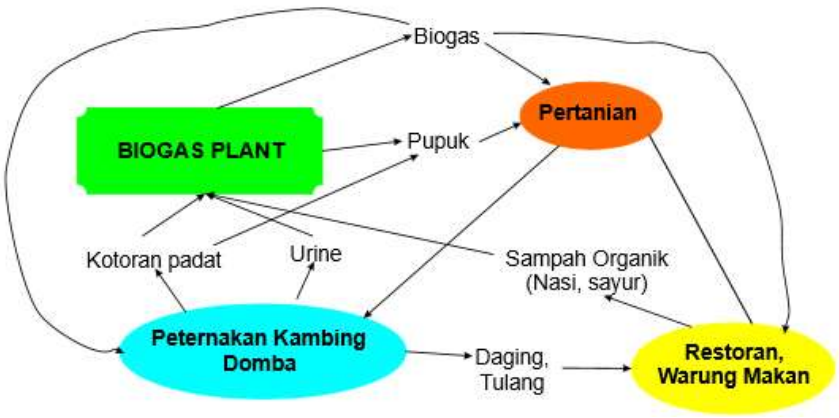


Figure 2. Zero waste concept of goat farming.

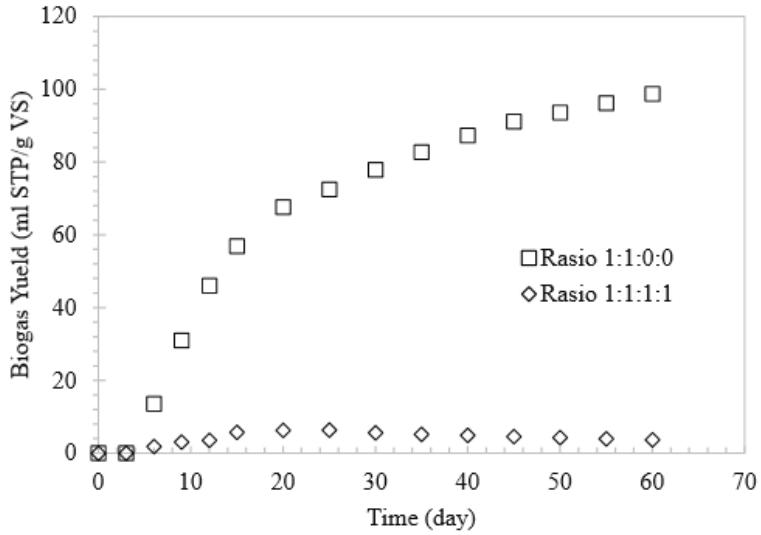


Figure 3. Yield of Biogas from co-digestion of goat manure and urine, rice and vegetable.

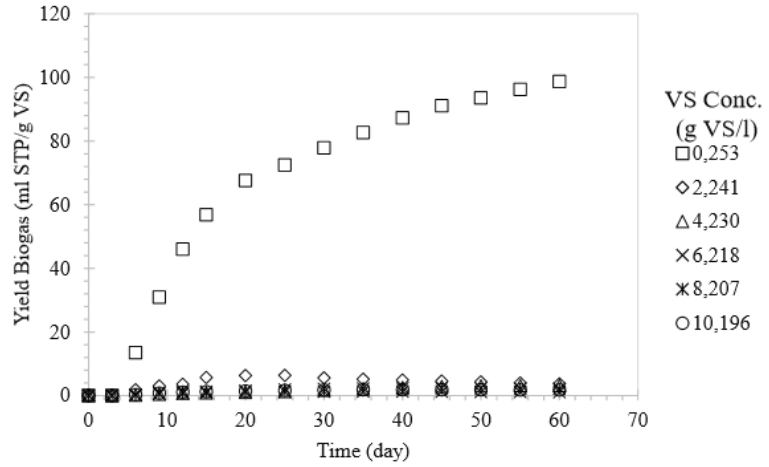


Figure 4. Yield of Biogas at various VS concentration of goat manure and restaurant waste.

Table 2. pH of initial and final condition during anaerobic digestion of goat manure and restaurant waste.

pH	Substrate VS Concentration (g VS/l)						
	0.253	2.241	4.230	6.218	8.207	10.196	Blank
Initial	8	8	8	8	7	8	8
Final	8	5	6	4	4	4	8

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Single-phase DC-AC inverter with low power dissipation with transformer and filter for photovoltaic-based home-scale electric power system

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Abstract. This paper describes the effects of modulation techniques and the number of pulses on low power dissipation in a single-phase inverter and a multilevel inverter. Multilevel inverters and singlephase inverters given pulse input use PWM (Pulse Width Modulation), SPWM (Sinusoidal Pulse-Width Modulation) and PWL (Piecewise -- Linear) modulation techniques, either in the form of square waves or multilevel pulses paired with the appropriate LCL filters. produce an inverter circuit that has a low THD (Total Harmonic Distortion) and high efficiency. The use of transformers is also mentioned in this paper to increase the source voltage at an output of 48 volts to around 220V-227Volt. Simulation results show that the effect of simple modulation switching techniques, such as PWM generated square waves, is simpler and more efficient if the right filter is used. The results of the simulation in PSpice show that of the switching techniques control in inverter system with fit filter can reduce the THD up to 1.81% and the efficiency is very high reaching of about 98%.

1. Introduction

Currently there are many research papers with power electronic themes about inverters and multilevel inverters, but each still has weaknesses, such as a single phase inverter that only uses a number of switching components but still requires filters to get good sinusoidal signals, while multilevel Inverters are the most efficient type of inverter because they solve the weaknesses faced by conventional inverter [1]. Multilevel inverter is a type of electronic power converter that can provide or produce the desired AC voltage level at the output of the converter using several numbers of low level DC voltage as input with / without using any filter circuit, but multilevel inverter requires more switching components than single-phase inverter. The multilevel that will be used is to use 3 separate DC sources. Multilevel inverter equipment is arranged cascade using a separate DC source, so as to produce three AC output voltage wave levels. This means that the number of inverters arranged in the cascade is three where the output is arranged in series. Multilevel Inverter 1 Phase configuration can be seen in the following figure 1.

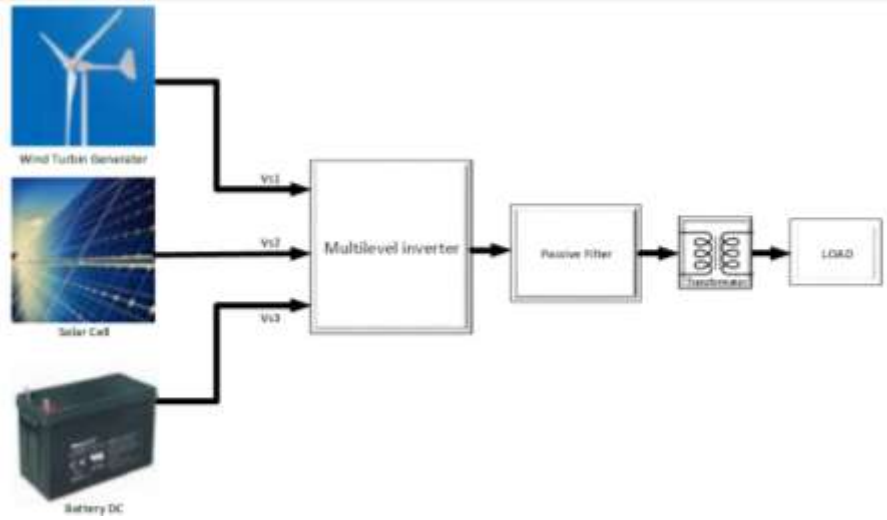


Figure 1. Diagram of a solar-based power generation system of multilevel inverter.

In Mixed-Level Hybrid Multilevel Cells multilevel inverter [2] the voltage levels of the cascade inverter cells are the same. However, it is possible to have different voltage levels between cells and can be referred to as asymmetric hybrid multilevel inverter. Figure 1 shows an example of 3 separate dc-bus levels, one with v2/3 and vdc2 and vdc3 is Vdc 1/6. Depending on the availability of the dc source, the voltage level is not limited to a certain ratio.

Multilevel inverter output voltage can be guided using PWL (Piecewise - Linear) switching control method, while for single-phase inverter output voltage uses PWM (Pulse Width Modulation) switching control method and SPWM (Sinusoidal Pulse-Width Modulation) switching control method, however the problem of the three controls above is total harmonics distortion (THD). To overcome this problem, passive power filters (PPF) are used [6]. To be able to supply electricity to the load, a solar power-based power generation system, single-phase inverter, is shown in Fig.2.

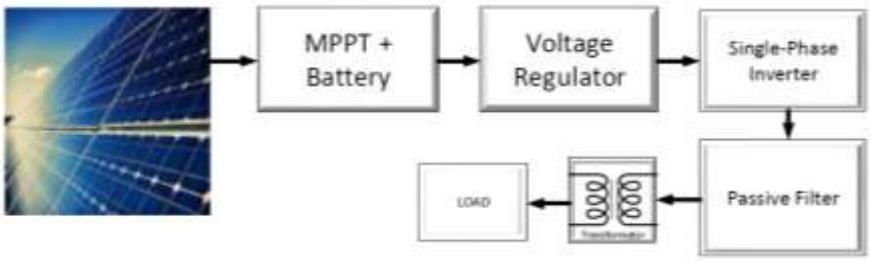


Figure 2. Diagram of a solar-based power generation system of single-phase inverter.

The remaining sections in this paper are organized as follows. Section II discusses the design of system models. Section III shows the simulation results. Section IV presents the comparative study presented in quantitative values in some tables. Finally, the work is concluded in Section V.

2. System Design and Modeling.

Multilevel Inverters, inverters, filters and transformers are designed, modeled and simulated using the SPICE Program\cite{b3}. Signal generators and analysis components are also modeled in the SPICE program. In this design, we will present eight simulation methods that show frequency response, THD, output power, voltage amplitude, and power efficiency as the basis for filter analysis, each using a transformer and without a transformer. Without a transformer here, analogous to the source voltage

of 220Volt, namely with several batteries arranged in series. In addition, the single-phase inverter is divided into 2 parts of the switching control method, namely PWM and SPWM. Whereas for multilevel inverter the swicthing control method used is PWL. For multilevel inverters used multilevel 3 level inverter and multilevel 2 level inverter.

2.1. Multilevel Inverter Model (Cascaded Multicell Inverter 3 level)

The topology used in multilevel here is based on the series connection of single-phase inverters with separate dc sources [4]. Fig. 3 shows the power circuit for one phase leg of a six-level inverter with three cells in each phase. The resulting phase voltage is synthesized by the addition of the voltages generated by the different cells. Each single-phase full-bridge inverter generates three voltages at the output +Vdc , 0, and -Vdc. This is made possible by connecting the capacitors sequentially to the AC side via the four power switches. The resulting output AC voltage swings from 3 to 3 with six levels, and the staircase waveform is nearly sinusoidal, even without filtering. Figure 3 shows an example of 3 separate dc-bus levels, one with 68% of Vdc , vdc2 and vdc3 is Vdc 16% of Vdc. Depending on the availability of the dc source, the voltage level is not limited to a certain ratio.

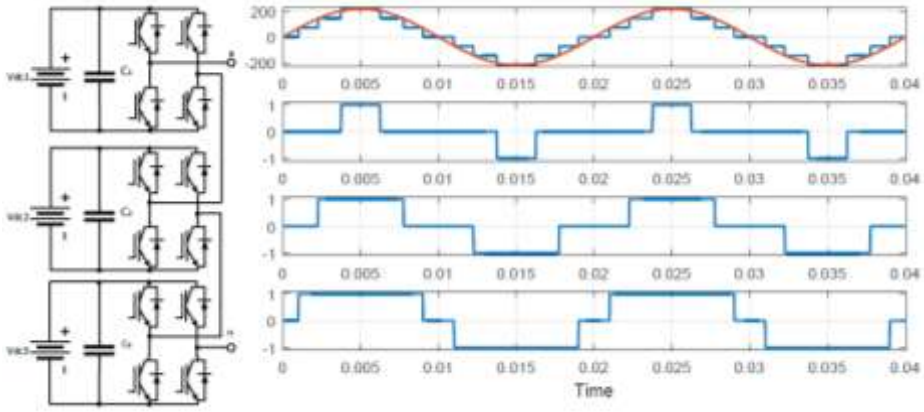


Figure 3. Cascaded inverter circuit topology 3 level and its associated waveform.

For each topology we use 2 tests, namely by using a transformer and without a transformer. For a 48 volt source voltage transformer will be used to reach a voltage of 220Volt, but for multilevel 3 level testing without using a voltage source transformer of 220Volt, it is assumed that some batteries are arranged in series to get a 220V source voltage. The 3 level cascaded inverter circuit topology requires 12 switching MOSFET devices, as well as as many diodes as that.

2.2. Multilevel Inverter Model (Cascaded Multicell Inverter 2 level).

After using a multilevel 3 level model, we will try to use a 2 level multilevel inverter to compare which one will get the smallest THD simulation results. For multilevel inverter 2 the level of the number of MOSFETs used is less than the previous multilevel inverter, this is due to the number of levels generated by the multilevel inverter output. The asymectric hybrid cascadeinverter cell topology shows that the more mosfets used, the more levels will be generated, because the output of the mosfet is arranged in series.Cascaded inverter 2 level circuit topology requires 8 switching devices for MOSFETs, as well as many diodes. Fig. 4 shows the power circuit for one phase leg of a four-level inverter with two cells in each phase. That figure shows two separate dc-bus levels, one with 75% of Vdc , and the other with 25% of Vdc. Depending on the availability of dc sources, the voltage levels are not limited to a specific ratio. This feature allows more levels to be created in the output voltage, and thus reduces the harmonic contents with less cascaded cells required.

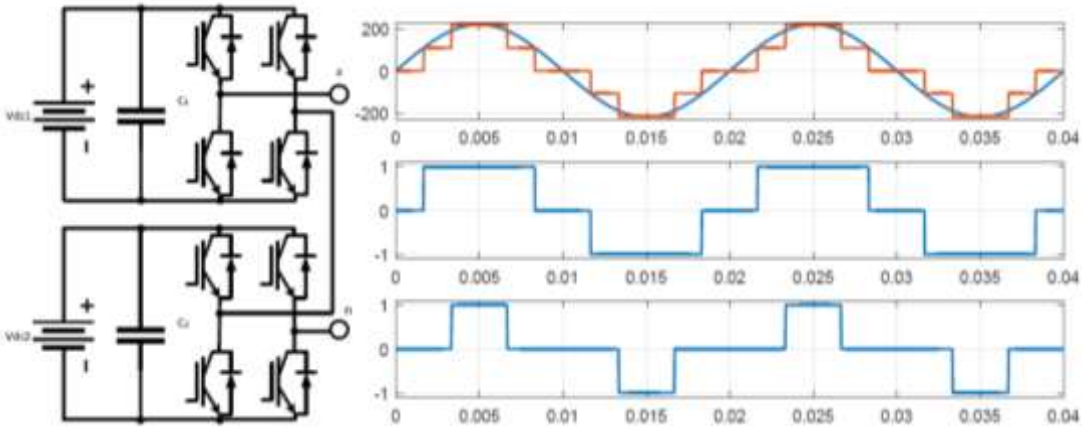


Figure 4. Cascaded inverter circuit topology 2 level and its associated waveform.

2.3. Single-Phase Inverter with Transformer Model.

For the single-phase inverter with transformer the power supply used is a 48 Volt battery, then the transformer is modeled using the PSpice application with 40mH primary windings and 800mH secondary windings and magnetic coupling is 1, which will increase the voltage up to 220Volt - 227Volt. The circuit scheme with full bridge configuration from a single-phase inverter with transformer is shown in Figure. 5.

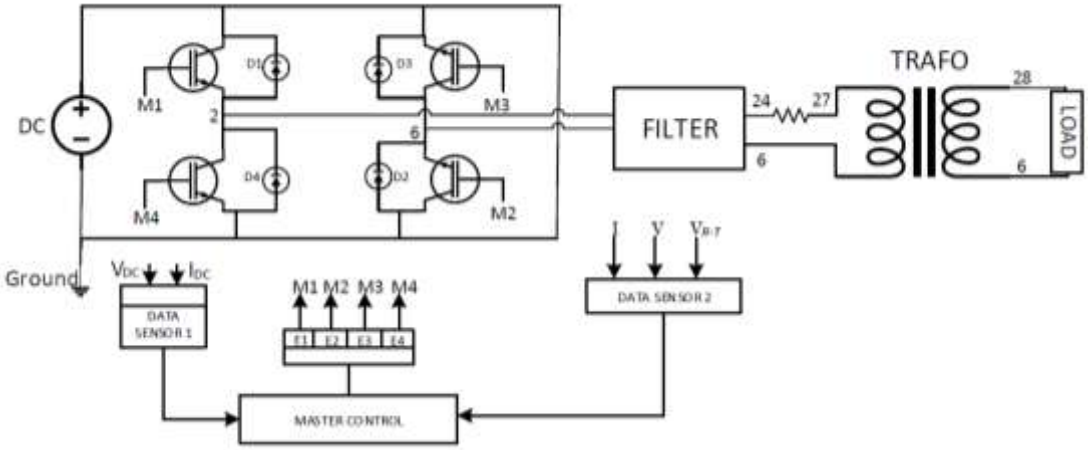


Figure 5. Single-Phase Inverter with Transformer Model.

M1, M2, M3, and M4 as respective switching devices MOSFET. Diodes D1, D2, D3, and D4 are protection elements for the MOSFET, respectively. The single-phase inverter generates filtered output voltages at point 24 and 6. The output transformer at the point 28 dan 6. The PPF output current are I 24,6 . E1, E2, E3 and E4 are power-driven PWM and SPWM switching control signals. Modulated signals are applied to the gate terminals of the MOSFET with a certain period to maintain the desired frequency of 50 Hz [5].

2.4. Single-Phase Inverter without Transformer Model

For Single-Phase Inverter without transformer the direct source voltage is 220V, which is assumed by several batteries to be arranged in series. The circuit scheme with full bridge configuration from a single-phase inverter without transformer is shown in Figure. 6.

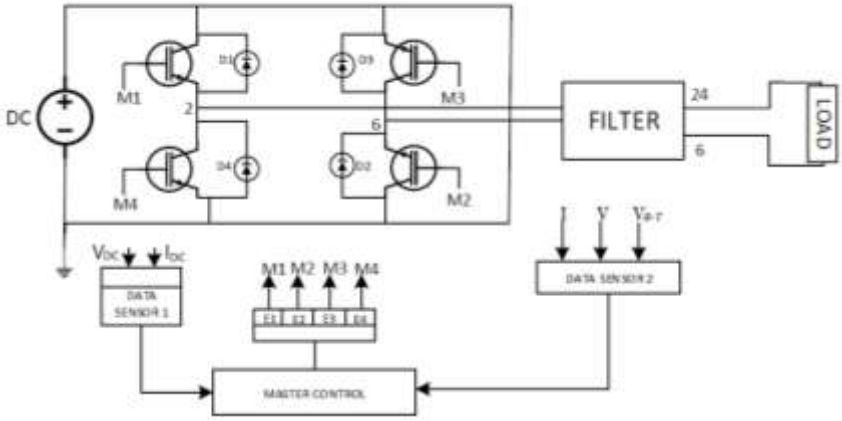


Figure 6. Single-Phase Inverter without Transformer Model (Trafoless).

Just like the previous single-phase inverter model, it is only different from the output of the filter output which no longer uses transformers. This method uses more batteries because the batteries are arranged in series quite a lot. while the battery is expensive.

2.5. Selected Filter Topology.

There are several filter models used in various applications with different harmonic traps, size, design cost and characteristics. The choice of passive filter topology used for filter resonance conditions is based on a separate passive shunt filter dampers for many security systems are applied [5]. In this paper, we will analyze the PPF outputs when its output terminal is connected to any type of filters. Fig. 7 shows the selected filter topology, which are briefly explained as follows.

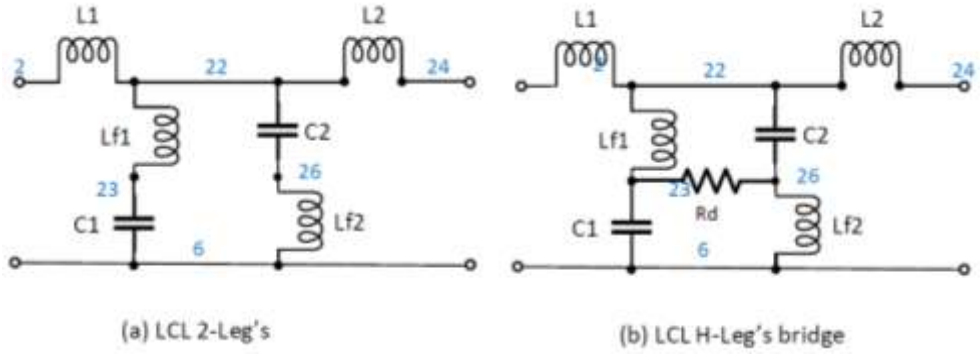


Figure 7. Type of Filter scematics (a)LCL 2-Legs (b) LCL HLegs bridges.

a) LCL filter with 2 LC legs or multi-tuned trap filter [6]. The filter serves to reduce current loss. Therefore, two equal combinations (LC-LC legs) without resistors is presented. Although this filter has no impedance resistors, it can produce good performance on harmonic reduction. But it has a frequency-loss which is difficult to mediate. It also has a high resonance, but when resonance is encumbered it can be overcome. Point 2 and 6 it's from the output of inverter single-phase, whereas for transformer or load its point 24 and 6.

b) LCL Filter + H-bridge damper. As the completion of the 2-leg's LCL filter, a resistor is inserted to make a bridge between two LC legs. The application of this filter is very suitable for three-phase inverters [7]. For more results on this topic, we refer readers to [6,7] and the references therein. We

will try to use this filter on single-phase inverters without transformers. Point 2 and 6 it's from the output of inverter single-phase, while points 24 and 6 are outputs of filters and are also inputs from transformers or loads. The LCL 2-leg's filter is used for single-phase inverters (PWM) and multilevel inverter (PWL), while the LCL H-leg's bridge filter is used for single-phase inverters SPWM controlled signal with Transformer.

3. Simulation Result.

This section presents several simulation results, i.e power from the input side, inverter output side, power from the load side, efficiency and THD. Each simulation has different parameters, so in this case we will display one by one the parameters used.

3.1. Selected Switching Control Signal for Analysis.

The parameters used in the simulation of filters and transformer are shown in Tables. The first simulation results presented in this section are the effectiveness of inverters and multilevel inverters using PWL, PWM and SPWM switching control signals.

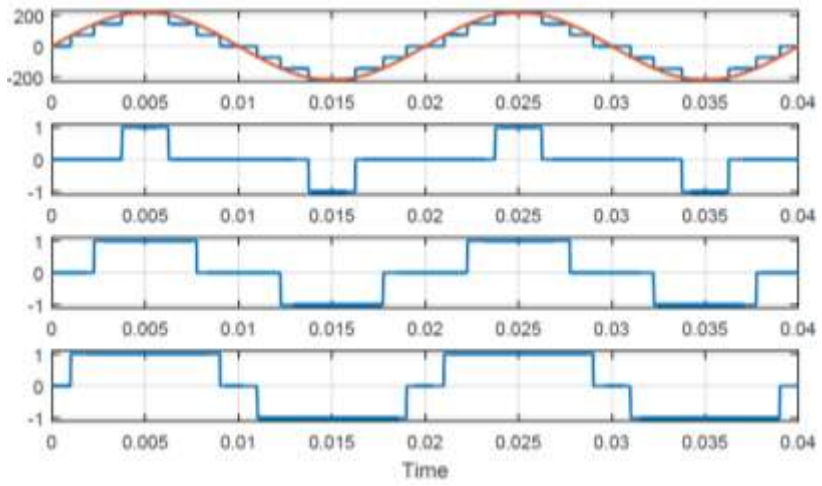
Table 1. Parameters simulation of 3 level cascaded multilevel inverter.

Level (3/2)	3level cascaded		2Level cascaded	
Trafoless/Trafo	Trafo	Trafoless	Trafo	Trafoless
Input Voltage	48 V	220 V	48 V	220 V
Output Voltage	61 V	214 V	83 V	227 V
Frequency	50 Hz	50 Hz	50 Hz	50 Hz
Output Power	27 Watt	229 Watt	34 Watt	275 Watt
Var./Param.	LCL 2-Leg's	LCL 2-Leg's	LCL 2-Leg's	LCL 2-Leg's
L1	8 mH	8 mH	14 mH	14 mH
L2	55 mH	55 mH	50 mH	50 mH
Lf1	2.3 mH	2.3 mH	3 mH	3 mH
Lf2	1 mH	1 mH	1.7 mH	1.7 mH
C1	192 uF	192 uF	142 uF	142 uF
C2	192 uF	192 uF	180 uF	180 uF
R	-	-	-	-
RT (Trafo)	10 Ohm	-	10 Ohm	-
L3 (Trafo)	45 mH	-	45 mH	-
L4 (Trafo)	900 mH	-	900 mH	-

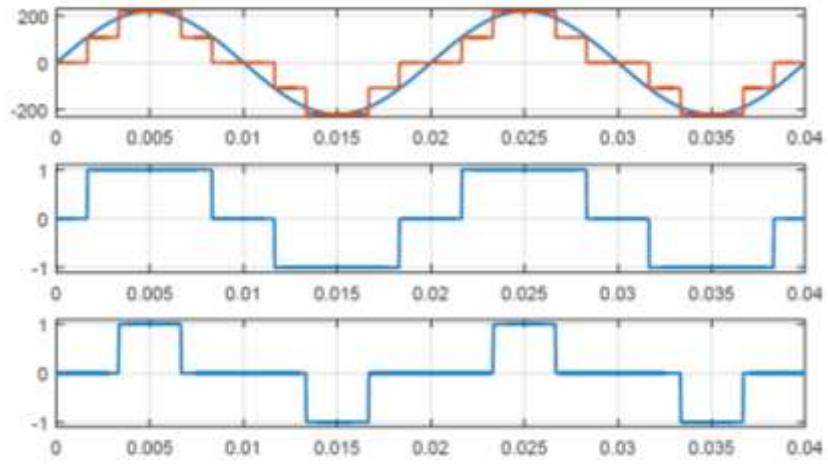
Table 2. Parameters simulation of single-phase inverter (SPWM/PWM).

Control Signal	PWM		SPWM	
Trafoless/Trafo	Trafo	Trafoless	Trafo	Trafoless
Input Voltage	48 V	220 V	48 V	220 V
Output Voltage	227 V	229 V	190 V	229 V
Frequency	50 Hz	50 Hz	50 Hz	50 Hz
Output Power	116 Watt	225 Watt	81 Watt	225 Watt
Var./Param.	LCL 2-Leg's	LCL 2-Leg's	LCL 2-Leg's	LCL 2-Leg's
L1	10 mH	10 mH	10 mH	10 mH
L2	15 mH	5 mH	15 mH	70 mH
Lf1	5 mH	10 mH	1.5 mH	1.5 mH
Lf2	5 mH	5 mH	4.5 mH	1.6 mH
C1	195 uF	118 uF	256 uF	211 uF
C2	195 uF	118 uF	260 uF	65 uF
R	-	-	-	38 Ohm
RT (Trafo)	10 Ohm	-	10 Ohm	-
L3 (Trafo)	40 mH	-	45 mH	-
L4 (Trafo)	800 mH	-	900 mH	-

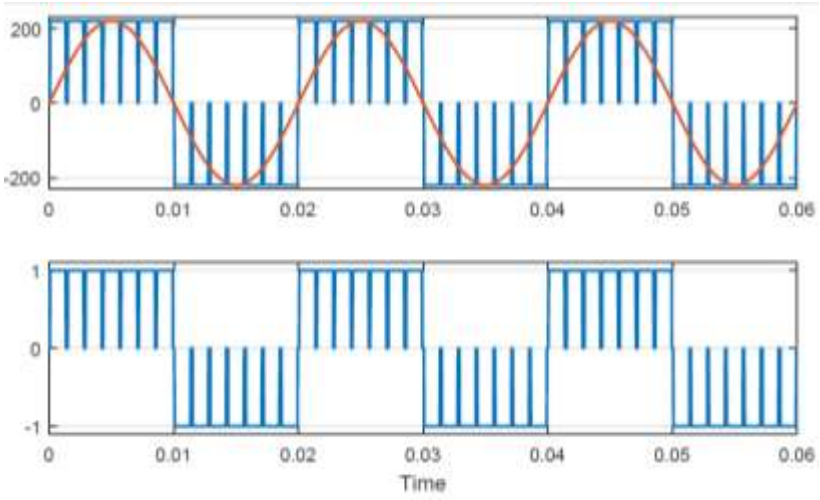
Three switching control signals, i.e. PWL, PWM or SPWM can be applied. This section analyzes the THD and output voltage amplitude when using one of third switching signals. Fig. 8 shows the time domain output voltage simulation results using third switching signals.



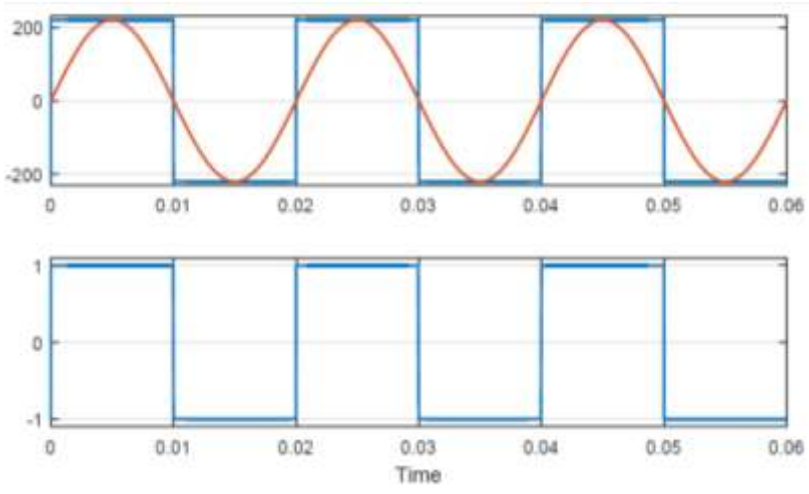
(a) PWL switching control method of 3 level cascaded multilevel inverter.



(b) PWL switching control method of 2 level cascaded multilevel inverter.



(c) SPWM switching control method of single-phase inverter.



(d) PWM switching control method of single-phase inverter.

Figure 8. Transient simulation of the PWL,SPWM and PWM switching control methods.

4. Measurement And Comparative Statistics.

This section presents the quantitative data of the simulation results presented in the previous section. The voltage provided varies with each inverter, ranging from 61V to 339V. Table 3 presents quantitative simulation data from all inverters. It seems that 3 levels of multilevel inverter (transformer) provide weakening performance for the best THD for output voltage and also have the highest output power of 229Watt. But for the efficiency of the power produced only 0.7%. Single-phase inverter with PWM has higher power efficiency than others, and also has a fairly high output voltage of 227V.

Table 3. The simulation result data.

Inverter	T/TL	THD	Voltage	Power (Watt)	Efficient (P)
3ML	T	3.88%	61 V	18 W	18%
	TL	1.31%	214 V	229 W	0.7%
2ML	T	2.39%	83 V	34 W	83%
	TL	2.73%	227 V	275 W	48%
SPSPWM	T	1.84%	190 V	81 W	35%
	TL	3.19%	219 V	150 W	3%
SPPWM	T	1.81%	227 V	116 W	98%
	TL	3.33%	339 V	225 W	9%

The explanation for abbreviations in table 4 is as follows:
3ML is 3 level multilevel inverter, 2ML is 2 level multilevel inverter, SPSPWM is single-phase inverter with SPWM control method, SPPWM is single-phase inverter with PWM control method, T / TL is Transformer or Transformerless

5. Conclusions

Based on the results of the simulations we have done, it can be concluded that:
1. To get a low power dissipation using a simple square wave (PWM) that is simple and maximized on the use of a suitable filter, besides that the selection of filters can significantly reduce the THD. no need to use SPWM or PWL.
2. In the results of this simulation it was found that the LCL Filter + H-bridge damper cannot achieve power dissipation as in the previous study [8], so it can be seen that the filter is only suitable for 3 phase inverters and is not compatible with single-phase inverters and multilevel inverter.
3. Use of LCL filter with 2 LC legs are very suitable for use in single-phase inverters (transformers) with the PWM swichting control method. this is evidenced by the results of the simulation of power dissipation obtained which is the greatest among the others, which is equal to 98% and the resulting THD is 1.81%, this is under the IEEE standard [9].With an input voltage of 48V it produces an output voltage of 227V.
4. Besides the use of a transformer on a single-phase inverter with a PWM swichting control method can increase the power (watts) of the inverter, this is evidenced by the output power of an inverter which is only 92W up to 116W.
5. In terms of the number of components it is very clear that single-phase inverters only require fewer components compared to multilevel inverters.

Acknowledgments

Authors wishing to acknowledge assistance or encouragement from colleagues, special work by technical staff or financial support from organizations should do so in an unnumbered Acknowledgments section immediately following the last numbered section of the paper.

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The influence of water and catalyst leach process toward propane oxidation on MoVTeNb catalyst

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Abstract. The effect of the water stream to the propane oxidation on diluted MoVTeNb catalyst has been investigated. The present work has elucidated that careful operation of high throughput instrumentation can be used in various beneficial ways to speed up the discovery process of improved catalysts in other forms than enabling efficient trial-and-error testing of compositional variations of a given catalyst system. The result shows that the addition of massive amounts of water to the feed should have a negative influence on the kinetics, as water will compete with all other polar molecules in the system for adsorption sites. This work also investigated the effect of catalyst leach process toward propane oxidation. From the result, it can be described that catalyst leach process tends to reduce the phase of the catalyst that responds to the total oxidation of propane. This work also proposed the reaction network and gave the comparison between the propane oxidation reaction kinetic using leached and un-leached catalyst. The result showed that the activation energy of the acrylic acid formation on the leached catalyst was slightly higher than that of on un-leached catalyst. On the other hand, the activation energy of the carbon dioxide formation on the leached catalyst was much higher than that of on un-leached catalyst. It can be described that the leaching process to the catalyst can reduce the phase of the catalyst responsible for the total oxidation of propane.

1. Introduction

The oxidation process using a catalyst has developed into a very important technology in the modern chemical industry. One of the important processes that utilize this technology is the functionalization of aromatics and alkanes, due to the advantageous economy and the easy processing. Acrylic acid is one of the most important catalytic oxidation products, which its consumption in 2020 is expected 8,000-kilotons. Acrylic acid is widely used in the industry as intermediate for polyacrylates and methacrylate esters production. These products can be used for various purposes, such as super adsorbents. Acrylic acid is presently factory-made from propylene in two steps via acrolein in a gas phase using special catalysts which the yield up to 80% [1]. Despite the promising yield of the product, the price of propylene has seen attention being drawn to develop a method for producing acrylic acid alternatively by direct oxidation of propane in the presence of a catalyst. One of the promising catalysts that are widely studied is a mixed metal oxide, such as MoVTeNb catalyst [2-7].

The problem that is still faced in the utilization of this catalyst is the control of the complexity of the reaction network consisting of consecutive reactions and parallel reactions [3, 8-10]. The phase-in MoVTeNb which is responsible for the production of acrylic acid from direct oxidation of propane is referred to as "M1" phase [2, 4, 11-13]. Mo and V are very suitable for the oxidation of alkanes via alkenes to carboxylic acids [14, 15]. Some results of previous studies have reported the proposed reaction mechanism [3, 9, 16], as well as the structure of the catalyst during the reaction [4, 17-21]. The presence of water in this oxidation reaction provides a reaction advantage as has been reported by previous researchers [3, 22-25].

In this paper, we will discuss the effect of the presence of water on catalytic reactions and the effect of the leaching process on diluted MoVTeNb oxide catalyst. Water is believed to have an indirect role in the process of propane oxidation reactions to acrylic acid. The leaching process is believed to effect on the phase composition of M1 and M2 in the catalyst which has a very important role in the oxidation reaction mainly related to the reaction network of propane to acrylic acid.

2. Experimental

2.1. Materials

The materials used for catalyst synthesis were Telluric acid (Aldrich), Ammonium metavanadate (Riedel-de Haën), Niobium ammonium oxalate (Aldrich), Ammonium heptamolybdate tetrahydrate (Merck), Aerosil300 (Degussa). The gases used for reactants were oxygen and propane (MOX).

2.2. Instrumentation

Nanoflow catalytic reactor is one of the equipment that is used for this high throughput experimentation study.

2.3. Procedure

Preparation of MoVTeNb oxide catalysts and kinetic studies was carried out according to the procedure described previously, and some kinetics data were also reported previously [4, 5, 7]. The catalytic reaction was done by presenting a small quantity of catalyst (0.1 g) mixed in SiO_2 to a total volume of 0.5 ml. The high total flow rates (15 mlN/min, GHSV = 1800 h^{-1}). The reaction rate is calculated by Equations presented below:

$$\text{Reaction rate (mol/h. gcat)} = \frac{\%vol\ x\ total\ flow\ x\ d\ x\ 60}{Mr\ x\ catalyst\ weight} \qquad (1)$$

Where Mr is molecular weight and d is density.

To study the effects of water dependence, the concentration of water varies and other concentrations are fixed. To determine activation energy, the oxidation reaction was studied at four different temperatures, namely, 653, 663, 673 and 683 K. After taking the natural logarithm of the equation, it can be seen that a plot of ln k versus 1/T should be a straight line whose slope is proportional to the activation energy.

$$k = Ae^{-\frac{E_A}{RT}} \qquad (2)$$

Where k is the rate constant, T is the absolute temperature (in Kelvin), A is the pre-exponential factor, Ea is the activation energy for the reaction, and R is the universal gas constant.

3. Result and Discussion

The characteristic of the MoVTeNb oxide catalyst has been reported in our previous work [4]. The catalyst consists of two main phases namely M1 and M2 phases. M1 phase is more related to the structure of Mo_5O_{14} and is responsible for the oxidation process of propane to acrylic acid, while the

M2 phase is more related to the orthorhombic variant of HTB structure which is responsible for the total oxidation process of propane to COx. Based on catalyst characterization, it shows that the M1 phase is more dominant than the M2 phase.

3.1. Effect of Water

There are several opinions about how water affects the performance of the catalyst and the distribution of products, such as by facilitating desorption of oxygenating from the catalyst or modifying the catalyst structure. The present study has substantiated that the modification of the catalyst surface required for partial oxidation by water concentration in the feed is a fact for the systems studied here. The beneficial effect of water in helping to wash off the partial oxidation products and to protect them from over-oxidation by blocking sites next to the adsorption site of the freshly formed products and so inhibiting the access of activated oxygen from neighboring sites have also been identified in the present study.

To interpret this point, kinetic investigations were lead with water as the varied feed component. The rate of propane disappearance and acrylic acid formation were calculated and plotted against the water concentration (see Figure 1 and 2).

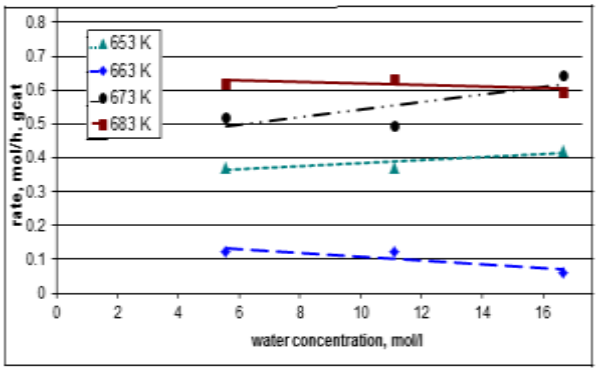


Figure 1. Rate of propane disappearance with respect to water concentration at 653, 663, 673, and 683 K

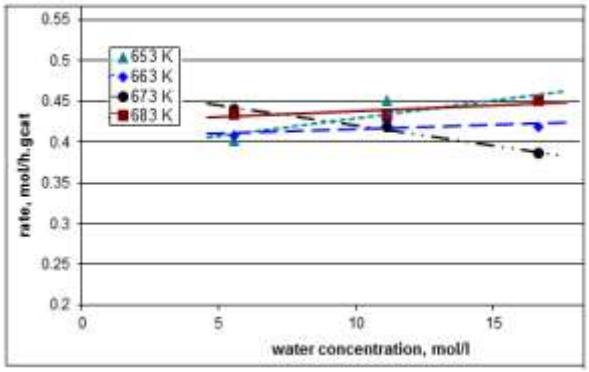


Figure 2. Rate of acrylic acid formation with respect to water concentration at 653, 663, 673, and 683 K

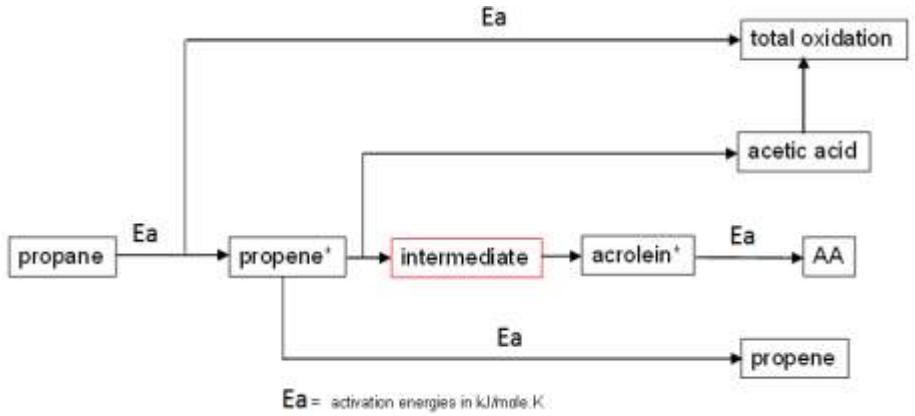
The reaction stoichiometry for propane to acrylic acid is $C_3H_8 + 2\ O_2 \rightarrow C_3H_2COOH + 2\ H_2O$. From the result above, the rate of propane disappearance (r_{prop_dis}) and acrylic acid formation (r_{AA_form}) from the selective oxidation of propane over this catalyst with respect to water concentration can be determined by the equation (see table 1).

In all cases, a small value of the reaction order with respect to water was obtained. This is unexpected taking into account that water is a reaction product in all processes considered here and that it will control the processes of C-H activation leading to (intermediate) OH groups. The addition of massive amounts of water to the feed should have a negative influence on the kinetics, as water will compete with all other polar molecules in the system for adsorption sites. It has to be assumed that the integrity of the catalysts requires its surface to be covered to a substantial extent with water. On such a surface the additional water created during the reaction of propane will not affect greatly the coverage and hence will not lead to a significant reaction order detectable by formal kinetics. In contrast to current opinion, the low values of reaction order do not imply that water cannot interfere with the reaction kinetics.

For acrylic acid a strong dependence of the reaction order on temperature is observed, showing at low temperatures a slightly beneficial and for high temperatures a slightly inhibiting effect of water. As the C-H chemistry should not be relevant, it may be concluded that at low temperatures the beneficial washing off effect is at work whereas at high temperatures the site competition effect prevents the optimization of the surface coverage with other species than water indicating that water desorption must be a strongly activated process.

3.2. Effect of leach process

For further development of the catalyst system, two conclusions can be drawn. It is very important to design the dilution of the active phase in such a way as to maximize the hydrothermal stability and to optimize the heat management of the entire catalyst. Concerning the active phase, it became evident that a single phase is essential as then the chances to bring about a single type of active sites, capable to perform minimum consecutive total oxidation the selective oxidation of propane. To this end, leaching and nanostructuring of the surface are suitable concepts. To clarify this point, a reaction mechanism has been proposed (Scheme 1, [7]) and then it will be compared the amount of energy activation of the propane oxidation reaction using unleach and leach catalysts



Scheme 1: Schematic representation of the reaction network

Overall, this propane oxidation reaction consists of three parallel processes paths. These processes are one main path that produces the desired product, acrylic acid. The other pathway is the total oxidation of propane to carbon dioxide, and another pathway is the process of desorption of propene. One thing that is quite good in this reaction process is that the total oxidation pathway of propane requires a fairly large activation process, so it is technically quite difficult to occur. The proposed reaction mechanism is consistent with the presence of 2 types of active catalyst sites referred to as M1 for the partial oxidation pathway to produce acrylic acid and M2 for the total oxidation pathway.

To further understand the effect of washing or leaching the catalyst on the presence of phases responsible for the formation of acrylic acid, activation energy calculations for each process are presented in table 1. This washing is intended to reduce the M2 phase which leads to a total oxidation reaction. It is expected that the reduction of the M2 phase in total in the catalyst material will be dominated by the M1 phase which pushes towards selective oxidation so that the desired product will be produced more.

Tabel 1. Comparison of activation energy in each process of selective propane oxidation using leached and unleached MoVTeNb [5,7]

Processes	Rate of reaction (r)		Activation Energy (kJ mol^{-1})	
	Unleached catalyst	Leached catalyst	Unleached catalyst	Leached catalyst
Propane disappearance	$k[C_3H_8]^{1.00}[O_2]^{0.24}$	$k[C_3H_8]^{1.00}[O_2]^{0.21}$	21,8	27,3
Propene formation	$k[C_3H_8]^{1.00}[O_2]^{0.00}$	$k[C_3H_8]^{1.00}[O_2]^{0.00}$	62,7	40,9
COx formation	$k[C_3H_8]^{1.00}[O_2]^{0.21}$	$k[C_3H_8]^{1.00}[O_2]^{0.31}$	123,2	177,3
Acetic acid formation	$k[C_3H_8]^{0.22}[O_2]^{0.24}$	$k[C_3H_8]^{0.83}[O_2]^{0.42}$	46,9	91,6
Acrylic acid formation	$k[C_3H_8]^{0.50}[O_2]^{0.11}$	$k[C_3H_8]^{0.49}[O_2]^{0.09}$	32,9	30,3

From table 1, it can be described that the process of removal (conversion) of propane requires slightly higher energy in the reaction using leached catalysts. It can be logically explained that the washing process causes several active catalytic sites both M1 and M2 phases to be washed away. The reduced active site will complicate the process of propane removal/conversion. However, in the process of using leached catalysts, it appears that the formation of propene is easier. Propene is an intermediate product which will immediately turn into the next oxidation product, acetic acid, and

acrylic acid. The formation of acetic acid which is a by-product requires higher energy, while the formation of acrylic acid as a product of the main reaction pathway requires lower energy. This proves that the washing process is quite successful in eliminating the M2 phase which is responsible for the total combustion of propane. This is confirmed by the fact that the activation energy of COx formation increases very high. This means that the formation of COx is increasingly difficult to occur. On the other hand, converting propane towards propene and continuing towards acrylic acid is even easier. This confirms that the washing process succeeded in reducing the M2 phase responsible for the total oxidation reaction of propane towards COx, and at the same time managed to maintain the M1 phase responsible for the propane selective oxidation reaction to acrylic acid.

4. Conclusion

In general, this study has provided a phenomenological framework for understanding the action of MoVTeNb in propane oxidation catalysis. It was found that there are two types of reaction sites present, one of which requires the presence of excess water to function. The extent to which these sites will be present depends on the details of the bulk material nanostructuring and can be modified by synthetic and post-synthetic steps. One of these steps is the washing process. Parallel reaction pathways for partial oxidation need to be treated more carefully so that acrylic acid can be produced optimally.

Acknowledgment

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Gas sensitive properties of ZnO nanorods formed on silicon and glass substrates

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Abstract. Nanostructured materials based on zinc oxide are being intensively studied, since such materials are used to create energy harvesters, gas sensors, and solar cells. Arrays of nanoscale ZnO nanorods are synthesized on silicon and glass substrates by the hydrothermal method. The formed ZnO nanorods with predominantly vertical orientation have an average transverse size of about 30–40 nm and a length of 500–600 nm. For electrical contact, V-Cu-Ni metallization was deposited over ZnO nanorods. The work investigated the gas-sensitive and electrophysical properties of the formed sensitive elements with respect to carbon monoxide (CO). It is shown that the sensor element based on ZnO nanorods on glass has a 30% higher sensitivity and lower (10 ppm) sensitivity limit than similar structures, but formed on silicon. Peculiarities of the response of gas sensors based on ZnO arrays of nanorods were determined, including the effect of temperature, the rate of gas flow, and the effect of the substrate. A method for measuring gas-sensitive properties has been developed. It is shown that sensors based on such sensor structures can be used as energy-efficient gas sensors, as well as detectors in early fire detection systems, robotic sensor systems, and other modern technologies.

1. Introduction

The properties of nanostructured materials based on oxide semiconductors are currently being intensively studied, since these materials have great potential for practical application. ZnO-based nanostructures are used to manufacture sensitive elements of gas sensors, piezo transducers and energy harvesters [1-4]. The principle of operation of gas sensors is based on the property of ZnO to change its electrical parameters during the adsorption of gas molecules.

The principle of operation of gas sensors is based on the property of ZnO to change its electrical parameters (for example, electrical conductivity) during adsorption of gas molecules. Resistive-type gas sensors based on ZnO nanorods formed by the method of pulsed laser deposition exhibit high sensitivity to carbon monoxide (II) [4]. However, research in this area is not enough. In particular, in [5, 6], the hydrothermal method formed arrays of ZnO nanorods on various substrates, but their gas sensitivity has not been sufficiently investigated. The purpose of this work was to study the gas sensitivity of gas sensors based on arrays of ZnO nanorods, to carbon monoxide (CO) at different temperatures.

2. Experiment

Arrays of ZnO nanorods were synthesized on p-type silicon and quartz glass by the hydrothermal method. A uniform distribution of the zinc acetate sol dissolved in ethanol on the substrate surface was achieved by centrifuging at a rotation speed of about 2000 rpm, further drying at 110-130 ° C and

annealing at 350-450°C [5, 6]. The hydrothermal synthesis of ZnO nanorods was carried out in an aqueous solution of zinc nitrate and hexamethylenetetramine ($C_6H_{12}N_4$) in a glass beaker.
Hydrothermal treatment was carried out in the temperature range 90-97 ° C for 1-3 hours. The formed ZnO nanorods are predominantly vertical in orientation with a height of 590–660 nm and have an average transverse size of about 30–40 nm — figure 1 (a.) Then, contact metallization of V-Cu-Ni 0.2-0.3 μm thick was applied on them. The resistance of the obtained structures ranged from hundreds of kOhms during the formation of ZnO nanorods on silicon and up to tens of Mom during the formation of ZnO nanorods on glass.

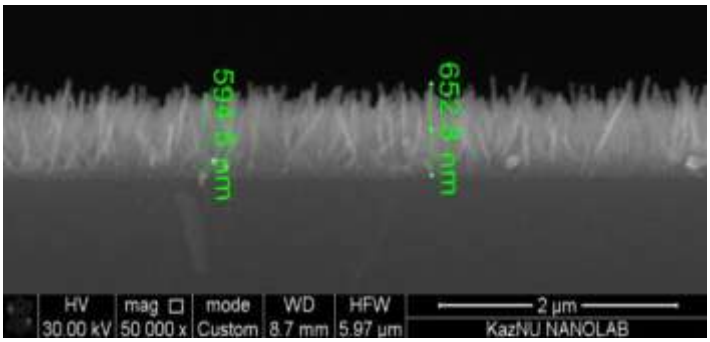


Figure 1. SEM images of the as-grown ZnO nanorod layer on a Si substrate.

Measurements of electrophysical and gas-sensitive properties were carried out on an automated bench for gas calibration of the collective use center "Microsystem Engineering and Integrated Sensors" — figure 2.



Figure 2. Automated gas sensor calibration stand: electronic control unit for the gas distribution system (1), solenoid valves (2), mixing chamber (3). receiver (4). unit for controlling the flow rate of the original gas components (5) unit for controlling the flow of gas mixture (6); measuring chamber (7); cylinders with original gas components (8), personal computer (9), Keithly multimeter 2450 (10) heating control unit (11).

With the help of the stand, it is possible to automatically generate a mixture of gases up to three components of a given concentration with a lower concentration limit of 1 ppm or less, with a dilution factor of up to 100. The supply of the finished gas mixture is possible by controlling the speed of the

gas flow is possible within 0.1–3.5 cm/min. The Study of the electrophysical and gas-sensitive properties of newly developed materials is possible by heating the samples to 400°C.
The measuring unit provides double shielding and allows high-accuracy measurement of parameters such as resistance of test samples of sensors and conductivity of samples of gas-sensitive materials in the range 0-10^{10} Ohm·cm (S^{-1}·cm).

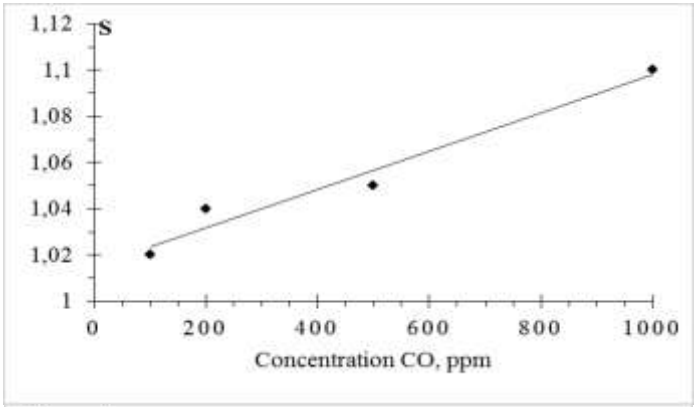
For this case, the CO concentration was set in the range of 20-1000 ppm in air at operating temperatures of 100-270°C. The air and CO mixture were introduced at a flow rate of 0.3 dm^3/min.

The response of sensor elements based on ZnO nanorods on silicon was calculated using the formula $S=R/R_0$, and the response of sensor elements based on ZnO nanorods on glass was calculated using the formula $S=R_0/R$ (here R_0 is the resistance of the sensor element in the absence of gas; R is resistance sensor element when exposed to gas).

3. Results and discussion

It was experimentally determined that the minimum sensitivity of sensor elements based on ZnO nanorods on silicon was 100 ppm, and that of sensor elements based on ZnO nanorods on glass was 10 ppm - figure 3 (a, b). The operating temperature of sensor elements based on ZnO nanorods on silicon was near 200°C (figure 3, a). At the same time, the operating temperature of the sensor elements based on ZnO nanorods on glass was in the range of 250-270°C (figure 3, b (curves 2 and 3)). At 200°C, the response was unstable (figure 3, b (curve 1)).

(a)



(b)

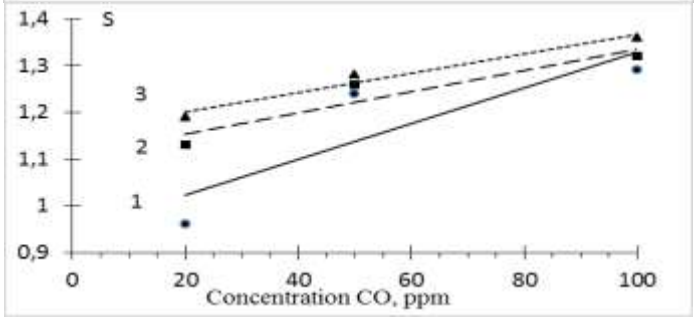


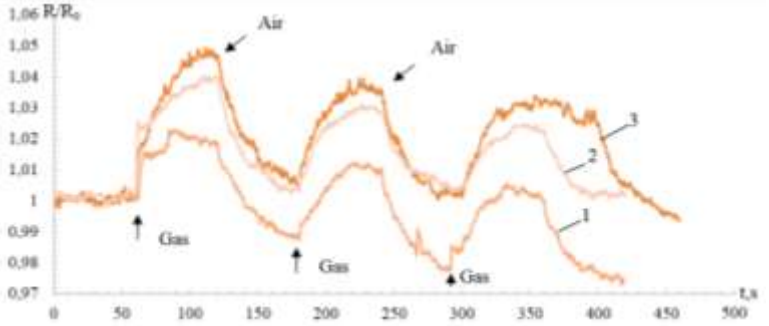
Figure 3. Dependence of the gas sensitivity coefficient of the investigated sensor elements based on ZnO nanorods on silicon on the CO concentration at 200 °C (a) and on glass (b) at 200 °C (1), 250°C (2) and 270°C (3).

In figure 4 shows typical responses of sensor structures based on ZnO nanorods grown on p-type silicon (figure 4, a) [7] and on glass (figure 4, b). The comparison shows that the response of the sensor formed on the glass became 1.3 times higher, and the sensitivity limit can reach units of ppm. Such parameters could not be achieved on sensor elements based on ZnO nanorods grown on p-type silicon.

In addition, the response to CO exposure for sensor structures based on ZnO nanorods grown on p-type silicon was inverse. When exposed to CO, the resistance grew (figure 4, a), but did not decrease,

as it was when exposed to CO on the sensor structure based on ZnO nanorods grown on glass (figure 4, b). The result obtained is explained by the fact that zinc oxide is an n-type semiconductor. In the case when ZnO nanorods are grown on p-type silicon and there are contact metallization on top of them, two p-n-junctions are formed, which are connected towards each other. When measuring the resistance in such a structure (figure 5, a), the measuring current proceeds in two ways.

(a)



(b)

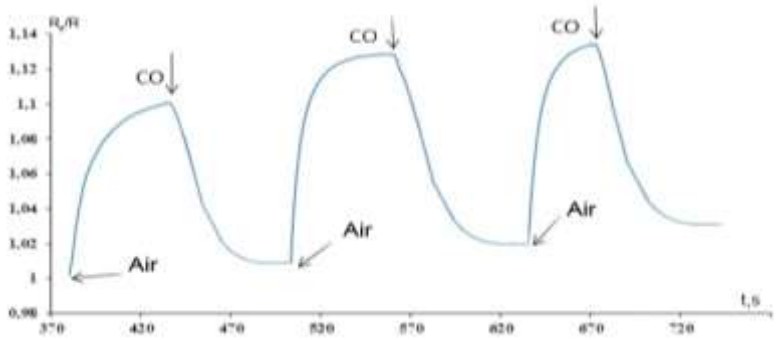
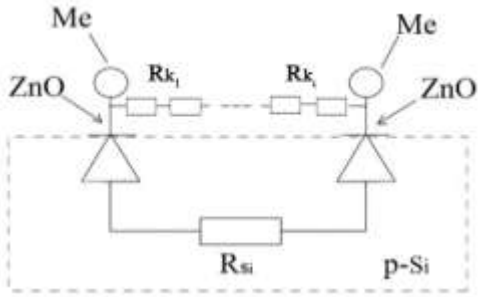
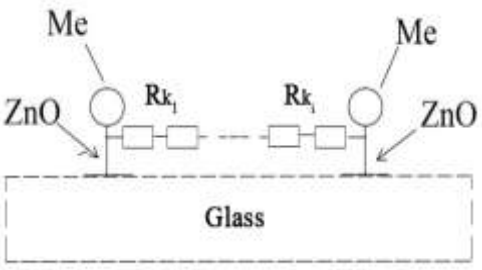


Figure 4. Normalized responses of sensor elements to CO 100 (1), 200 (2), 500 (3) ppm at 200 °C based on ZnO silicon nanorods (a) and response to CO (50 ppm) at 250 °C (ZnO on glass) (b).

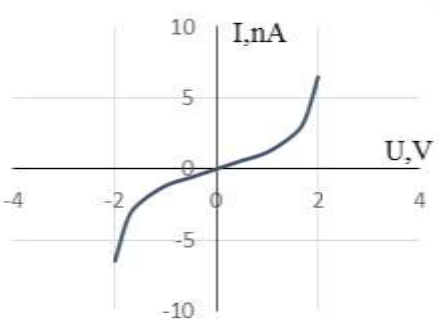
a)



b)



c)



d)

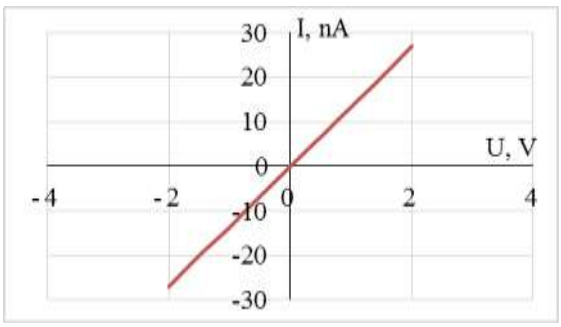


Figure 5. Electrical equivalent circuit (a, b) and volt-ampere characteristic (c, d) of the sensor structure based on ZnO nanorods on silicon (a, c) and glass (b, d).

The first path is from the first metal contact to the nanorods, on which it lies, and further, through numerous contacts of ZnO nanorods in contact with each other (Rk_i) to the second metal contact. The second way: from the first metal contact to ZnO nanorods, then through them to the silicon substrate, and through it to the second contact through ZnO nanorods. Since the resistance of the R_{Si} silicon substrate is less than the resistance of Rk_i nanorods in contact with each other ZnO nanorods, the current will mainly flow through the silicon substrate. As a result, two p-n-junctions are formed, connected towards each other - figure 5, a. In structure on the glass realizes only the first path of the passage of electric current - figure 5, b. These assumptions are confirmed by the current-voltage characteristics of the ZnO structures of nanorods grown on p-type silicon (figure 5, c), and on glass - (figure 5, d).

In the first case (figure 5, d), the current-voltage characteristic is non-linear and its form corresponds to the electrical equivalent circuit (figure 5, a). In the second case, the current-voltage characteristic is linear (figure 5, d), which corresponds to the electrical equivalent circuit (figure 5, b) and is consistent with the results presented in [8].

4. Conclusions

In this work, the sensitivity of sensory elements based on arrays of ZnO nanorods formed on p-type silicon and glass to carbon monoxide (CO) at temperatures of 200–270 ° C was investigated. Studies have shown that the shunting effect of two pn-junctions involved in opposite directions leads to a decrease in the gas sensitivity coefficient and the inverse response of the sensor structure based on ZnO nanorods grown on p-type silicon.The obtained response of the formed sensors based on the ZnO array of nanorods grown on glass was 30–40% higher than the response of a similar sensor structure based on the array of nanorods but grown on silicon. The maximum response of the sensory structure at 270 ° C was 1.36, when exposed to CO from concentrations of 100 ppm, and 1.28 and 1.19 at 50 and 20 ppm, respectively.

Thus, using gas sensors based on ZnO nanorods, one can measure the carbon monoxide concentration at a level of 10-50 ppm, which is necessary, for example, for the manufacture of gas fire detectors.

Acknowledgements

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The study of the properties of lead zirconate-titanate films on silicon substrate after halogen lamps rapid thermal annealing

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Abstract. Ferroelectric thin films of lead zirconate titanate (PZT) are important is creation of ferroelectric MEMS, memory devices, sensors of physical quantities and converters energy. The thermal annealing use to obtain satisfactory electro-physical parameters and optimal crystal structure PZT films. The rapid thermal annealing (RTA) in comparison with isothermal annealing have a possibility of selective annealing of individual layers of the multilayer PZT composition by selecting appropriate temperature and duration of the RTA. The purpose of this work is identification the optimal modes of rapid thermal annealing with halogen lamps to change the phase-structural state of PZT films. The PZT thin films with a thickness of 1.0 ± 0.1 μm were deposited by oxygen atmosphere high-frequency reactive plasma sputtering on silicon (100) substrates and silicon substrates with SiO_2 on surface. After applying, PZT film underwent RTA at temperatures of 600-800 °C and with speed 60 degrees/s. With X-ray phase analysis is revealed structure-phase composition of the PZT film. Besides, the effect of RTA was investigated using electron microscopy. It is established that temperature change at RTA leads to a qualitative change in the phase-structural state of the PZT films as compared to their initial state. This give a chance to use RTA in formation of the PZT films with given parameters.

1. Introduction

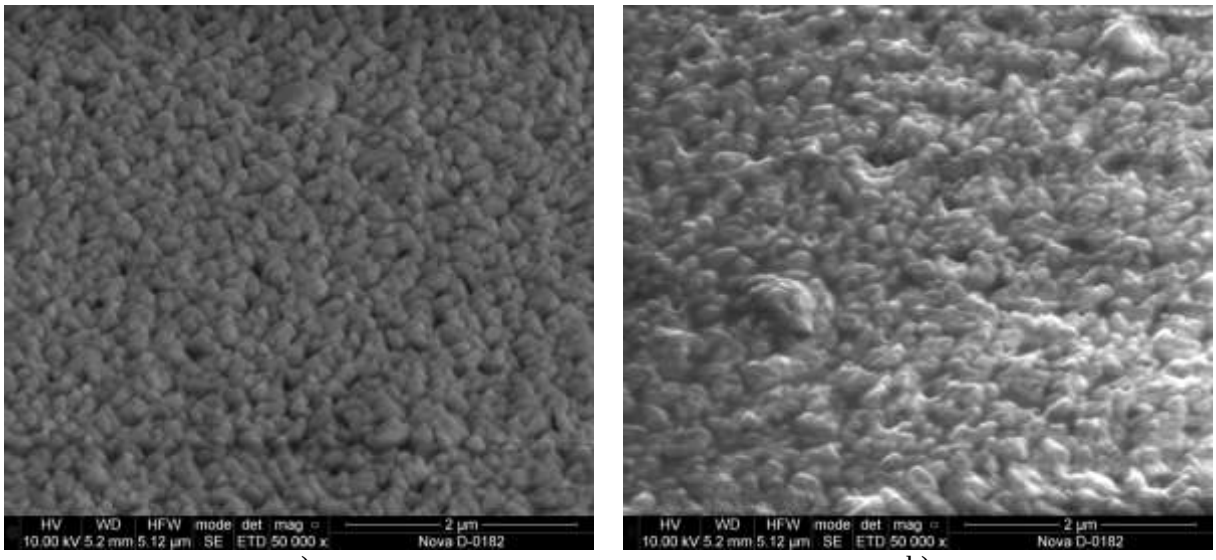
The use of materials in microelectronics in the form of nanostructured thin polycrystalline and epitaxial films (ferroelectrics, ferromagnets, multiferroics, etc.) is largely determined by the state of the art of creating these films. First of all, this is due to the size effects, the density of structural defects and the nature of interaction with the substrate. Thin ferroelectric films of lead zirconate titanate (PZT) are among the most important in the creation of ferroelectric memory devices and ferroelectric microelectromechanical systems (MEMS), as well as sensors of physical quantities and converters energy [1-4]. The use of nanoscale ferroelectric films requires solving a number of technological problems. First of all, these are the tasks of choosing materials, optimizing the composition and thickness of the film, the homogeneity of the film structure, etc. [5, 6]. Herewith, an important problem formation of PZT films is their thermal annealing in order to achieve the optimum crystalline structure and electrophysical parameters films at the minimum heat treatment temperature them. The advantage of rapid thermal annealing (RTA) in comparison with isothermal treatment, is the possibility of selective annealing of the PZT lay by selecting the appropriate temperature, duration and speed of the RTA [7]. The positive effect of RTA on the structure and electrical properties of PZT thin films was noted, for example, in [8–10]. The purpose of this work is identification the optimal modes of RTA with halogen lamps to change the phase-structural state of PZT films.

2. Experimental

Ferroelectric PZT thin films of composition $Pb(Zr_{0,3},Ti_{0,7})O_3$ of were deposited by oxygen atmosphere high-frequency reactive plasma sputtering on p-type silicon (100) substrates and on the similar silicon substrates with SiO_2 on surface. High-frequency reactive plasma sputtering was performed on the installation "Plasma 80 SE". PZT films were formed at a power of 400 W, a substrate temperature of 400 °C and an oxygen pressure in the chamber of 0.45 Torr for 30 minutes. The thickness of formed PZT film was 1.0±0.1 μm. After deposition the film, PZT was subjected to RTA by halogens lamps in air at temperatures of 600–800 ° C and speed 60 degrees/s. Rapid thermal annealing was carried out on the installation ITO-18M [11]. The surface of the initial samples and the samples after the RTA were examined using an electron microscope Nova NanoLab 600 - figure 1. The film thickness was measured using an MII-4 optical microscope. X-ray diffraction (XRD) analysis was performed on a DRON-3 unit at the CuK_α wavelength - figure 2. The results of the study of the structural-phase composition of the PZT films are presented in table 1.

3. Results and discussion

The surface morphology of PZT films before and after RTA at 700 °C is shown in figure 1.



a) b)

Figure 1. SEM images of the surface of the PZT films on silicon before annealing (a) and after RTA at 700 ° C (b).

XRD analysis was performed by comparing the form of diffractograms with the card 01-070-4055 from the PDF-2 database. To highlight the diffractogram peaks in the background of noise, a Savitzky–Golay smoothing filter with an interval width of 7 was used. The initial phase structure of the PZT film formed on both oxidized silicon and silicon plain substrates was identical and is shown in figure 2, diffractogram a.

Studies have shown that the influence of all RTA temperatures on the structure of PZT films formed on oxidized silicon substrates was catastrophic. The perovskite structure of PZT in all cases was transformed into a pyrochlore structure. Further investigation of such films became impractical.

At the same time, it was seen for the PZT films that the polycrystalline perovskite structure of the PZT is formed in the direction of crystal growth (110) and (001) with pronounced preferential directions (110) - figure 2, diffractograms b, c, d. The measured ratio of the intensities of the peaks I_{100}/I_{110} was 0.49-0.52 for the PZT samples that did not were exposed RTA and was expose the RTA at 500 °C and 600 °C. The ratio of peak intensities decreased to 0.43 for a sample annealed at a RTA temperature of 700 °C - figure 2. It can be seen that, at a temperature of RTA of 700 °C, a more pronounced formation of a crystalline perovskite (110) structure occurs. This trend is also noticeable in the growth of the size of the areas of coherent scattering of X-rays from PZT crystallites.

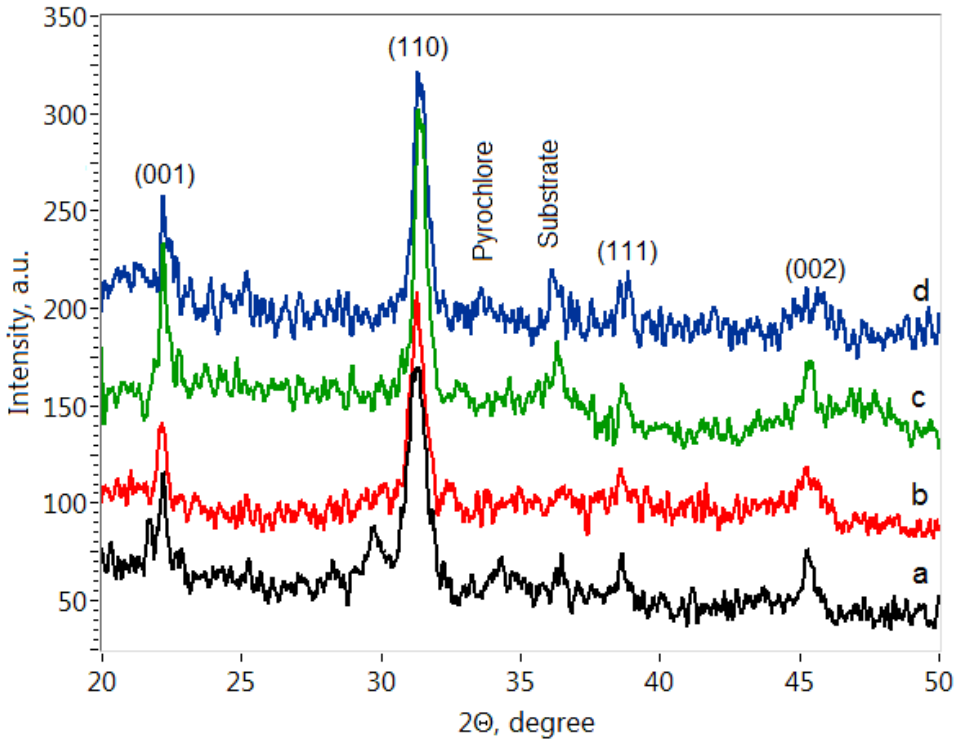


Figure 2. XRD patterns of PZT films before (a) and after RTA in the mode of 500 °C (b), 600 °C (c) and 700 °C (d).

The size of the coherent scattering regions was estimated using the Scherrer's equation [12]. The size of the coherent scattering regions of the perovskite (110) structure increased more than twice: from 13.1±0.3 nm for the PZT film without annealing to 30.3±4.9 nm for the sample annealed by RTA at temperature of 700 °C. At the same time, the size of the regions of coherent scattering of crystallites of the perovskite (100) structure decreases from 51 to 17.6 nm. A similar behavior of the perovskite structure for isothermal annealing was observed in [13, 14].

The growth of the crystallinity of the structure with increasing temperature RTA affects the increase in the sizes of the PZT blocks. The measurements were carried out on the basis of SEM images of the surface of the PZT films before and after the RTA – figure 1. From table 1 and figures 1 it can be seen that as the RTA temperature increases, the block size on the surface of the PZT film increases: from 117±3 nm, for the PZT film without annealing to 285±5 nm for the sample annealed by RTA temperature of 700 °C. The latter suggests that as the temperature of the RTA increases, a PZT film is compacted, which is also confirmed by a decrease in the PZT film thickness with an increase RTA temperature – table 1.

Table 1. Dimensional factors PZT film

Sample	PZT block size (nm) (SEM image)	Size of coherent scattering regions from (001) crystallite (nm) (XRD analysis)	Size of coherent scattering regions from (110) crystallite (nm) (XRD analysis)	Film thickness (μm)	I_{100}/I_{110}
Without RTA	117	51	13	1,2	0.52
RTA 500	132	47	20	1,2	0.49
RTA 600	155	47	26	0,9	0.51
RTA 700	285	18	30	0,8	0.43

Studies shown that RTA leads to a qualitative change in the phase-structural state of the PZT film compared to its initial state. RTA of PZT films on oxidized silicon substrates, the perovskite structure of PZT films is transformed into the pyrochlore structure. RTA of PZT films on non-oxidized silicon substrates, reverse processes occur, namely, their crystallinity improves. On the one hand, a more pronounced formation of the crystalline perovskite (110) structure occurs. This is expressed in an increase size of the regions of coherent scattering of crystallites and a decrease in the intensity ratio of the I_{100}/I_{110} peaks. On the other hand, a seal of the PZT film is observed, which is expressed in an increase in the size of the PZT blocks and a decrease in the film thickness at higher RTA temperatures. Data analysis showed that PZT films annealed at 500 °C – 600 °C have the best uniformity. The structure of studied films is represented by nanoscale grains with an average size of 20–47 nm, some of which form columnar clusters that form in the direction of film growth, and is characterized by different grain sizes. The average grain size, the degree of granularity, and the number of columnar clusters in PZT films in range 500 °C – 600 °C RTA less than in other films studied.

4. Conclusions

The results obtained indicate that the observed differences in the structure and phase composition films of the initial state and after the RTA are mainly due to the existence and difference temperature gradient arising in the RTA process. Also, it should be noted that RTA leads to an increase in the crystallinity of PZT film and to the compaction of PZT film. Thus results of experimental studies have shown the possibility of using RTA in the formation of PZT films.

The results were obtained using the equipment of the centers for collective usage “Microsystem Engineering and Integrated Sensory” and “Nanotechnologies” of Southern Federal University.

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Temperature Dependence of Electrical Properties of ZnO Nanorods Array

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Abstract. Zinc oxide nanostructures (nanotubes, nanorods, nanowhiskers, etc.) are a promising material for various electronics devices for power system and green energy such as piezoelectric energy harvesters and solar cells. Electrical properties of ZnO nanorods grown on a glass substrate by the hydrothermal method in an aqueous solution of zinc nitrate were investigated in this work. The SEM micrograph shows that the grown nanorods are vertically oriented and the XRD pattern confirm its crystallanity with (002) preferred orientation. The temperature dependent resistivity of ZnO nanorods array measured from 300 to 523 K shows temperature hysteresis and region with positive temperature coefficient of resistance at the heating that was not observed at cooling. The origin of this behavior is explained with the two competing processes - thermal generation of electrons and oxygen species adsorption on the ZnO surface. Oxygen adsorption leads to decrease in the number of oxygen vacancies that are electron donors, and consequently to a decrease in conductivity of ZnO nanorods. The values of activation energy of conductivity were calculated from the slope of linear regions on the Arrhenius plot which are 0.246, 1.466 and 0.248 eV for the heating curve and 0.650 and 0.315 eV for the cooling curve.

1. Introduction

Zinc oxide (ZnO) is wide band-gap semiconductor and promising material for various electronics devices for power system and green energy such as piezoelectric energy harvesters and solar cells, gas sensors [1]. Recently, considerable attention has been paid to the formation and investigation of the ZnO nanostructures (nanotubes, nanorods, nanowhiskers, etc.) which used in functional electronics devices [2, 3]. Therefore, an urgent task is to establish the mechanisms of electrical conductivity in such nanostructures and to study the influence of external influences on them, such as temperature. In this paper, we studied the effect of temperature on the resistance of an array of nanorods.

2. Experimental

An array of ZnO nanorods was grown by hydrothermal technology in an aqueous solution of zinc nitrate $Zn(NO_3)_2$ $6H_2O$ and hexamethylenetetramine $C_6H_{12}N_4$ on a glass substrate during 1 hour at temperature 95 °C [4, 5]. The surface morphology was studied using a scanning electron microscope (SEM) Nova NanoLab 600, and X-ray diffraction (XRD) analysis to study the crystal structure was done in a MiniFlex Rigaku diffractometer with CuKα radiation. The difractogram of polycrystal ZnO (JCPDS card no. 00-001-1136) was used to characterize the phase composition of nanorods. To measure the electrical parameters of the material, metal contacts V-Cu-Ni with a thickness of 0.2-0.3

μm were applied to the sample surface by vacuum deposition. Resistance measurements in the temperature range of 300–523 K were carried out using a Keithley 2450 sourcemeter.

3. Results and discussion

SEM studies have shown that the formed ZnO nanorods are mainly vertical, however, a significant number of nanorods are in contact with each other. Nanorods have a length of up to 0.5-0.6 μm [5] and an average transverse size of about 30-40 nm (figure 1). XRD analysis showed that the predominant growth direction of zinc oxide during the hydrothermal synthesis of ZnO nanorods is the direction (002) (figure 2).

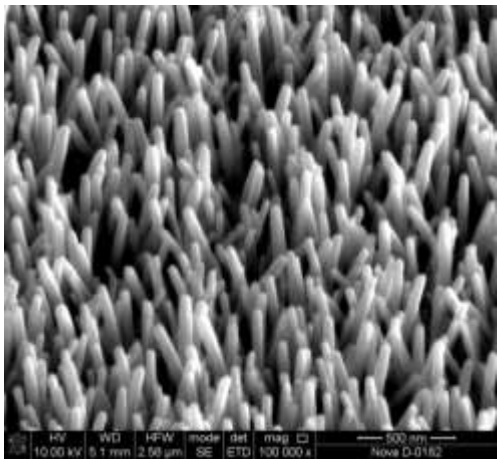


Figure 1. SEM micrograph of ZnO nanorods array

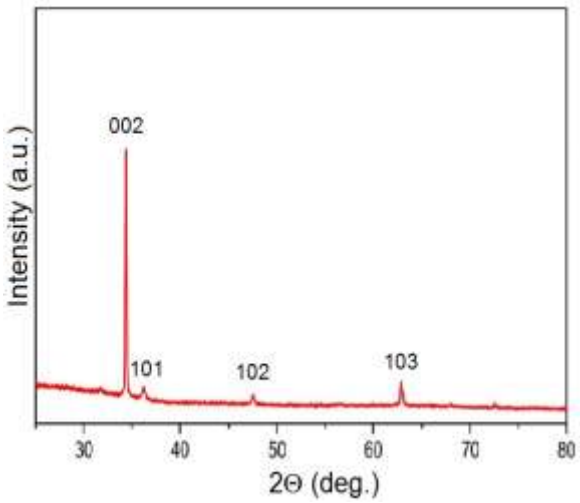


Figure 2. XRD pattern of ZnO nanorods

The temperature dependence of the resistance shows that the heating and cooling curves at temperatures above 373 K do not coincide, that is, there is a temperature hysteresis (figure 3).

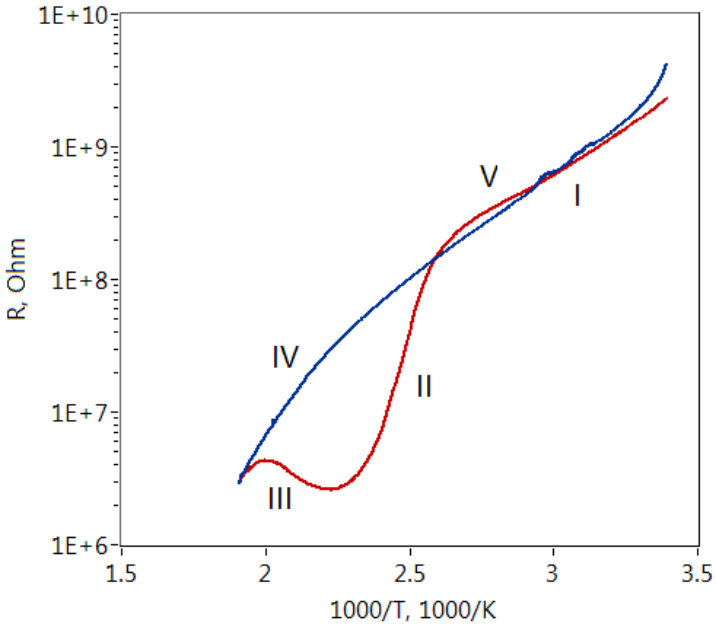


Figure 3. Temperature dependent resistivity of ZnO nanorods array

On this dependence, we can distinguish regions that are well approximated by the Arrhenius equation [6]:

$$\rho = \rho_0 \exp\left(\frac{E_a}{kT}\right), \quad (1)$$

where ρ_0 is preexponential factor, E_a is activation energy of conductivity and k is Boltzmann constant. Three such regions can be distinguished on the heating curve – I, II and III, and two on the cooling curve – IV and V (Figure 2). The values of the activation energy of the conductivity of a ZnO nanorods array calculated by equation (1) are given in Table 1.

Table 1. Activation energy of the conductivity of a ZnO nanorods array

Region	Temperature band, K	Activation energy of conduction (E_a), eV
I	300 ÷ 373	0.246
II	390 ÷ 423	1.466
III	450 ÷ 493	0.248
IV	523 ÷ 463	0.650
V	400 ÷ 300	0.315

It is known that the electrical conductivity of zinc oxide is determined by oxygen vacancies, which are electron donors [2], and, accordingly, the activation energy of conductivity is determined by donor levels formed by vacancies in the forbidden zone of ZnO. During heating, in regions I and II, the decrease in the resistance of the sample with increasing temperature is determined by the thermal generation of electrons. The different activation energy of conductivity for these regions indicates that two different donor levels are sources of electrons.

Region III is a region with a positive temperature coefficient of resistance; it is observed only during heating and is absent upon cooling. A similar behavior of the electrical resistance of zinc oxide with temperature was observed in [7], where sintered ZnO was studied. The increase in resistance with increasing temperature in this area can be explained by the influence of adsorbed oxygen. Oxygen molecules in the atmosphere at temperatures of 373–573 K are adsorbed on the surface of zinc oxide and become negatively charged due to the capture of electrons from near-surface ZnO layers [8]:

$$O_2(\text{gas}) \leftrightarrow O_2(\text{ads}) \quad (2)$$

$$O_2(\text{ads}) + e^- \leftrightarrow O_2^-(\text{ads}) \quad (3)$$

$$O_2^-(\text{ads}) + e^- \leftrightarrow 2O^-(\text{ads}) \quad (4)$$

$$O^-(\text{ads}) + e^- \leftrightarrow O^{2-}(\text{ads}) \quad (5)$$

This leads to the formation of a depleted layer in the near-surface region of ZnO nanorods and a decrease in their conductivity [9]. The activation energy of conductivity on this site will correspond to the energy of oxygen adsorption. A further decrease in resistance after region III is probably caused by the predominance of thermal generation of electrons.

When the temperature-decreases, extremums on the temperature dependence of the resistance is not observed, that may be due to the lack of oxygen species desorption. Sections IV and V on the cooling curve also correspond to two different values of the activation energy (Table 1).

Thus, the variations in conductivity during heating and cooling is due to two competing processes– thermal generation and recombination of electrons on the one hand, and their capture by oxygen

adsorbed on the surface on the other. Moreover, if in the first case, the equilibrium concentration is established almost instantly, then in the second it depends on the speed of the processes of adsorption and desorption. The presence of hysteresis in the temperature dependence of the conductivity indicates low rates of these processes, comparable with the rates of heating and cooling.

4. Conclusions

The temperature dependent resistivity of ZnO nanorods array obtained by hydrothermal method has been investigated. The values of activation energy of conductivity were calculated from the slope of linear regions on the Arrhenius plot. The origin of thermal hysteresis is explained with the two competing processes – thermal generation of electrons and oxygen species adsorption on the ZnO surface.

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Utilization of rice straw and used paper for the recycle papermaking

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Abstract. Rice Straw is one of the most important materials that has been used for pulp and paper production due to its abundance and cost-effectiveness. However, the pulping and papermaking characteristics of the mixture of rice straw and used paper have rarely been investigated. In this experiment, delignified rice straw was mixed with used paper in order to make recycle papers with acceptable properties. Soda pulping process was carried out to remove out of lignin. The delignification was designed to measure the effects in terms of sodium hydroxide concentration and temperature, on the cellulose and lignin content of rice straw, and its tensile strength and water absorption. The mass ratio of used paper and rice straw was varied and observed its physical properties and compared to paper from natural rice straw. The delignification was conducted using NaOH concentrations (4-10%w) and temperatures (60-90^{o}C) for 1 hour. Ratio of rice straw to used paper was varied (1:1-1:9). This optimum condition was obtained from rice straw delignification at NaOH concentration of 8% and temperature of 90°C. The results of the optimum condition obtained the highest amount of cellulose content and tensile strength while the lowest amount of lignin content and water absorption.

1. Introduction

In recent years, the three major problems that would continue to puzzle the development of the paper industry are the shortage of resources, the contamination of the environment and the level of technical equipment. The most dominating factor is the shortage of raw material resources, which is largely due to the contradiction between the structure of the raw materials and the structure of the fibre resources. Thereby, non-wood fibres possess a rich variety of excellent properties in physical and optical aspects, which could be used to improve their products. Production of pulp from non-wood resources has many advantages, such as easy pulping capability, excellent fibres for the special types of paper In some developing countries, about 60-80% of the cellulose fibre comes from non-wood materials, such as bagasse, rice straw, corn straw, bam-boo, reed, grass, jute, flax, sisal, and so on [1]. Particularly, in developing country such as Indonesia, the raw materials from non-wood plants are potential to use in fibre source for papermaking.

Indonesia is the third largest country in the world in producing rice. The total harvested area of rice is 15,697 million acres and the production reaches to 81,073 million tons. The amount of rice straw disposal as by products of paddy milling is 40.537 million tons about a half of total rice production

[2]. Rice straw is one of the most important materials that has been used for pulp and paper production due to the cellulose content is high enough. Rice straw contains of 33-40% cellulose, of 24-28% hemicellulose and of 2-25% lignin [3]. The production of paper is essentially a process of removing the lignin contained in the fibre of raw materials in order to obtain a high cellulose content and low lignin content in pulp or paper [4]. The soda process has been known to be the oldest and simplest pulping process. It is also applicable to leafy and conifer wood and non-wood raw materials**,** such as agricultural residues [5, 6].

Research of papermaking rice with a variety of processes and additional raw materials have been done by several researchers, among others: Influence of rice straw cooking conditions in the soda-ethanol-water pulping on the mechanical properties of produced paper sheets [7], feasibility of rice straw as a raw material for the production of soda cellulose pulp [5], two step soda pulping processes of rice straw for the recycle papermaking [8], pulping of wheat straw with caustic potash-ammonia aqueous solutions and its kinetics [9]. The effects of sodium hydroxide content on mechanical and physical properties of rice straw paper [10]. In spite of several study in rice straw soda pulping, little research has been conducted on the pulping and papermaking characteristics of the mixture of rice straw and used paper or waste paper [11].

In addition, over the last decade, waste minimization, reuse, as well as material recycling have received increased attention due to the governing waste management's regulations and legislations in both national and international scope. As secondary fibre resources, waste paper has an important role to meet the demand of cellulose industries [12]. Waste paper which has been recycled are needed in the process of papermaking, hence, the consumption of waste paper keep increasing by year. This fact has a positive impact of preserving virgin natural fibre to a great extent. The recycling process of the conventional office paper reduces the abundance of waste paper. Moreover, after being cleaned and reformed, used paper could be converted back into pulp. In this experiment, in order to obtain recycle papers with desirable properties, rice straw was delignified with different NaOH concentrations at different temperatures during soda pulping prior to mixing with office waste papers. The delignification was designed to measure the effects in terms of sodium hydroxide concentration and temperature on the cellulose and lignin content of rice straw, and its tensile strength and water absorption to establish the optimum operating pulping conditions. The ratio of used paper mixture to rice straw was varied in order to observe the physical properties (tensile strength and water absorption) of recycle paper and compared with delignified natural rice straw paper.

2. Experimental

2.1 Materials

Rice straw from Mojokerto, East Java, Indonesia. NaOH, 95% (PT Chiwi Kimia), etanol 95%, benzena p.a, sulfuric acid, 72%, and oxylic acid p.a

2.2 Soda Pulping Process

The wastes of rice straw were cut, milled, and screened prior to pulping. In the soda pulping process of rice straw, various NaOH concentration (4, 6, 8, 10) %, delignification temperature (60, 70, 80, 90)^{o}C were varied. Rice straw was delignified with NaOH solution with a ratio 1:17 (w/v) in a laboratory flask for 1 hour. The resulting pulp was neutralized by washing with water. Delignified rice straw was added with water and blended with motor stirrer in 300 rpm. The mixtures were poured into a filter and pressed by water aided by a gravity force to remove out water. The resulting cake was a sheet of paper which was then dried in the oven for further characterisations, such as the evaluation of chemical composition (cellulose and lignin contents**)** and physical properties (tensile strength and water absorption).

2.3 Papermaking process

Recycle papers were made by mixing delignified rice straw and used paper with a various mass ratio of 1:1, 1:3, 1:5, 1:7 dan 1:9. Waste papers were cut into small pieces, added with water, and then blended. Delignified rice straw were added with water and then blended before being mixed with blended waste papers. The mixtures were poured into a filter and pressed by water aided by a gravity force to remove out water. The resulting cake was a sheet of recycle paper which was then dried in the oven for further physical properties characterisations (tensile strength and water absorption).

2.4 Paper characterisations

The evaluation of the chemical composition of pulp and paper was characterized chemically in accordance with the applicable Indonesian National Standard (SNI), which are : cellulose (SNI 0444-2009), lignin (SNI 0492-2008) as well as kappa number determination (SNI 0494:2008). Further for physical characterisation, such as the measurement of tensile strength and water absorption was conducted. Tensile strength was measured using autograph (SNI ISO 1924-2:2010) for the water absorption measurement with Cobb method (SNI 0499:2008).

2.5 Experimental Design

In this experiment the relation of input variables and output variables were regression modelled using a second order polynomial equation.

$$Y_1 = \beta o + \beta_{1.} X_1 + \beta_{2.} X_2 + \beta_{11} X_1^2 + \beta_{22} X_2^2 + \beta_{12.} X_{1.} X_2 \quad (1)$$

where X_1 and X_2 are independent or input variables, i.e. NaOH concentration, delignification temperature.Y_i (i = 1-2) is the response or output variables, i.e. cellulose, lignin content, tensile strength and water absorption. βo is a constant, β_1 and β_2 represent the linear coefficients, whilst β_{11} and β_{22} are the quadratic coefficients, β_{12} is the interaction coefficients**.** The result of the physical test was analysed by statistic with 95% significant level. The software Microsoft Excel was performed to analyse the results in the form of analysis of variance (ANOVA).

3. Result and discussion

In this soda delignification process, NaOH concentration, temperature was varied in order to obtain the optimum condition. In Table 1, eight experiments conducted, together with the delignification process conditions and their corresponding with chemical contents (cellulose and lignin) and physical properties (tensile strength and water absorption).

Table 1. Delignification conditions and Experimental Results of Pulping Process Including Cellulose and Lignin content, Tensile Strength and Water Absorption

C_{NaOH} (%)	T (°C)	Cellulose (%)	Lignin (%)	Tensile Strength (N/mm²)	Water Absorption (g/cm2)
4	90	74,218	5,484	2,143	195,665
6	90	76,839	4,776	2,700	195,030
8	90	79,490	3,958	4,364	193,576
10	90	74,583	4,175	4,175	191,029
8	60	71,655	10,775	1,083	253,964
8	70	73,175	10,163	1,125	220,624
8	80	74,779	9,668	1,179	190,976
8	90	79,380	4,576	3,917	185,667

Table 1 shows that for variations of temperature 60°C-90°C in a concentration of NaOH constant at 8% of the increasing temperature will increase the cellulose content followed by the decrease in the

lignin content in the paper resulted. The reason is the increasing of delignification temperature will increase the rate of delignification in NaOH solution [9]. Thus, lignin will be more easily dissolved in NaOH. The highest cellulose of 79.38% and the lowest lignin of 4.576% were obtained at delignification temperature of 90°C.

Tensile strength was generally influenced by the fibre length and molecular bonds. The longer the cellulose fibres and the stronger of molecular bonds they would be, the higher the tensile strengths of the paper it would be**.** The removal of the lignin in the cell will increase the molecular bonding between cellulose fibres, thus it would increase the tensile strength. The higher concentration of NaOH**,** it is used in delignification, the more lignin could be dissolved and decreased the surface roughness. It indicates that the paper has improved fibre structure with fine arrangement to each other, therefore it could be able to improve fibre properties as well as strengthen bonds between the fibres [10]. However the possibility of the cellulose fibres degradation increases as NaOH concentration, the tensile strength decreases at concentration of NaOH above 8%. The same trend was observed by the variations in delignification temperatures. The increase in temperature would increase the delignification process so it would increase the tensile strength, on the contrary, the water absorption would decrease. The lowest water absorption reaches at 90°C.

The result of experimental data (Table 1) was fitted with a second-order polynomial model by performing multiple linear regressions (equation 1). The results of the experiment have been summarized in Table 2 and p-value presented in Table 3.

Table 2. Linear and non-linear coefficient resulted from the experimental design of dependent variables (pulp composition and physical properties) according to Equation (1)

Dependent Variables (Yi)	βo	β_2	β_1^2	β_2^2	$\beta_1.\beta_2$	R^2
Cellulose (%)	1,24	-0,014	-50,72	$6,23x10^{-5}$	0,081	0,932
Lignin (%)	-0,46	0,017	2,94	$1,23x10^{-4}$	$6,96x10^{-3}$	0,97
Tensile Strength (N/mm²)	41,81	-1,109	$1,61x10^{3}$	$6,53x10^{-3}$	2,65	0,868
Water Absorption (g/cm^2)	827,76	-14,496	$2,51x10^{3}$	$8,49x10^{-2}$	-5,09	0,998

Table 3. p-value (α=5%) resulted from the experimental design of dependent variables (pulp composition and physical properties) according to Equation (1)

		p value	(α=5%)		
Dependent Variables (Yi)	Intercept	X_2	X_1^2	X_2^2	$X_1.X_2$
Cellulose (%)	0,030	0,743	0,029	0,313	0,027
Lignin (%)	0,104	0,992	0,739	0,031	0,616
TS (N/mm²)	0,124	$8x10^{-10}$	0,138	0,134	0,123
WA(g/cm^2)	$9,64x10^{-3}$	$9,8x10^{-10}$	0,688	0,033	0,604

Table 2 shows that all the dependent variables were high validity of model fitting with the experimental ($R^2 \geq 0,9$). According to p-value in table 3, it indicated that the independent variables to dependent variables have significantly influenced when $p<0.05$. During the delignification process, the concentration of NaOH in the quadratic function (X_1^2) as well as the interaction between concentration and temperature ($X_1.X_2$) on cellulose content has significant influence ($p < 0.05$). On the other hand, the lignin content would follow the quadratic function of temperature (X_2^2). Furthermore, the tensile strength of the resulting paper follows the linear function of temperature (X_2), while the influence of temperature on water absorption follows the linear function (X_2) and quadratic function (X_2^2).

The effect of the ratio of used paper and rice straw (1:1, 1:3, 1:5, 1:7, 1:9) on tensile strength and water absorption are presented in figure 1 and figure 2. Based on Figure 1, the tensile strength of recycle paper decreases as the percentage of the used paper in the mixture is increasing. However, the overall tensile resistance of used paper mixture with delignified rice straw was still greater compared to natural delignified rice straw. Used paper contains fibril natural fibres, therefore when reformed to the recycle paper, the paper strength will decrease. In the production of paper, the additive needed to make the better performance of paper in term of physical or mechanical properties. During the mechanical pretreatment process, the additive or filler could be removed and replaced by short fibre. The more composition waste paper is used, it will decrease hydrogen bonds resulted of short cellulose fibre source. The composition 1: 1 obtained the highest tensile resistance is 8.649 N/mm², while the tensile on natural delignified rice straw paper is 4.364 N/mm². The tensile strength of the recycle paper from the mixture used paper and rice straw was compared to commercial paper. The tensile strength obtained from the commercial standard of paper properties is 10.833 N/mm².

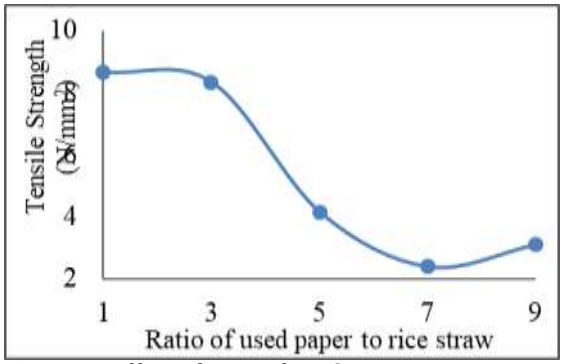


Figure 1. Effect of ratio of used paper to rice straw on tensile strength

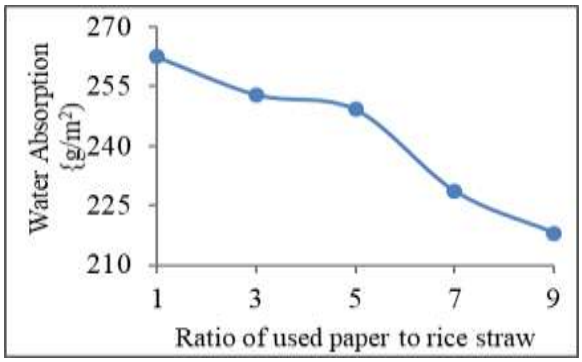


Figure 2. Effect of ratio of used paper to rice straw on on water absorption

In Figure 2, the more composition of used paper in the mixture will reduce the amount of water absorption. It is caused there has been already a "sizing agent" additive on used paper. This additive aims to make the paper more hydrophobic, therefore when paper used for writing can be able to prevent excessive spread of ink.

The optimum pulping condition achieves using NaOH concentration of 8% at 90^{o}C based on the relatively the highest tensile strength and the lowest water absorption measured, i.e 8.648 N/mm² and 185.667 gr/m². This Kappa number determined at this condition was 4.499, which the kappa number requirement white paper stock was less than 5. A lower kappa number means that less lignin remains in the pulp, implying that more effectively than a pulp with a higher kappa number [13, 14]. The corresponding measure tensile strength and water absorption commercial recycle paper were 10.60 N/mm^2 and 45 gr/mm^2 respectively. These recycle papers have been suitable for writing/printing papers based on SNI 14 0-937-2005. In order to achieve higher grade standard, several additives were still needed to improve physical or mechanical properties in recycle paper.

4. Conclusion

This optimum condition was obtained from rice straw delignification at NaOH concentration of 8%, delignification temperature of 90°C. The highest % cellulose and the lowest % lignin, tensile strength, water absorption achieved at this optimum condition, such as 79.489%, 3.958%, 4.363 N/mm² and 185.667 gr/m² respectively. For the variable mixture of rice straw and used paper, the highest tensile resistance was 8.648 N/mm² for a ratio of 1:1. The lowest water absorption was 218.025 gr/m² for a ratio of 1:9. This investigation showed the potential of using the agricultural waste of rice straw and the used paper for the recycle papermaking. The recycle papers have achieved the adequate properties required for writing paper, however more suitable if being used as art or wrapping papers.

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Mass transfer kinetic model and removal capacity of acid blue 29 adsorptions onto activated carbon

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Abstract. To date, industrial waste containing dyes is still a problem. One of the promising methods to reduce the dyes content from such waste is adsorption. The purpose of this study is to examine the suitability of kinetic models and to determine the removal capacity of acid blue 29 adsorptions onto activated carbon. Two mathematical models were developed to evaluate the adsorption kinetics. The first model only takes into account the convective mass transfer of the dyestuff to the surface of the adsorbent, while the second model also takes into account the diffusion of the dyes in the adsorbent pore. The result showed that the adsorption process followed the Langmuir equilibrium and the kinetic fits to the second model in which the adsorption rate is controlled by convection mass transfer in the liquid phase as well as the intra-particle molecular diffusion that occurs in the pore. The dye removal capacity inversely proportional to the dye concentration and reaches 86.6% when the initial dye concentration is 75 ppm.

1. Introduction

Up to recent decades, the contamination of industrial waste streams by synthetic dyes still becomes a problem which needs special attention [1]. Dyes are widely used in industries such as cosmetics, leather, printing, paper, food, and textiles. During the coloring process, approximately 10-15% of the dyes will enter the waste stream [2]. It is chemically stable and has very low biodegradability, so that when it enters the environment or to the cell tissues of plants, animals or humans it will persist for a long time [3].

The adverse effect of the presence of synthetic dyes is to reduce the oxygen content and penetration of light in water. Besides, in the ecosystem, the pollutant inhibits photosynthesis and growth of biota [4]. Moreover, it was reported that exposure to a small amount of dye (<1 ppm) can cause several adverse effects such as skin irritation, dermatitis, allergy, cancer and even mutagenic effects on aquatic organisms and human [5].

Many methods and technologies were developed to remove these pollutants such as coagulation, precipitation, filtration, ion exchange, membrane technology, and adsorption. Among these methods, adsorption is seen as a very prospective choice because it is technically simple, high efficiency and economically competitive [6,7].

Studies of acid blue 29 adsorption using different adsorbents have been carried out by several researchers, among others: observation of the removal efficiency using activated carbon-clay composite [8], evaluation of the effect of dyes' structure on the efficiency of the adsorption [9] and investigation of the adsorptive potential of chemically activated olive pomace boiler ash [10]. In this work, acid blue 29 adsorptions onto activated carbon was carried out in a batch system. Two kinetic models were developed, in the first model the transport of adsorbate to be assumed only occurs from

the bulk solution to the particle surface while the second model takes into account the intra-particle diffusion of adsorbate molecules to the active sites through the pore of the particles. The study was focused on investigating the suitability of the two kinetics models for the adsorption system.

2. Theory and experiment

2.1 Adsorption equilibrium correlation

The adsorption equilibrium is the relationship between the concentration of adsorbate in the adsorbent phase and in the fluid phase at equilibrium at a certain temperature. Three mathematical relationships are generally used to represent adsorption equilibrium, i.e: Langmuir (Eq. 1), Freundlich (Eq. 2) and Linear (Eq. 3).

$$\frac{1}{C_\mu} = \frac{1}{C_{\mu,max}} + \frac{1}{C_{\mu,max}\,k}\frac{1}{C_{eq}} \quad (1)$$

$$C_\mu = K\,C_{ceq}^{1/n} \quad (2)$$

$$C_{eq} = HC_\mu \quad (3)$$

where, C_μ: the amount of adsorbate adsorbed per mass of the adsorbent at equilibrium, $C_{\mu,max}$: the theoretical monolayer saturation capacity, C_{eq}: solute concentration in solution at equilibrium, k, K, n: constant, H: a distribution constant.

2.2 Modeling

In this study, two adsorption models were developed, called the first model (the model I) and the second model (the model II). The model I assumes that adsorption only occurs on the surface of the adsorbent and there is no intra-particle concentration gradient. Then model I adsorption mechanism consists of (1) mass transfer of the adsorbate from the solution bulk to the surface of the adsorbent through the film layer on the outer surface of the adsorbent; (2) adsorption of the adsorbate at the surface of the adsorbent.

The first model implies that, in the liquid phase, the rate of decrease in adsorbate concentration is equal to the rate of mass transfer of the solute from the solution to the adsorbent. Meanwhile, the solute mass transfer rate from the solution to the adsorbent will be equal to the rate of accumulation of the adsorbate on the adsorbent. Therefore the following two equations apply to the first model.

$$\frac{dC_L}{dt} = -\frac{k_c A}{V}\left(C_L - C_L^*\right) \quad (4)$$

$$\frac{dC}{dt} = \frac{k_c A}{m}\left(C_L - C_L^*\right) \quad (5)$$

where, C_L: the solute concentration in liquid phase, k_c : the convective mass transfer coefficient, A: the outer surface area of the adsorbent, C_L*: the concentration of the adsorbate at the liquid phase interface, V : the volume of solution, t : time, C : the concentration of adsorbate on the adsorbent and m : mass of adsorbent. The initial condition are: at t=0, $C_L = C_{Lo}$, C = 0. The boundary condition is $C_N = H\,C_L$*, where C_N: concentration of solute at the solid surface.

The second model assumes that the adsorbent is porous media so that the mass transfer of the adsorbate occurs with three mechanisms, namely: (1) mass transfer of the solute from the solution bulk

to the surface of the adsorbent through the film layer of the liquid phase, (2) intraparticle diffusion of solute from the adsorbent surface to the center of the adsorbent through the pore, (3) adsorption of the solute at the active sites in the pore. Assuming the adsorbent particles are spherical and have uniform diffusivity and porosity, the following differential equations apply to the adsorption of the second model.
At the middle of the solid:

$$\left(-De\,4\pi\pi^2\left.\frac{\partial C}{\partial r}\right|_r\right)-\left(-De\,4\pi\pi(+\Delta r)^2\left.\frac{\partial C}{\partial r}\right|_{r+\Delta r}\right)=4\pi\pi^2\Delta r\frac{\partial}{\partial t}\left(\varepsilon C+C_\mu\rho_{ads}\right) \quad (6)$$

At the center of the solid:

$$De\,4\pi\pi\frac{\Delta r}{2})^2(\frac{\partial C}{\partial r})=\frac{4}{3}\pi(\frac{\Delta r}{2})^3(\varepsilon+\frac{\rho_{ads}}{H})(\frac{\partial C}{\partial t}) \quad (7)$$

On the surface of the adsorbent:

$$k_c\,4\pi\pi^{\,2}(C_L-C_L{}^*)=De\,4\pi\pi^{\,2}(\frac{\partial C_N}{\partial r})_{surface} \quad (8)$$

Where, C: concentration of solute at solid, ρ_{ads}: density of adsorbent, ε: ratio of the solution volume to the total volume, ρ_{ads}: adsorbent density, R: adsorbent radius, r: position in adsorbent in the radial system, D_e: effective diffusivity.

2.3. Experiment
The acid blue 29 dye was purchased from a local chemical supplier. Meanwhile, activated carbon was obtained from Merck Millipore. The activated carbon has a particle size <100 μm and bulk density: 150 - 440 kg/m^3. Batch adsorption experiments were carried out using a 250 ml beaker with constant speed stirring using a magnetic bar. The volume of acid blue 29 solutions used in each batch is 100 ml with the initial concentration was varied by 75, 125, 185, 225 and 275 ppm. While the mass of activated carbon used was varied as much as 0.1, 0.1125, 0.125, 0.1375 and 0.15 g. Thus the ratio of the mass of activated carbon to the volume of the solution varies by 0.001, 0.001125, 0.00125, 0.001375 and 0.0015 g/ml. The concentration of acid blue 29 in solution at certain times and at equilibrium was measured using a UV-Vis spectrophotometer - Agilent 8453.

3. Result and discussions

3.1 Equilibrium analysis
At this work, the equilibrium point is considered to be achieved by allowing the adsorption process to take place overnight. The acid blue 29 concentration in activated carbon and in solution at equilibrium obtained from the experiment, which is marked as dots, and plot of Langmuir, Freundlich and Linear equilibrium correlations is shown in figure 1. While the values of the parameters of the equilibrium correlation are presented in table 1. The results showed that the Langmuir and Freundlich equilibrium correlations are better suited to the experimental data than the Linear correlation. Linear correlation generally only applies to low concentrations. Based on the value of the coefficient of determination, the correlation of Langmuir is the most suitable.

Since the Langmuir equilibrium correlation is developed based on the assumption that the adsorbent surface can only adsorb one layer of the adsorbate molecules, then this result confirmed that the acid blue 29 molecules absorbed on the surface of activated carbon form a single layer (monolayer) with an adsorption capacity of 156.25 mg/g. Adsorption of several types of acid dyes

with activated carbon following the Langmuir correlation [11]. The adsorption capacity obtained in this study is higher than that obtained by Marrakchi et al. which is 104.83 mg/g using activated carbon – clay composite [8] and lower than that obtained by Auta et al. Which is 453.12 mg/g using waste tea activated carbon [12].

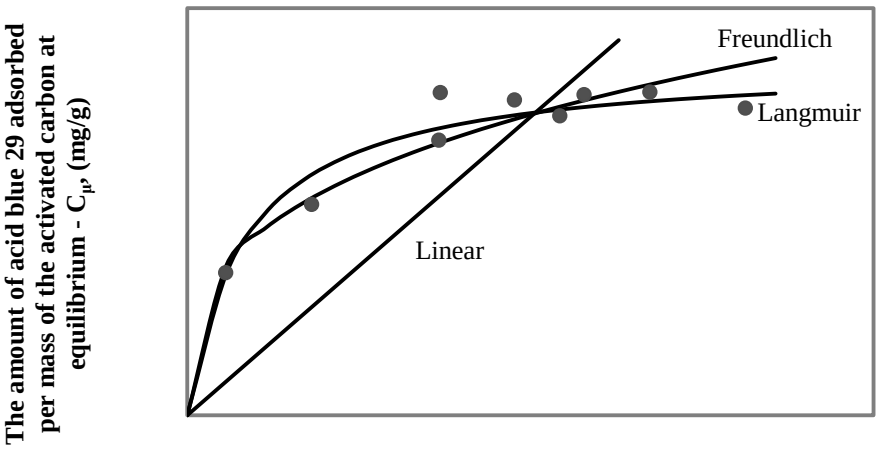


Figure 1. The acid blue 29 adsorptions equilibrium curve on activated carbon

Table 1. Equilibrium parameters of acid blue 29 adsorption on the activated carbon.

Equilibrium adsorption model	Parameters		The coefficient of determination (R^2)
Linear	**H**	**0.063 g/L**	**0.523**
Freundlich	**K**	**31.728**	**0.910**
	1/n	**0.320**	
Langmuir	**k**	**0.067 L/mg**	**0.956**
	$C_{\mu,max}$	**156.25 mg/g**	

3.2 Suitability of the model with experimental data

To solve the first and the second model, the finite difference method was applied. Then, the numerical computation was run to simultaneously solve a set of the differential equations using the Matlab program. In the computation, the adsorption equilibrium parameters obtained from the experiment were used. The numerical computational results, which are the acid blue 29 concentration change concerning to time during the adsorption process, are presented in figure 2 as a continuous line. Meanwhile, the related real values which were obtained from an experiment taken at several certain times were displayed as discrete data in the form of dots.

The results clearly show that the second model is more suitable than the first model. This finding has confirmed that acid blue 29 adsorptions onto activated carbon occurs with a mechanism that involves intra-particle diffusion through the pores of the activated carbon. Both external mass transfer and intra-particle diffusion play a role in dye adsorption. At the initial stages, the external mass

transfer is more significant, while at the final stages the mass transport is mainly controlled by intra-particle diffusion [13].

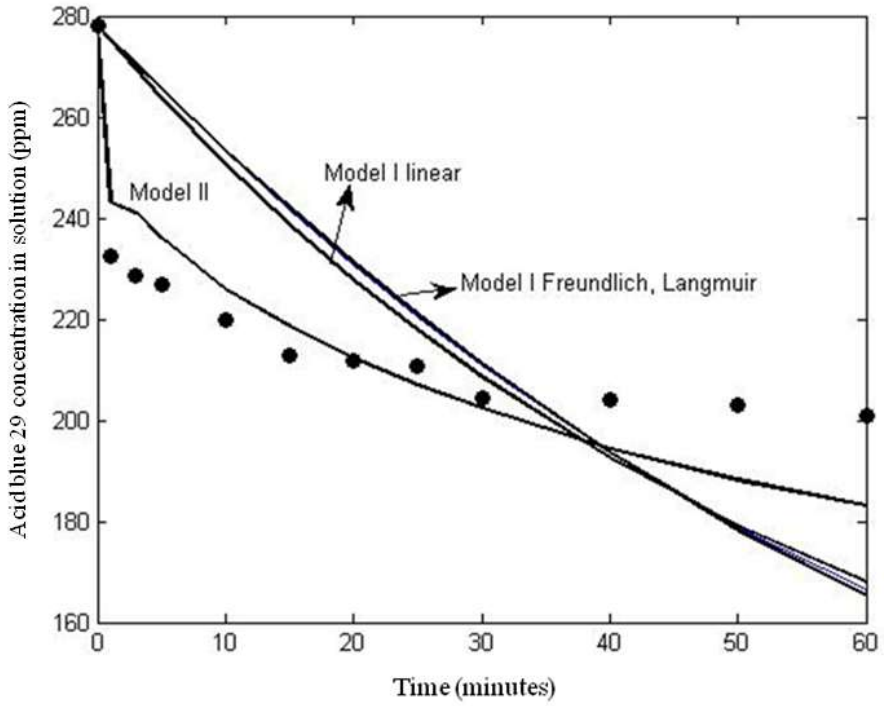


Figure 2. Decreasing the acid blue 29 concentration to the time for the initial concentration of 275 ppm and the ratio of the adsorbent to the solution of 0.001 g/ml.

3.3 The convective coefficient and the effective diffusivity

The output of solving the first model equation is the value of k_c, the convective mass transfer coefficient. It was found that, even though it hasn't changed significantly, the coefficient decreases with the increasing initial concentration of the dye. For the mass of adsorbent to the volume of solution ratio of 0,001 g/ml, the convective coefficient is $6{,}40.10^{-2}$ cm/minute when the initial dye concentration is 75 ppm and it is $0{,}48.10^{-2}$ cm/minute when the initial dye concentration is 275 ppm. A similar trend also occurs in acid dye adsorption kinetics modeling developed by Aksu et al. [14]. Varying the ratio of the mass of adsorbent to the volume solution showed that, even though it doesn't change significantly, the convective coefficient increases with increasing the ratio. For initial dye concentration of 275 ppm, the convective coefficient is $0{,}48.10^{-2}$ cm/minute when the ratio is 0,001 g/ml and it is increase to $0{,}62.10^{-2}$ cm/minute when the ratio is 0,0015 g/ml. Thus this study showed that the value of the convective coefficient is not much influenced by the concentration of the dye in the solution nor the ratio of the mass of adsorbent to the volume of the solution.

Since the second model takes into account the intra-particle diffusion in the adsorbent pores, the outputs of the second model solution are the convective coefficient of the dye in the liquid phase and the effective diffusivity of the dye in the adsorbent particle. From the computation results, it found that the convective coefficient is not affected by the initial concentration of the dye nor the ratio of the mass of adsorbent to the volume of the solution. The average value of the convection coefficient is 0.7248 cm/minute. Meanwhile, the effective diffusivity decreased with increasing acid blue 29 initial concentration, from 1.40×10^{-4} cm/minute at initial dye concentration 75 ppm to 1.64×10^{-6} cm/minute at dye initial concentration 275 ppm at mass adsorbent to solution volume ratio 0,001 g/ml. Besides, it found that the effective diffusivity was not influenced by the changes of the mass adsorbent to the volume of solution ratio.

Decreasing the effective diffusivity at high dyestuff concentrations was also observed in the adsorption of tectilon red acid dyes on granule activated carbon which might be a result of collisions between dye molecules in the pore which caused additional diffusion barriers. Also, at high concentrations, the possibility of agglomeration of dye molecules that have large molecular sizes can also cause micropore-clogging and inhibit diffusion [15].

3.4 Percent removal

In this work, the percent removal of the acid blue 29 is defined as the ratio of the difference between the initial dye concentration in the solution and the concentration at a certain time to the initial concentration. In this study, it was found that the higher the initial concentration of dyes, the smaller the percent removal of the acid blue 29. For radio of mass of adsorbent to solution volume of 0.001 g/ml, the percent removal reached 86.6% when the initial dye concentration was 75 ppm and decreased to 48.8% when the initial dye concentration was 275 ppm. It was reported that the percent removal of dyes by adsorption was in the range of 68% – 99% [16].

4. Conclusions

Acid blue 29 dye adsorption onto activated carbon follows the Langmuir correlation and fits with the second model in which the adsorption rate is controlled by convection mass transfer in the liquid phase as well as the intra-particle molecular diffusion that occurs in the pore. It found that the convective coefficient is independent to the initial concentration of the dye and the ratio of the mass of adsorbent to the volume of solution, on the other hand, the effective diffusivity depends on the initial concentration. The dye removal capacity increase when the initial dye concentration in the solution decrease and reaches 86.6% when the initial dye concentration is 75 ppm.

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Effects of electroculture on shoot proliferation of garlic (*allium sativum* l.)

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Abstract. The Philippines is an archipelago that always experiences yearly devastating typhoons which hinders continuous agricultural crop production. Using an old horticulture technique called electroculture, supplied electric voltage can stimulate plant growth, improve crop quality, and increase crop yields as long as the contributing factors are present – dormancy and essential nutrients. Using garlic (*Allium sativum* L.), three set-ups were prepared: control, 6 V, and 12 V electrocuted systems. Then, the effects of the supplied voltage in terms of plant height were visualized. The reaction of the garlic (*A. sativum* L.) to the application of voltage gave unfavorable results – the average height is relatively higher for the controlled system having 78.2 cm compared to the 6 V and 12 V set-ups of 55.7 cm and 57.1 cm, respectively. However, from the data of the 12th, 17th, 18th, 19th, 20th, 21st, 25th, and 26th day of the experimental period, the electricity applied somehow assisted the plant's growth. Drying and decrease in height were also visible during the 29th day of the experiment. Further experimentation and optimization can be done to substantiate the results of this present work.

1. Introduction

The Philippines is a tropical country where farming is the staple source of food with principal crops growing such as rice (*Oryza sativa*), corn (*Zea mays*), coconut (*Cocos nucifera*), banana (*Musa*), pineapple (*Ananas comosus*), coffee (*Coffea*), and mango (*Mangifera indica*) [1,2]. As one of the major exporter of agricultural products, the rate of production of each crop must be continuous. However, the country always experience yearly devastating typhoons and natural calamities that hinders ceaseless production [3].

In order to compensate for this loss, electroculture, an overlooked planting method can be a promising technique to use. Electroculture is a method of applying electric currents to a plant to assist its seed germination process [4]. The earliest experiments on the subject recorded appear to be those of Dr. Maimbray of Edinburgh in 1746 where he electrified two myrtle plants which in turn gave a positive result [5]. Based on the observations of Palafox (2013) [6], plants that grew beside power lines are healthy. In which they concluded that the plants utilize the electric current produced by the power lines to speed up its growing process. They also considered the contribution of thunderstorm to the plant's germination and growth process, hence, gave a favorable result. Though, some researchers have found out that applying electrical current to a plant decreases its growth rate [7,8] while others

stated that electric current application does not affect the plant's growth [9]. Previous experiments on electroculture use root crops and monocotyledon seed and showed satisfactory results.

Yet, the influence of electricity to garlic (*Allium sativum* L.) plant, which is considered to be a monocotyledon bulb, has never been studied. Garlic (*A. sativum* L.) is an important dry season crop that usually takes about seven to nine months for it to be ready for harvest [10] and the Philippines need about 46,000 metric tons to meet the local garlic (*A. sativum* L.) demand [11].

Thus, this study aims to determine the effects of applying varying electrical voltages (6 V and 12 V) for 30 days on shoot proliferation of garlic (*A. sativum* L.). The influence of electricity will only be based from the observable changes in the height of the garlic (*A. sativum* L.) shoots. The results may lead to an early emergence, a sign of higher produce yields, or a prolonged germination process that will hinder continual harvest. Nevertheless, these collections of data can contribute to the understanding of the electroculture technology in relation to garlic (*A. sativum* L.) and other crop farming. It can potentially alleviate the Philippines' dependence on importation and uplift the agricultural sector in terms of crop production.

2. Materials and Methods

The garlic (*Allium sativum* L.) cloves bought in a local nursery was planted in plastic pots (5.4 in. ◌ 7 in.) with loam soil in an upright position, 2 inches deep from the surface then covered with compost. Watering schedule was set every two days at 12:00:00 PM with 200 mL of water to maintain the dampness of the soil. Also, exposure to sunlight was maintained. A measuring stick was installed until outgrowths are visible.

Electrocution was performed with 6 V and 12 V from a nail buried 1 inch beside where the garlic (*A. sativum* L.) clove was planted attached to battery sources via alligator wire clip. The electricity applied was scheduled same time twice a day (morning and evening) for 5 minutes. A total of three set-ups were prepared – set-up A for the control, set-ups B and C with 6 V and 12 V applied, respectively. Only the favorable conditions for planting garlic (*A. sativum* L.) were maintained. All measurements performed in this study were carried out in three replicate runs and the mean values were reported.

3. Results and Discussion

Figure 1 shows a month-long progress measurement of the garlic (*Allium sativum* L.) plant's average height, expressed in centimeters (cm), for the controlled and electrocuted systems. The average weather conditions recorded during this specific experimental period were as follows: temperature of 27ºC, 0.79% relative humidity, and atmospheric pressure of 1,009.50 mbar.

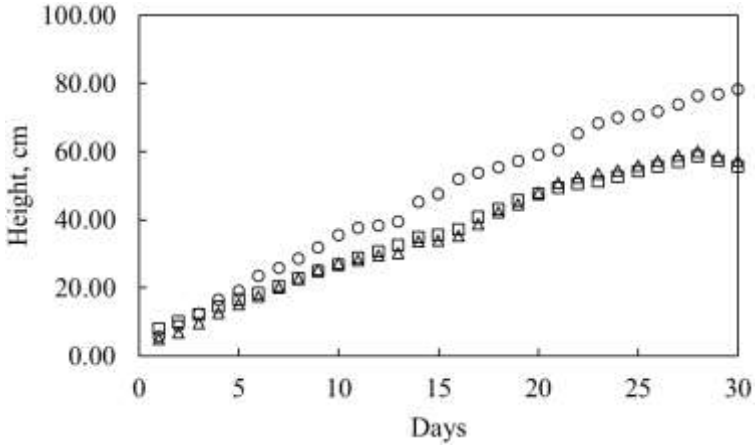


Figure 1. Garlic (*Allium sativum* L.) shoot's height daily progress – Control (◌), 6 V (▯), and 12 V (▬).

As shown in figure 1, the garlic (*A. sativum* L.) plant's average height in the controlled system is relatively higher with value of 78.20 cm compared to the two electrocuted systems – 6 V and 12 V set-ups having only 55.70 cm and 57.10 cm, respectively. However, the tallest outgrowth was first become visible under 6 V having a value of 8.10 cm. Based from the gathered data, application of electricity gave an unfavorable result. Uneven sprouting occurred during the period of the application of electricity. A continuous growth was visible until the 29th day where the outgrowth drying occurred for 6 V and 12 V electrocuted set-ups. These results are comparable to the study conducted by Murr (1964) [7] where leaf tip damage was evident from grain sorghum (*Sorghum bicolor*), orchard grass (*Dactylis glomerata*), yellow bush and wax beans (*Phaseolus vulgaris*), and corn (*Z. mays*). These phenomena were caused by the damages gained by the important cells for metabolism.

Nonetheless, looking at figure 2, based on the daily change in height of garlic (*A. sativum* L.) plant, data on the 12th, 17th, 18th, 19th, 20th, 21st, 25th, and 26th day of the experimentation somehow exhibited enhancement in the garlic (*A. sativum* L.) plant's shoot proliferation.

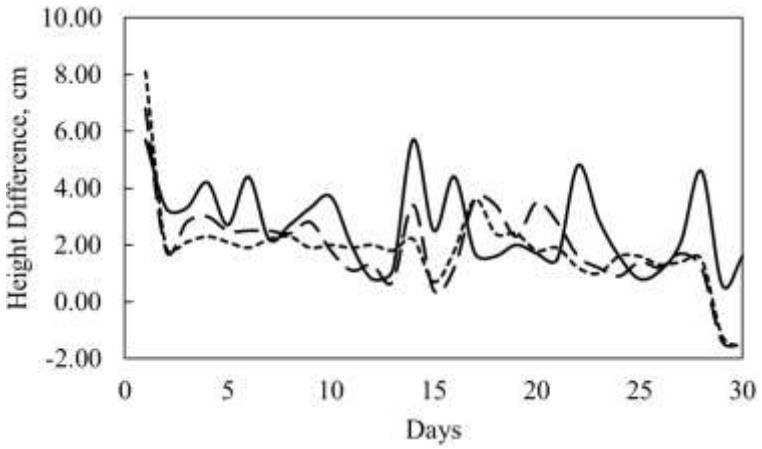


Figure 2. Garlic (*Allium sativum* L.) shoot's daily change in height – control (—), 6 V (— —), and 12 V (_ _ _).

As theorized by Dudgeon (1915), in the presence of electrical liberation, essential nutrients of the soil tend to be more soluble for easy assimilation, the formation of starch and sugar was increased, and all processes were accelerated, thus, an increase activity in the plant [12]. Somehow, the effects of adopting electroculture farming techniques will help to increase the yield unless the planted crop did not undergo dormancy period. According to a study conducted by Woldeyes (2016), three months of dormancy period must be maintained for the crop in order for it to adjust to its environment [13]. In this case, simultaneous application of electricity was performed during this period for visualizing the effects of an accelerating parameter to the plant's growth.

Nutrients, another essential factor for the plant's growth must be present in the soil. As reported by Goldsworthy (2006), cells only respond to artificial current if there are calcium ions available in the environment [14]. Calcium ions act as an accelerator together with the supplied electric current in a process of channel opening. Once a plant sensed a change in voltage, calcium channels (voltage gated) flip open to let calcium ions enter. Also, these ions follow electrical stimulation. The connection of the two parameters to plant growth is the main reason why sometimes, electroculture experiments are not successful.

Another source of disparity is the type of plant used for this experiment. Early experiments utilized plants of different classification that falls under root crops – carrots (*Daucus carota*), potato (*Solanum tuberosum*), and radish (*Raphanus raphanistrum*); and grains – mostly barley (*Hordeum vulgare*), corn (*Z. mays*), and wheat (*Triticum*). Almost all root crops that were subjected to electroculture are all dicotyledon and all grains are monocotyledon. However, garlic (*A. sativum* L.) is considered to be a crop that grows underground having a monocotyledon type of seed. The feasibility of this study to use garlic (*A. sativum* L.) for electroculture planting gave disapproving results. It seems that garlic (*A.*

sativum L.) plant's properties, together with the applied electricity inhibit the metabolic capacity of the plant.

4. Conclusion

The success of electroculture technique depends mainly on the following parameters: dormancy and essential nutrients. Dormancy is a period wherein a crop adjusts to the environment's condition in order for it to survive drastic changes. On the other hand, essential nutrients are needed for the plant's metabolic processes. Comparison between the controlled system vis-à-vis electrocuted systems – 6 V and 12 V set-ups, showed that the electricity supplied inhibits the maximum growth of the garlic (*Allium sativum* L.) plant within a month of experimental period with values of 78.20 cm, 55.70 cm, and 57.10 cm, respectively. During the 29th day of electrocution process, garlic (*A. sativum* L.) experienced dryness and decrease in height for electrocuted systems – 6 V and 12 V set-ups because of the damage received by the important cells for metabolism and growth. Still, based from the data of the 12th, 17th, 18th, 19th, 20th, 21st, 25th, and 26th day of the experimental period, the electricity applied somehow assisted the plant's growth. The electrocution process would be successful if there were calcium ions present in the soil based from records and observations of past researches.

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The use of pyrolusite to remove Pb and Cd in aqueous solutions : isotherm and thermodynamic

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Abstract. The utilization of natural material as an adsorbent to eliminate contaminants in the water is of great interest. Natural material can be directly used without further treatment which may lead to higher environmental impact. In this study, pyrolusite which is immensely available in Indonesia, especially in East Nusa Tenggara, were used to adsorb Cadmium (Cd) and Lead (Pb) in single and simultaneous condition. Several operational parameters such as initial concentration, pH and temperature were applied in order to elaborate the sorption mechanism and to determine the adsorption capacity. The amount of absorbed Cd and Pb were increased at a higher pH and reached the optimum condition at pH 7 for both. The adsorption isotherm for both adsorbate were best modeled following The Langmuir equation, giving an adsorption capacity as high as 108.70 mg/g and 123.45 mg/g for Cd and Pb respectively. Additionally, thermodynamics data showed that the adsorption process in this study was endothermic process.

1. Introduction

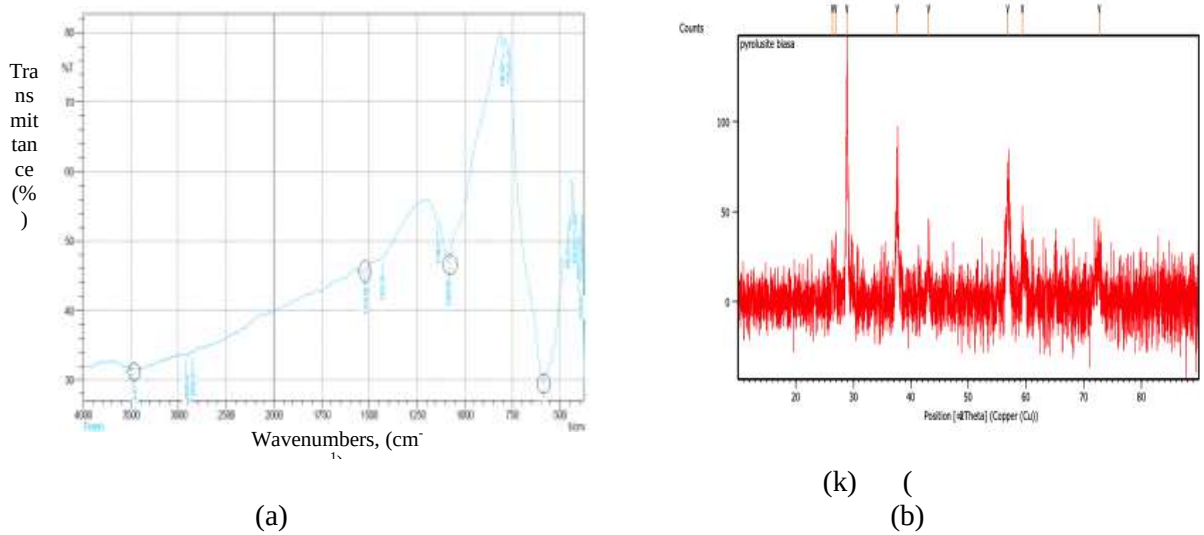
The unexpected presence of Cd and Pb in water system will cause serious effect on human health such as necrosis, proteinuria, gastrointestinal and neurology problem, even lead to malformation and cancer in worst case [1-3]. Therefore, continual effort to find the most feasible technique in order to eliminate Cd and Pb from contaminated water. Chemical precipitation, by adjusting pH of the solution or after coagulation – flocculation process, is considered as the easiest method to remove heavy metals. However, this treatment produces excessive sludge that needs to be further treated [4]. Filtration, including membrane and ultra-membrane system; reverse osmosis and electro-dialysis are other systems, but less effective in term of operational and economic perspective [5,6]. Meanwhile, the application of the biological approach is still ongoing process as stability on the performance need to be improved. Adsorption has been widely used in different scale because of its simplicity in operation and high efficiency over a wide range of concentration [7]. Currently, there are many researches focus on the investigating and/or modifying adsorbent materials in order to find ones that have high adsorption capacity [8]. Assorted materials encompassing natural minerals (soils), industrial by-products (eg. fly ash, steel slag), agricultural products (e.g. rice husk, sawdust, peanut shells), fishing waste (e.g. Shrimp and crab shells) have been reported to have high adsorption capacity [9]. Among those materials, natural minerals (soils) with oxides based content such as Iron and Manganese oxides are highly preferred. Oxides based minerals usually found with poor crystalline structure and known as a potent scavenger of trace metals in soil, sediment and water [1]. Manganese has been known as one of the most common minerals on earth [10]. One of the most important Manganese oxide minerals

is pyrolusite, which has low economical value in natural state. Pyrolusite is massively available in Indonesia especially in East Nusa Tenggara. For this particular mineral, single chains of edge-sharing $Mn(IV)O_6$ octahedral share corner with other chains to build a framework structure accommodating tunnels of square cross sections that are one octahedron by one octahedron [11]. Pyrolusite is an essential material used as an oxidant in organic synthesis and for industrial battery, however information on its potential function in wastewater or water treatment area is still limited. The utilization of manganese (di)oxides as adsorbent for water contaminants have been reported by several papers. Manganese oxide in synthetic form (AMO – amorphous manganese oxide and MOF - manganese dioxide formed in situ) were used to remove Cu, Cd, Pb and Zn [7,12]. The application of beta manganese dioxide (ß-MnO_2) to eliminate Pb(II) in single condition was successfully presented by considering several parameters [1]. Meanwhile the use of natural manganese dioxide to eliminate Cu in aqueous solutions had been successfully presented by Demirkiran (2015), with efficiency as high as 96.5%. In spite of existing information, further investigation is still needed in order to have a better understanding on the performance of pyrolusite as adsorbent for heavy metals. Based on that consideration, a set of batch experiments was conducted to evaluate the mechanism of pyrolusite to adsorb Cd and Pb in aqueous solutions.

2. Materials and Method

2.1. Materials

The entire chemicals used in this study, including $Pb(NO_3)_2$, $CdNO_3$, HCl, NaOH, $KMnO_4$, H_2SO_4 and Sodium oxalate were in analytical grade and no treatment needed prior to the utilization. Pyrolusite, an ore form of manganese dioxide was supplied by a private company in Surabaya. Characterization of pyrolusite were done by titration process to quantify the manganese oxides content, Fourier Transform Infra-red (FTIR, Shimadzu) to identify the surface functional groups and X-Ray diffraction (XRD) in order to determine the structural condition. The content of manganese oxides in pyrolusite was as high as 84.76% (w/w) as described in previous work [4].



(a) (k) ((b)

Figure 1. (a) FTIR spectra for pyrolusite; (b) XRD pattern for pyrolusite.

As described in figure 1(a), the result of FTIR analysis indicating a stretching vibration of Mn-O and Mn-O-Mn bonds at the peak of 590cm^{-1}. Two other peaks, at 1085cm^{-1} expresses a vibration of hydroxyl groups that are joined to Mn atoms, and at 1519cm^{-1} reveals bending vibration of O-H and H_2O which insinuates that water molecule exists in nanostructure. In addition, the rise at peak of 3464cm^{-1} indicating stretching vibration on O-H bond and bending vibration of the absorbed water molecule in the lattice. XRD analysis was conducted with Cu Kœ radiation (1.544À) and operated at the voltage of 40kV and tube current of 30mA. Figure 1(b) portrays the peaks that appear

(2Ø=28.8949°; 37.6337°; 43.0352°; 56.8375°; 59.4419°) are mostly reflection of manganese dioxide (except value at the peak of 2Ø=72.6963°), indicating a relatively high purity of the material.

2.2. Method

All batch experiments in this study were conducted at temperature T=298K and under ambient condition. To evaluate the effect of pH in adsorption process, 200 mL of heavy metal solutions (Cd or Pb) with the initial concentration of 10 mg/L were prepared into conical flask, follow to that 2.5 g/L pyrolusite was added. The flask was put on thermo–shaker for mixing at 160 rpm, and at certain interval sampling was done until reaching equilibrium condition. Sample solutions were filtered using membrane filter 0.45 μm (Sartorius) prior to analysis with UV – Spectrometer (HP series 8453). The desired pH level (4, 5, 6, 7) for both metals solutions was set using either 0.1 M HCl or NaOH. The reduction of heavy metals concentration in aqueous solutions expressed as removal efficiency that can be calculated with equation (1). The adsorption capacity (q_e) was defined by equation (2) and also used in the determination of isotherm models.

Removal efficiency (%) : $= \frac{C_0 - C_e}{C_0} * 100\%$ (1)

Adsorption capacity (q_e, mg/g) : $q_e = \frac{(C_0 - C_e)}{m} * V$ (2)

Where C_0 is the initial concentration of Cd or Pb (mg/L), C_e is the concentration of heavy metals at equilibrium condition (mg/L), q_e (mg/g) is Cd or Pb adsorbed at given mass of adsorbent in the working volume (L). Adsorption isotherm models were developed by running batch experiments in different initial concentrations. The collected data of equilibrium concentrations for each metal were analysed using two adsorption models, Langmuir and Freundlich.

Langmuir : $q_e = \frac{b q_{max} C_e}{1 + b.C_e}$ (3) Freundlich : $q_e = k_f C_e^n$ (4)

where C_e is the heavy metals concentration in the solution at equilibrium (mg/L), b is Langmuir constant related to the affinity of binding sites (L/mg), q_{max} is the maximum adsorption capacity (mg/g), k_f is a Freundlich constant related to roughly adsorption capacity (mg/L), n is the constant related to adsorption density. In order to have an understanding on the effect of temperature, another series of batch experiments in three different temperatures (298K, 308K and 318K) were carried out. Thermodynamic data expressed as values of standard enthalpy change (ΔH°), standard entropy change (ΔS°) and Gibb's free energy (ΔG^0). Those values can be determined by applying these equations:

$K_d = \frac{C_s}{C_e}$ (5) ; $ln\ ln\ K_d = \frac{\Delta S^\circ}{R} - \frac{\Delta H^\circ}{RT}$ (6) ; $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ (7)

where C_s and C_e are the removed and remaining concentrations of heavy metals, respectively. R (8.314 $Jmol^{-1}K^{-1}$) is the ideal gas constant, T is temperature in Kelvin. The values of ΔH^0 and ΔS^0 were defined from the slope and y-intercept on the plot between $ln\ ln\ K_d$ versus $\frac{1}{T}$.

3. Results and Discussion

3.1. Effect of pH

Figure 2(a) depicts the transition of Pb and Cd removal from the aqueous solutions in different pH. The trends were similar for both metals, initially steep at pH 4 to 6 then the change was relatively flat at the pH of 6 to 7. In all pH condition, the removal of Pb was higher than Cd, with the best achievement at pH = 7 which were 84.06% and 81.82% respectively. At acid condition (pH < 7), the

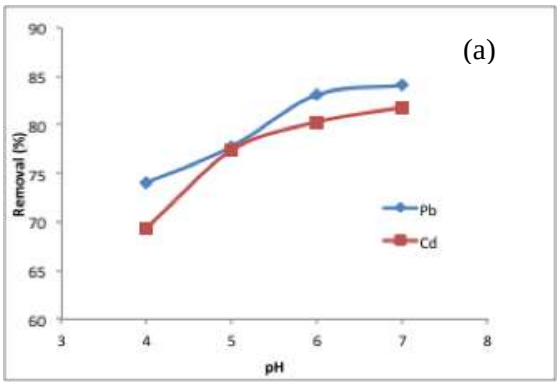
main species of Pb and Cd are Pb^{2+} and Cd^{2+}, thus the removal is mainly driven by adsorption process. The surface charge of pyrolusite will then very crucial in determining the portion of the adsorbed metals. Several papers mentioned that pyrolusite (MnO_2) have a net charge of zero at the pH of 1.4 to 4.5, known as pH_{pzc} (point of zero charge) [13-15]. Lately from a deeper investigation it was confirmed that the pH_{pzc} of pyrolusite is 4.2 [1]. This mean that if the pH solution is above 4.2 the surface charge of pyrolusite will tend to be negative due to deprotonation process, in which hydrogen ions leave the sites [16]. This phenomenon causes the decreasing of electrostatic repulsion between the adsorbent and metal ions, as consequence the interaction will be more intense since electrostatic attraction being dominant. Minor change in the portion of metals removed at pH 6 to 7 can be explained from the speciation of Pb and Cd, at pH 6.69 – 7 for Pb and 9.03 for Cd the solubility of both metals decrease significantly and tend to precipitate (as described in reaction 8 and 9), this instability diminishes the adsorption process.

$$Pb(H_2O)_3OH^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons Pb(H_2O)_2(OH)_{2(s)} + H_2O_{(l)} \quad (8)$$

$$Cd(H_2O)_3OH^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons Cd(H_2O)_2(OH)_{2(s)} + H_2O_{(l)} \quad (9)$$

3.2. Effect of Temperature

The removal of Pb and Cd through adsorption process in three different temperatures is presented in figure 2(b). For both metals, the highest removal was achieved at 318K which were 88.07% and 84.60% for Pb and Cd respectively. The results indicate that the adsorption process of Pb and Cd onto pyrolusite was more favorable at higher temperature. A plausible elucidation for this is that dissolved metals need to destroy the hydration sheaths prior to the adsorption process. The destruction process needs energy, while the adsorption process of metals onto pyrolusite emits energy. The need of energy seems to be more than the available source, thus in higher temperature the elimination of heavy metal ions is more effective. Adsorption mechanism of Pb and Cd on pyrolusite can be evaluated from thermodynamic data, as provided in Table I. The positive value of standard enthalpy (ΔH^o) relates to the information that the adsorption process is endothermic. The low value of ΔH^o in this experiment is similar to that found in [1], confirming that the adsorption process of Pb onto pyrolusite is weak, which also apply for Cd. However, since the value of ΔH^o for both metals is still bigger than 4200 J/mol, the weak adsorption process is still determined by chemical reaction [17]. The negative value of ΔG^o reflects the spontaneity process, at higher temperature the process is more spontant. The lower ΔG^o value the lesser energy required for the attachment process of adsorbent – adsorbate [18]. In this case, the need of energy for adsorption process of Pb to pyrolusite is smaller compared to Cd. The positive value of ΔS^o suggests structural changes in adsorbate and adsorbent creating disorder-ness of the solid-liquid system [19].



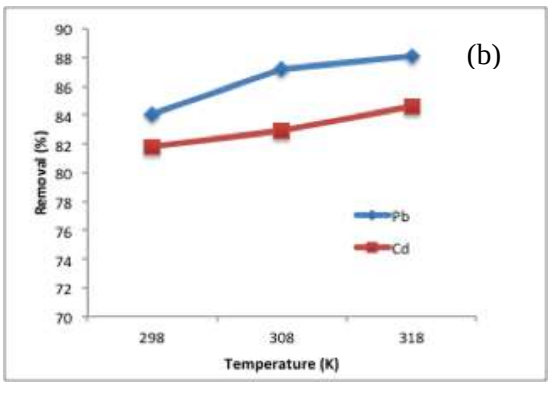


Figure 2. (a) Removal of Pb and Cd in different pH value; (b) Removal of Pb and Cd in different temperature

Table 1. Thermodynamic data of the adsorption of Pb and Cd

T (K)	C_0 (mg/L)	ΔS^O (J/mol.K)	ΔH^o (J/mol)	ΔG^o (J/mol)
		Pb		
298	10	72.18	13335.66	-8173.98
308	10	72.18	13335.66	-8895.78
318	10	72.18	13335.66	-9617.58
		Cd		
298	10	52.15	7851.74	-7688.96
308	10	52.15	7851.74	-8210.46
318	10	52.15	7851.74	-8731.96

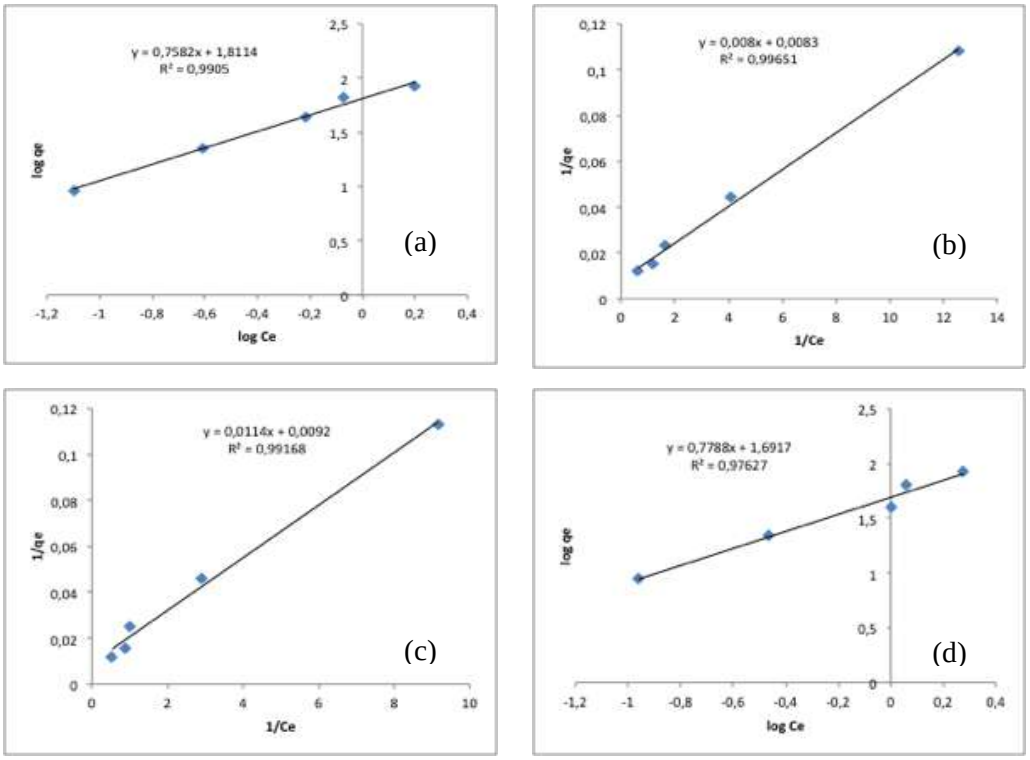


Figure 3. (a) Linear plot of Langmuir for Pb, (b) Linear plot of Freundlich for Pb, (c) Linear plot of Langmuir for Cd and (d) Linear plot of Freundlich for Cd

Table 2. Langmuir and Freundlich isotherm parameters for Pb and Cd

Model	Parameter	Pb	Cd
Langmuir	b (L/mg)	1.01	0.88
	q_{max} (mg/g)	123.45	108.70
Freundlich	K_f (mg/g)	64.71	49.09
	n	0.76	0.78

3.3. Adsorption Isotherms

In this study, Langmuir and Freundlich were applied to identify the isotherms adsorption that can be used to describe the distribution of adsorbate in liquid and solid phase. The collected data of each metal concentration at equilibrium condition (C_e) were plotted versus the amount of adsorbed metal in pyrolusite (q_e) following the equation (3) and (4) for Langmuir and Freundlich model respectively. The result of analysis provides information that for both metals, Langmuir model fit better than Freundlich model to elaborate adsorption process onto pyrolusite (Figure 3), which is expressed by the higher value of R^2 (0.99651 and 0.99168 – Langmuir for Pb and Cd respectively compared to 0.99050 and 0.97627 – Freundlich for Pb and Cd). Langmuir model suggests that adsorption mechanism is driven by chemical process (chemisorption) through three stages, which are external diffusion, internal diffusion and chemical interaction. The finding that Langmuir model is more suitable to the adsorption data also indicates that pyrolusite has homogenous surface and as the result creating identical adsorption activity. Pb and Cd are adsorbed by forming a complete monolayer all around the surface of adsorbate. By that, assumption of interaction between adsorbate following the formation of monolayer as suggested by Freundlich model is negligible. Following to that, the maximum adsorption capacity of pyrolusite for Pb and Cd determined by the preferred model were 123.45 mg/g and 108.70 mg/g respectively. The adsorption capacity of pyrolusite, a natural manganese dioxide, for Pb and Cd is superior if compared to other natural materials. For example, by using kaolin, fly ash, blast furnace slag and bentonite, it was reported the adsorption capacity (mg/g) for Pb were 4.50; 5.00; 5.50 and 7.60 respectively [20]. The use Australian zeolite could reduced Pb and Cd as much as 9.97 mg/g and 6.72 mg/g, comparable to that the Korean zeolite had the adsorption capacity of 8.90 mg/g and 7.10 mg/g respectively [11, 21]. Considering the finding, pyrolusite could be used as an effective and low cost adsorbent for heavy metals

4. Conclusions

Pyrolusite was successfully tested as an alternative adsorbent for Cd and Pb in aqueous solutions. The thermodynamic data and isotherm model that the adsorption process for both metals is endothermic and spontaneous, indicating that chemical reaction drove the mechanism. The adsorption capacity of pyrolusite for Cd and Pb following Langmuir model were 108.70 mg/g and 123.45 mg/g respectively.

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Current perspectives and mini review on zeolitic imidazolate framework-8 (zif-8) membranes on organic substrates

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Abstract. Zeolitic Imidazolate Framework (ZIF) membranes have been considered as promising membrane for gas separation processes due to its robustness and good separation capability. The separation of hydrogen (H_2) from larger gases is one of their potential application. Among different types of ZIF, ZIF-8 is considered as potential candidates for H_2 separation owing to its small aperture size and excellent chemical stability. In recent years, ZIF-8 membranes have been fabricated on both inorganic and polymeric substrates. The fabrication of ZIF-8 layer on polymeric substrates is more challenging than its inorganic counterpart because of the incompatibility issue between organic substrates and ZIF-8. However, the flexibility nature of polymeric substrates offers better mechanical stability at high pressure than inorganic substrates. The purpose of this mini review is to present the state of the art and challenges of research on ZIF-8 membrane synthesis on different polymeric substrates. These challenges include the formation of cracks and defects due to compatibility issue and membrane stability at different operating conditions. Current research results showed excellent gas separation properties of ZIF-8 membranes on polymeric substrates that can surpass the trade-off line of gas permeability and selectivity.

1. Introduction

Carbon Capture and Storage (CCS) is indispensable to enable the ongoing utilization of fossil fuels while reducing the emissions of CO_2 to the atmosphere. CCS is a three-step process including CO_2 capture from other gases in the gas emission source; CO_2 transport to a storage location, and the permanent storage of CO_2. The considerable cost of capture, more than 60 % of the total cost for CCS, is slowing down the implementation of commercial CCS. It is reported that the cost for capture process already consumes energy up to 40 % of the overall energy cost [1]. The key to reduce the CO_2 capture cost is to increase the separation efficiency of capture material and technique. Therefore, the discovery of new materials with excellent capture of CO_2 develops into the greatest challenge in this field. There are three options available to capture CO_2, i.e. (i) post-combustion, (ii) pre-combustion, and (iii) air separation followed by oxy-fuel combustion captures [2]. Post-combustion capture deals mainly with the separation of CO_2 from flue gas. Pre-combustion capture consists of the production of carbon monoxide (CO) – hydrogen (H_2) mixture by combusting fuel with air, and then the CO is supplied into a catalytic reactor to be converted into H_2 and CO_2. Oxy-fuel combustion involves pure oxygen to burn fuels that can produce pure CO_2 [1]. Until recently, chemical absorption and adsorption are considered as mature technologies to separate gas mixture that contains carbon dioxide

[3-4]. However, chemical absorption consumes large amount of chemical solvent especially when treating huge amount of gases [2]. In addition, the simplicity of adsorption in operation and wide option for adsorbent material make adsorption technology developed as a good option for gas separation technique. In spite of these advantages, there are still much research needed to find the best adsorbent material to capture CO_2 from gas mixture. Besides chemical absorption and adsorption, membrane technology achieves a growing interest in gas separation processes by many researchers. This is because membrane can offer very high surface areas for gas separation in a small footprint as well as easy to scale up. However, membrane available today for gas separation processes still cannot achieve the desired separation performance, thus its realization in industrial operation is still limited.

Polymeric membrane gas separation process gains much interest in current trend on gas separation research because it is believed that this technique has not been explored into its optimum capacity. The application of pure polymeric membrane in gas separation field is limited by the trade-off phenomenon between membrane permeability and selectivity. A logarithmic correlation between membrane permeability and selectivity for different gas mixture from data available in the literatures has been developed by Robeson (2008) [5]. The correlation indicates that there is an upper bound line exists in which recent polymeric membrane cannot surpass. It means that until now one main challenge for researchers in the field of gas separation membrane is to find the best membrane that can provide permeability and selectivity exceed Robeson's upper bound line [6]. In current years, Metal Organic Frameworks (MOFs) has received a growing interest from many researchers as potential fillers in mixed matrix membranes (MMMs) as well as pure MOFs membranes. MOFs contain metal cations connected by organic linker. MOFs have coordination network and bonding, which make them less stiff and brittle than zeolite. Thus, it is considered that MOFs are able to show flexibility in terms of gate opening and linker dynamics [7]. There are more than hundreds of MOFs structure that have been synthesized and it is a big challenge to choose suitable MOFs that will be used as membranes.

Zeolitic Imidazolate Framework (ZIF) materials are investigated more widely by many researchers as gas separation membrane or filler for mixed matrix membrane than any other MOFs because of their framework flexibility and high chemical and thermal stability [8]. The bonding in ZIF is coordination bonding that is weaker than covalent bonding in zeolite. This means that the bonding between metal node and organic linker is not kinetically stable. This instability means that substitution by other ligands such as water might be happened. However, for some ZIF such as ZIF-8, ZIF-11 and ZIF-69 the stability of their structures can be maintained even in boiling solvents like benzene and water [9]. Hydrophobic ZIF-8 with sodalite (SOD) topology connecting Zn^{2+} metal and organic imidazolate linker is reported has 3.4 Å aperture diameters and it can retain their structure at the temperature up to 400^{o}C. ZIF-8 has properties that make it considered as the most hydrolytically stable porous coordination polymer [10]. However, in recent report by Zhang, et al. the effective aperture size of ZIF-8 particles is reported as 4.0 to 4.2 Å [11]. Because of this flexibility, ZIFs are considered able to increase the permeability of polymeric membrane in separating gas mixtures. ZIF-8 emerges as one type of ZIF that are studied and employed widely as membranes in gas separation processes. Simple fabrication process, use of an environmental-friendly solvent, and high gas permeance due to its open structure have attracted much research to explore this material. The number of publications related with ZIF-8 used as filler in MMMs and as pure membranes shows an increasing trend as shown in Figure 1. There are also a number of reviews on MOFs membranes [12-13], but a review on ZIFs membrane on polymeric substrate is still required to present the current trend on this membrane.

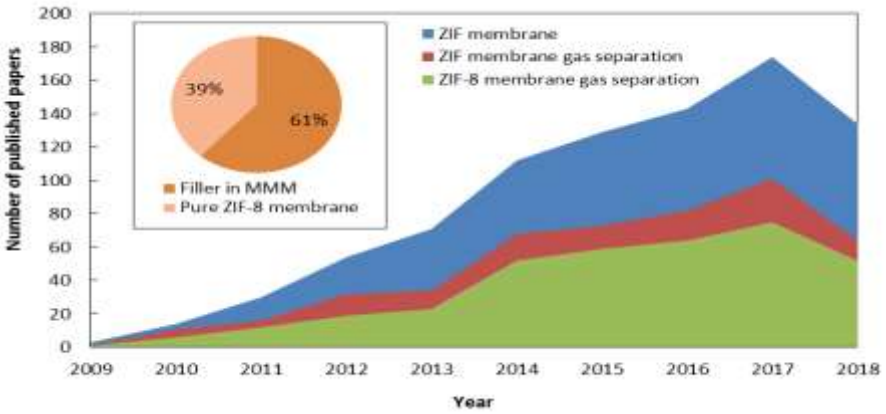


Figure 1.The number of published papers related to the search term of "ZIF membrane", "ZIF membrane gas separation", and "ZIF-8 membrane gas separation" indexed by Web of Science (23 July 2018). The insert is the distribution of ZIF-8 use for gas separation membrane.

2. The synthesis of ZIF-8 membranes

The fabrication of excellent ZIF membranes, such as ZIF-8 membranes, on the surface of porous substrates for gas separation process is relatively difficult. The challenges in ZIF-8 membrane fabrication include: the incompatibility issue between ZIF-8 and substrate materials and the flexibility of ZIF-8 materials. In addition, the issue on the reproducibility of the synthesis procedures of ZIF-8 membranes remains a challenging topic recently [12]. The techniques employed to fabricate ZIF-8 membranes can be classified into two techniques, i.e. *in situ* growth technique and secondary growth technique. In addition, inorganic and organic porous supports have also been utilised as the platform to grow ZIF-8. Figure 2A-B present the schematic diagram of *in situ* and secondary growth techniques to fabricate ZIF-8 membranes.

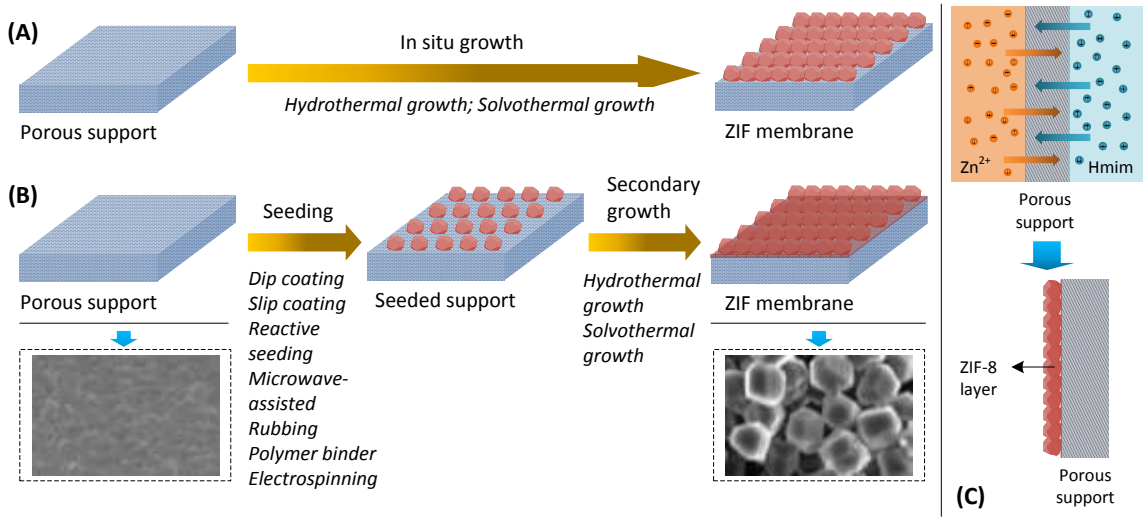


Figure 2. Schematic diagram of ZIF-8 membrane preparation by: (A) in situ growth method; (B) secondary growth method, and (C) counter diffusion method.

2.1. The In situ growth of ZIF-8 membrane on porous support

Compared to secondary growth, *in situ* growing technique does not require seed particles. During the synthesis, porous support is soaked or immersed in ZIF-8 precursor solution either at room

temperature or at elevated temperature [12-13]. In terms of support, unmodified and modified supports have been employed for in situ grow ZIF-8 particles. In addition, both flat sheet and hollow fibre supports have been used to grow ZIF-8 particles.

In general, the growing of ZIF-8 by using this technique on involves high temperature and long fabrication time due to the incompatibility issue. To reduce temperature and time, several researchers employed microwave heating and sodium formate to enhance the heterogeneous nucleation of ZIF-8. Bux et al. (2009) has been successfully fabricated defect free ZIF-8 membrane using this technique [14]. The ZIF-8 membranes resulted a good H_2 separation performance. Unmodified porous α-alumina supports were also used as support for the growth of ZIF-8 crystals in the presence of sodium formate [15]. Similar technique was employed into porous polymeric polysulfone support to produce a ZIF-8 membrane with a micrometre and nanometre sized crystals on support surface [16]. On another line of research, the combination of in situ growth and layer-by-layer techniques was applied on polysulfone membrane to produce ZIF-8 membranes with low synthesis temperature [17]. In recent years, the growing of ZIF-8 on hollow fibre porous supports has also been started to produce membranes with larger surface area compared to flat sheet membranes. ZIF-8 membrane from concentrated synthesis gel was successfully prepared on the surface of ceramic hollow fibre supports [18]. *In situ* growth on modified support was carried out to create a more efficient ZIF-8 growing process. ZIF-8 film was grown on the inner surface of the APTES modified ceramic hollow fibre using a modified seeding process [19].

2.2. The secondary growth method of ZIF-8 on porous support

Besides its advantages such as simple fabrication technique, the *in situ* growing technique of ZIF-8 membranes faces some challenges. Such challenges include the difficulty to control the growing of particle on the surface of the substrate as the nucleation and crystal growth occur at the same time [12]. To enhance the performance of ZIF-8 membrane, several studies have been successfully employed secondary growth method to produce defect free ZIF-8 membranes. The secondary growth technique discriminates the nucleation and growth steps, thus offers a better control on the microstructure of the membrane. Rubbing of seed particles on the surface of porous substrates is a relatively common technique used as a precursor during the secondary growing of ZIF-8 crystals. Ge et al. (2012) fabricated ZIF-8 thin film on the surface of polyether sulfone by firstly rubbed the support surface with ZIF-8 seed particles followed by secondary growing technique. Other techniques for seeding are dip-coating and slip coating. One study employed dip-coating to seed YSZ tubular support [20]. Slip coating to seed alumina support was also carried out to synthesise ZIF-8 membrane. Produced membrane showed very good olefin/paraffin separation performance [20-21]. In addition to dip-coating and slip coating, another technique, i.e. reactive seeding, was also used as a precursor before the secondary growth of ZIF-8 membranes [22]. In this technique, microwave-assisted seeding was carried out to enhance the attachment of ZIF-8 seeding layer to a α-alumina support with rapid nucleation process.

Despite of its attractiveness on producing defect free ZIF-8 membranes, the membranes produced using secondary growth technique experience delamination due to the weak interaction between ZIF-8 layer and porous support [23]. Hence, support surface modification started to be employed to improve the adhesion of ZIF-8 particles on the surface of porous support [24-26]. A study to improve the attachment of ZIF-8 particles on the surface of porous supports utilised vapour phase modification to add amine functional groups and reduce the pore size of support. This technique could produce ZIF-8 membrane with relatively continuous structure [26]. Another technique to improve the attachment of nano-ZIF-8 particles is by using polyethylene imine (PEI) as a coupling agent. This coupling agent forms hydrogen bonds with ZIF seed crystals and free hydroxyl groups of ceramics (α-Al_2O_3) porous substrate. PEI may also form Zn – N coordination bonds with Zn cations on the surface of the ceramic. The crystal seeds were attached to the porous substrate using dip coating method [27].

2.3. Novel methods to synthesise ZIF-8 membranes on porous support

In addition to *in situ* and secondary growth methods, several studies offer new and innovative techniques to grow ZIF-8 layer on the surface of porous support. Such techniques include counter diffusion technique [28]. The experimental set up of contra diffusion technique to grow ZIF-8 on nylon support is presented in Figure 2C. ZIF-8 layer on the zinc nitrate with cubic structure was more uniform than fibre like structure of ZIF-8 crystals grown on the 2-methylimidazolate surface. ZIF-8 membranes with relatively good gas separation performances could be synthesised in one cycle of crystallisation process thus reduce the synthesis time.

Another observation from this experiment suggested the different of crystal structure formed by changing the position of zinc nitrate and 2-methyl imidazole in the contra diffusion apparatus. Gas separation performance of such membranes could produce gas selectivity higher than Knudsen selectivity, which indicated the formation of defect free ZIF-8 membranes.

3. Future perspectives and conclusions

Table 1 presents literature data of ZIF-8 membranes that have been synthesised recently. The data compiled the gas separation performance of ZIF-8 membranes fabricated on organic and inorganic supports in order to compare the performances of these two membranes. Gas permeance and selectivity data for ZIF-8 membrane in Table 1 indicates the roles of ZIF-8 layer thickness and size of ZIF-8 crystals on gas separation performance of membranes. A thin layer of ZIF-8 on the surface of substrate ensures high gas permeance through the membrane. Up to now, the ZIF-8 membranes that have been synthesised could achieve H_2 permeance of more than 60,000 Gas Permeation Unit (GPU), which is very high compared to pristine polymeric membranes. On the other hand, the gas selectivity of the membrane should be maintained as high as possible before the membrane can be applied in real applications. In terms of organic support, there is still a possibility to improve the performance of ZIF-8 membranes to produce high gas permeance with good separation capability. In addition, a study on the mechanical strength of ZIF-8 membranes on polymeric supports is still relatively new and indispensable before the membrane can be applied in industrial scale. Other challenges in the fabrication of ZIF-8 membranes include developing a single step synthesis method that can be produced in large scale and tackling the reproducibility issue in the synthesis of membrane [12]. Thus, the development of pure MOFs membrane, especially ZIF-based membrane, offers promising performance to surpass the gas permeability-selectivity trade-off. However, some challenges in membrane fabrication, such as method reproducibility and relatively long preparation time, still need to be addressed. Several techniques can be considered to tackle the problems, such as surface modification and post-treatment of the membranes.

Table 1. Selected ZIF-8 membranes synthesised at various substrates and synthesis conditions.

Support	Modification approach	Thickness (⌈m)	H_2 permeance*)	Selectivity		Ref.
				H_2/CO_2	H_2/N_2	
PD/SWCNT	Contra diffusion	~0.55	6.31	43	NA	[29]
PVDF hollow fibre	TiO_2 functionalised	~1	201	7	7.8	[30]
PVDF hollow fibre	Ammoniation	~40	24.43	12.18	14.31	[24]
PAN hollow fibre	Dehydrogenation	< 1	3.05	6.85	N/A	[25]
Nylon hollow fibre	Contra-diffusion	~2.5	11.3	N/A	4.6	[31]
Nylon hollow fibre	Contra-diffusion	~16	126.2	N/A	3.7	[28]
Porous polysulfone	Micro-nanosized growth	~50	2.0	N/A	12.4	[16]
BPPO hollow fibre	Chemical modification	0.2	20.5	12.8	9.7	[26]
Poly(amide–imide)	Interfacial microfluidic	~0.9	1.23	NA	NA	[32]
BPPO flat sheet	Contra diffusion	~2	7.5	5.1	8.3	[23]
Porous AAO	PDA-modified	< 0.2	287	14	18	[26]
Titania (flat sheet)	Microwave-assisted	~30	0.6	4.61	11.5	[14]
YSZ hollow fibre	Secondary seed growth	~2	15.4	3.85	11	[20]
SS-nets (flat sheet)	PDA-coated surface	~30	266	8.8	15.4	[33]

*) Permeance unit is in ($x10^{-7}$ $mol.m^{-2}.s^{-1}.Pa^{-1}$)

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Power generation in a plant-microbial fuel cell assembly with graphite and stainless steel electrodes growing *vigna radiata*

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Abstract. Plant-microbial fuel cells (PMFCs) are an interesting renewable energy technology that has the potential to generate clean electricity without competing with agriculture for land space. In this study, the electricity generation potential of mung beans (*Vigna radiata*) in a PMFC set-up with different electrode materials was explored. Three types of set-ups were prepared with five replicates each: PMFCs with stainless steel electrodes, PMFCs with graphite electrodes, and control pots without electrodes. This experimental set-up allowed for the evaluation of the better electrode material, and whether the PMFC environment harms or benefits the plants. The voltage gathered suggests that the potential difference generated in the PMFCs with differing types of electrodes were statistically the same ($\alpha = 0.05$). The same can be said for power and power density, although the system with stainless steel electrodes generated more power towards the end of the experiment. It was also evident that PMFCs with stainless steel electrodes experienced prolonged time lags due to the reduced biocompatibility of stainless steel. Polarization studies showed that a single PMFC is capable of generating power densities of 0.35 mW/m^2 and 0.12 mW/m^2 for stainless steel and graphite systems, respectively. The increased power density of PMFCs with stainless steel indicate the lowering of internal resistance brought by the stainless steel. Plants in the PMFCs set-ups were seen to grow faster, taller, and have higher pod output than those in the control set-up. These results indicate that the PMFC technology can be implemented in agricultural land for the continuous generation of passive electricity while growing food crops, eliminating the competition between energy generation and agriculture.

1. Introduction

The relentless energy crisis and environmental issues has prompted studies on diverse technologies as a source of alternative renewable energy [1]. An extended discipline of Microbial Fuel Cells (MFCs) that uses plants as the source of microbial organisms and converts chemical energy to electrical energy is the *Plant-Microbial Fuel Cell* (PMFC). This technology has been gaining attention and has been continuously studied for the last decade in which claims to produce non-destructible and sustainable green electricity via living plants [2]. Sustainable renewable energy is the next generation of energy transition and P-MFCs has great competency in reducing the dependence on the destructive use of fossil fuels. This bio-electrochemical system generates electricity concurrently without the need of disrupting the living plants thus defeating competition between arable lands for food production power generation plants that beguiles deforestation. It also eliminates the need of additional energy input from external sources as other biomass resources and renewable energy requires. With this alternative, the transport of biomass is no longer needed in which avoids the depletion of nutrients in the

ecosystem [3]. PMFC technologies are based on the principle of rhizodeposition, which is the excretion of organic compounds from the roots that is the source of electrons and electricity generation by electrochemically active bacteria in a microbial fuel cell [4]. The PMFC is a version of a MFC where the system makes use of living plants as the source of microbial matter where its roots are located within the anodic region assumed to be an anaerobic environment within the structured fuel cell allowing the system to act as a bioreactor that enables the conversion of chemical energy to green electrical energy. The requisite elements for Plant-Microbial Fuel Cell assembly are the electrodes, a membrane separator, an external circuit connecting the two electrodes and a resistor.

For Plant-Microbial Fuel Cells, present studies have demonstrated current production associated with plant rhizodeposits using plants from flower bearing species such as *Ipomoea aquatica, Typha latifolia* and *Canna indica* and plants from grass species such as *Oryza sativa, Glyceria maxima, Spartina anglica, Arundinella anomala, Lemna minuta* and *Arundo donax* [5]. The grass species in particular have shown to be useful for electrical power generation [6]. Previous researches focused on power production by the optimization of the reactor design and configurations, plant selection or nutrient media [6] and the development of bio-electrocatalytic interfaces [7].

Prior the launch of PMFCs to an industrial scale, numerous aspects of its study requires further undertaking. Several limiting factors present great challenge toward the engineered and commercialized application of a MFC Technology [8]. From poor electro-active bacteria kinetics, insufficient understanding of the electron transfer mechanism within the cell, the influence of complex environmental conditions and its effect on the microbial colonization and the knowledge of microbial community structures remains a large chunk of uncertainty in the study of PMFC systems [7]. For most PMFCs executed in laboratory conditions, energy sustainability and durability have yet to be achieved as the electrical power generated is considerably very low that lacks sufficiency to drive electronic devices available today [9]. The search for effective architecture and materials that will enable high generation of electrical energy in a PMFC system is constant as there are very few existing studies on the use varying electrode materials and their resulting performance in the power generation. In addition, the performance exhibited by the PMFCs are significantly affected not solely by the internal system but also its external environment as well; in which has not been considered thoroughly in the previous studies. Up to this date, a variety of selection of plant species and methods of creating PMFC assemblies and configuration are continuously studied in order to improve and industrialize this technology for green electricity generation.

The objective of this study is to design and construct a Plant-Microbial Fuel Cell assembly using graphite rods and stainless steel mesh as the electrode materials with Mung beans (*Vigna radiata Wilzeck).* Through the comparisons of the electrical potentials, the capability of electricity generation using the fuel cell chamber design utilizing different electrode materials was to be identified. This will discern which electrode material more effective for the design system. Also, this study aims to evaluate the effect on PMFC elements in the growth and development of the model plants to evaluate whether a PMFC can be used to simultaneously generate electricity and produce biomass.

2. Materials and Methods

2.1. PMFC Assembly and set-up

Each single-chambered PMFC was composed of the electrodes, a resistor load, a semi-permeable membrane, the soil and the plant specimen. The stainless steel mesh and graphite rods were used as the electrode materials for the system. The resistor used had the load of 2000-Ω. A layer of cheesecloth was used as the membrane separator and copper wires were used as the external conductor that connected the electrodes with the resistor load.

The overall exterior that contains the assembly is made from polycarbonate plastic. Each fuel cell had the dimensions of 6-in x 6-in x 12-in (L x W x H). Two holes big enough for copper wires to pass through were made on one side of the customized pots with respect to the position of the electrodes. Additional holes were made on the bottom of the pot for drainage. From bottom to top of the container, the cell consists of 1-inch layer of garden soil, the cathode electrode, 5-inch layer of garden soil, the cheesecloth membrane cut in accordance to the dimensions of the pot, 4-inch garden soil, the

anode electrode and finally the plant. The container was completely filled with soil which was patted thoroughly in every layer (Figure 1).

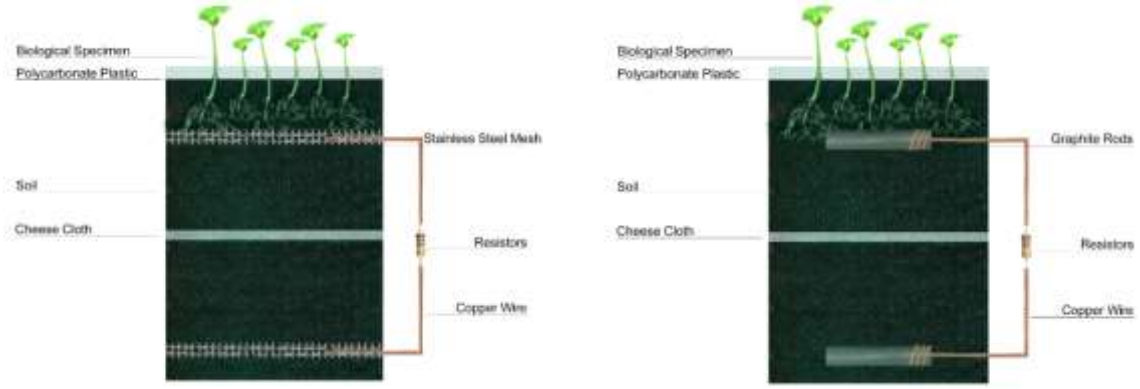


Figure 1. PMFC assembly with stainless steel (left) and graphite (right)

Green Mung Beans (*Vigna radiata Wilczek*) seeds that were sourced from the local market in Intramuros, Manila was the selected plant specimen for this experiment. The specimens were grown from seedlings in a soil medium composed of coconut coir and garden soil potting mixture sourced from Los Baños, Laguna. No additional nutrient media was used for planting. For outdoors planting, the seeds were required to be buried about 1-inch deep covered in soil as these particular seedlings require darkness to germinate. The seeds were planted on seed trays and were exposed to 8 to 10 hours of sunlight daily. The plant grow-out lasted for thirty days. During this period, plant care involved light watering to keep the seed bed moist to enhance the germination process. On the last day of plant grow-out period, the plants were transferred in the P-MFC set-up and were left for ten days to allow the microbial organisms to settle and consolidate with the soil. Continuous plant care was conducted. Upon plant transfer, the roots of the plant were fully covered with soil to avoid the plant from drying-out.

2.2. Collection and Treatment of Data

Voltage was recorded against an external resistor six times a day for 30 days straight using a digital multimeter (RS Pro RS14). Soil pH meter, hygrometer, and thermometer were used to monitor growing conditions. Current ($I = V/R$), power ($P = IV$), and power density ($P_D = P/A$) were computed from voltage readings taken against a 2000-ohm resistance.

2.3. Polarization

The polarization studies were conducted to indicate the power output of a certain fuel cell system under various resistor loads that are exhibited by polarization curves. This type of study is the most common method in testing a fuel cell's performance and determination of the optimum condition that it can achieve and is represented by a polarization curve that contains linear data that relates the power density and the current density. This allows comparisons with existing publications of fuel cell technology. The polarization studies conducted used sixteen different resistor loads varying from 5 Ω to 50,000 Ω. The voltage reading using each of these resistors were individually were recorded and compared to one another by producing a polarization curve showing the behavior of power generated of a fuel cell chamber with respect to the step-wise incline of resistor loads. Current density was plotted against power density to complete the polarization curve.

3. Results and Discussion

3.1. Voltage, power, and power density

The measured voltage and calculated power and power density are shown in Figures 2 and 3 below.

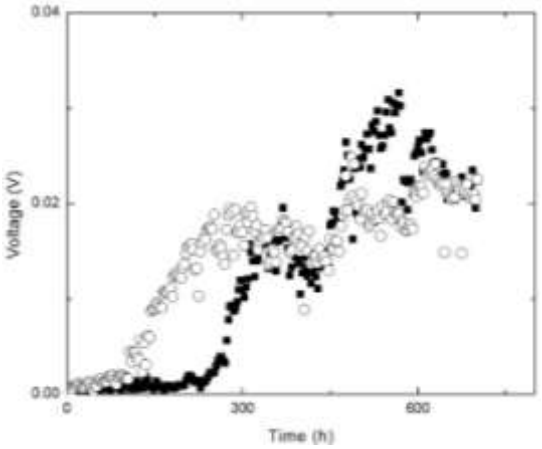


Figure 2. Voltage readings versus time (■: stainless steel, ○: graphite)

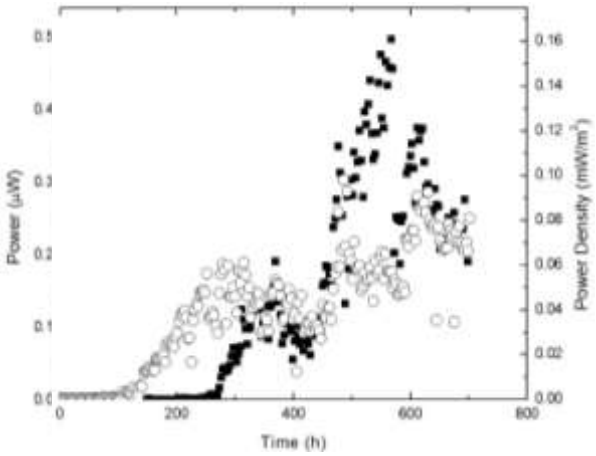


Figure 3. Power and power density versus time (■: stainless steel, ○: graphite)

There is no significant difference between the power and power density of both PMFC set-ups containing different electrodes ($\alpha = 0.05$). However, it is important to note that the PMFCs with stainless steel electrodes attained higher absolute power and power densities towards the end of the experimental period. The time lag for stainless steel systems was larger than that with graphite, presumably because of the inhospitable nature that stainless steel provides for bacteria (biocompatibility). The slow incline at the initial phase is due to the settlement of rhizodeposits where it is in the process of binding uniformly with the new soil. Right after, anaerobic reactions occur allowing the production of electron donors enabling the transfer of electrons that leads to the generation of electrical energy. The steady incline of power density generated means that the system is at a state of equilibrium and the environmental conditions are stable enough for the electricity generation.

3.2. Polarization

A polarization curve is made of the values of power densities under varying resistor loads. Through this fuel cell chamber's designed system will identify which resistor load will produce the optimum performance. The polarization studies conducted was done on the 30th day of data collection. At this point, the plant has reached maturity and is already bearing fruits.

By increasing the load stepwise, the polarization studies produced parabolic trends pinpointing the absolute maximum power generated found at the parabola's peak in which is the preferable resistance value to enable optimum conditions of the designed microbial fuel cells. For the stainless steel systems the maximum power density attained was 0.35 mW/m^2 under the resistance of 8200 Ω. This is 40% more than the power density using the default resistor of 2000 Ω which was 0.25 mW/m^2. This means that the applied external resistance was lower than that of the internal resistance, resulting to a lower yield. On the other hand, PMFCs with graphite electrodes obtained the maximum power density of 0.12 mW/m^2 under a resistance of 10000 Ω which is 50% larger than the power density under a resistance of 2000 Ω (0.08 mW/m^2). Overall, PMFCs with stainless steel electrodes obtained maximum power densities that are about 200% larger than graphite electrodes. Even though graphite is more biocompatible, stainless steel electrodes have lower resistances and thus contribute to the lower resistance of the PMFCs, thereby translating to higher power and power densities.

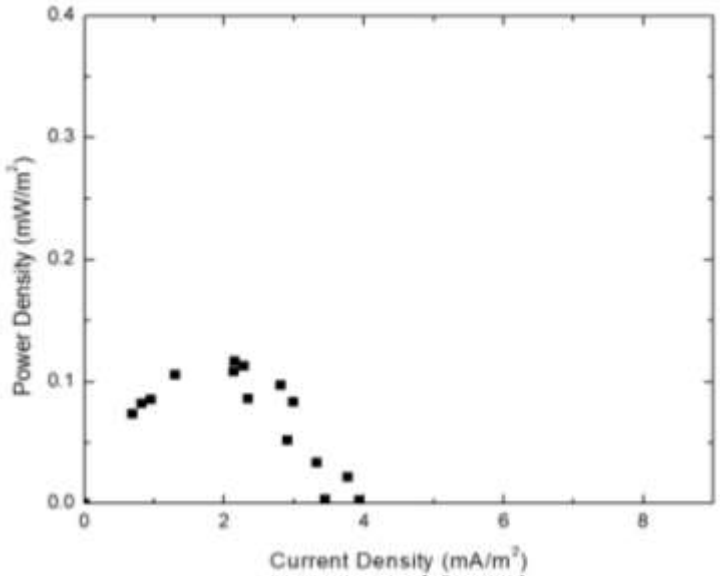


Figure 4. Polarization curves for PMFCs with stainless steel (●) and graphite (■) electrodes

3.3. Growth and development of plants

A separate set of trials (control) were made duplicating the entire PMFC set-up, only this time without electrodes. All replicates were exposed to the same conditions as those with electrodes. It is of interest whether the electricity generation of the PMFC has a positive or negative effect on the plants' growth. It was evident during the experimentation process that plants growing in the fuel cell assemblies with the electrode materials in their system showed more abundance and better growth as compared to the ordinary trial as the plants growing with the electrode elements appeared to be healthier and stronger. In the duration of the experiments, the trials with the electrode materials was observed to have greener leaves with taller, thicker and sturdier stems as compared with the control with brownish pale-green leaves and thinner stems. The maximum height of control was only about half the height of the plants with the electrode material. Upon monitoring, the highest average height measured for the plants in the PMFC trials reached 42 cm in height while the height of those in control seemed stunted reaching to its highest average height of 22 cm. Fruit pods in the control were smaller compared to the pots with electrode material; the average length of the mung bean pods were about 8-cm in length for PMFC trials wherein the plants in a non-fuel cell environment was only about 4 to 5 cm long. In terms of maturity, the control plants matured later by two weeks than all the experimental trials conducted. The results of this study are in agreement with the results from a previous research [10] wherein the plants grown under polarized conditions (in PMFCs) have higher levels of intracellular nutrients compared to the control (no electrodes).

3.4. Scale-up potential

The choice of the plant specimen was upon consideration of accessibility and availability in the area. Mung bean is included in the 21 major crops produced in the Philippines and according to the Philippine Statistics Authority's quarterly bulletin of the major vegetables and roots crops in the quarter of April to June 2018, the production of Mung bean has increased by 3.3% compared to the same quarter of the previous year, 2017. This translates to 24,800 metric tons of mung bean per annum. Approximately, for a yield of 1000 kg/ha, mung bean production would cover about 24,800 hectares of land which has the potential to generate about 760 MWh/y of passive electricity solely from the farming of mung beans. This can be made possible through stacking, as illustrated in a previous study [11].

4. Conclusions

The possibility of concurrent food and power generation was confirmed with the designed single-chambered PMFC for both systems utilizing graphite and stainless steel electrodes with *V. radiata*. However, the low levels of generated power density remains a challenge as it remains to be insufficient for applicable use. This may be due to the cell configuration and the used resistance within the system.

Polarization studies suggested that optimum levels of power density could be achieve by using resistor loads of 8200 Ω and 10000 Ω in stainless steel and graphite systems respectively. Executing the designed P-MFC under this resistor loads may produce power density up to 50% larger than the current power generated.

Through comparison between plants growing in the PMFC set up and normal plant set-up (control) without PMFC elements, the plants appeared to be healthier and has more rigorous growth in contrast to the control with stunted growth and smaller pods. This is on the note that all plants were exposed to same environmental conditions.

With the land covered by the Mung bean production in the country, this study proves that it has high potential as a sustainable alternative green energy resource if only it can surpass the challenges of low power density production. Future studies must be focused on amplification of power generated by the system to fuel the hopes on one day being able to generate clean electricity alongside agriculture.

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Drying of celery leaves *(Apium graveolens L.)* using a PV/T solar dryer

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Abstract. Celery (*Avium graveolens L.*) has been naturally used to treat hypertension and cancer. Fresh celery contained a high water content of ±86% which may lower the quality upon storage for a long time. Drying was applied to reduce moisture content in order to prolong the shelf-life. Drying of celery was carried out using a self-designed photovoltaic-thermal (PV/T) solar dryer as well as conventional dryers such as oven and vacuum oven for the comparisons at an approximate temperature of 49^{o}C. The PV/T solar dryer was able to simultaneously convert the solar energy into thermal and electrical energy. The electrical energy was in turn used to drive the blowers to create a forced convective flow of heat transfer. Drying in the PV/T solar dryer was carried out in 3 different weather conditions while 3 different pressures (10; 40; 70 kPa) were tested during drying in the vacuum oven. The PV/T solar dryers demonstrated the best results in terms of constant drying rate (0.986 kg H_2O/min.m^2) and drying time (87 minutes). Total chlorophyll content retained was 5.42 mg/L. The PV/T solar dryer seemed promising to be further developed for an efficient drying process since it required low energy consumption while using the costless renewable solar energy.

1. Introduction

Indonesia is amongst the world's richest nations in terms of its biodiversity including plants and herbs. There are more than 30,000 herbs present in Indonesia, however only 25% of them of which medicine efficacy have been known and moreover only about 1,200 species have already been processed as raw materials for medicinal traditional herbs or so called *jamu* [1]. Celery (*Avium graveolens L.*) contained micronutrients, vitamins and phenolic compounds and widely used as herbs for lowering hypertension and for cancer prevention [2, 3]. Herbs as well as natural plants generally contained a high moisture content which could accelerate the microbial growth leading to physical deterioration. An effective drying process was required to reduce the water content thus improving the shelf life of celery.

Several drying methods were conducted in order to reduce moisture content in celery [4, 5]. The most suitable drying techniques involved low temperature of less than 70^{o}C to preserve the nutrient

contents [5]. However, there has been no investigation yet related to drying of celery in a solar dryer. Solar dryer has become promising as a drying alternative for drying herbs using the renewable energy with preserved texture of dried samples [6]. The solar energy was able to be converted into thermal energy by means of a solar panel. Moreover, a hybrid solar dryer using an amorphous Si type PV/T system was capable to convert solar energy into thermal as well as electrical energy. Therefore, this system could produce high energy efficiency besides a much higher performance stability compared to the individual solar dryer [7]. This hybrid system has been increasingly applied in diverse applications due to the high demand of the use of renewable energy, especially in Europe [8, 9].

This research objective was to reduce the moisture content of celery by using a hybrid PV/T solar dryer. This self-designed PV/T solar dryer was expected to be able to convert a higher solar energy per drying surface area since the electrical energy would in turn drive the blower inducing active drying facilitated by force convection mechanism. The drying characteristics were studied and compared with those obtained by using the conventional dryers such as oven and vacuum oven drying. The bioactive content particularly chlorophyll content retained in the dried samples were also determined. The use of hybrid solar dryer could be promoted as a dryer means alternative which was pollution free while using a cost free and renewable solar energy for supporting many sustainable green processes.

2. Materials and Methods

2.1 Materials

Celery (*Apium graveolens L.*) was purchased from Wonokromo local market, Surabaya, Indonesia; technical grade acetone 98% (Brataco, Indonesia); demineralized water

2.2 Drying of celery leaves

Celery leaves were separated from the rods and other parts and then cleaned to remove soils and other dirt. The leaves were subsequently cut into 2 parts whereby each part had the dimension of about 3 x 4 cm. Sample amounts of about 15 grams were weighed with the balance (Mettler, Toledo) and closely loaded into the aluminium drying pan (29 x 25 cm) in a single layer.

A self-designed photovoltaic/ thermal (PV/T) solar dryer was shown in details in Figure 1. The solar dryer was mainly made of aluminium for the body, glass roof at the top, and a drying cabinet consisting of 4 trays supported by hooks made of plywood boards. A PV/T collector connected to the solar dryer simultaneously converted the solar energy into thermal and electrical energy. It consisted of amorphous Si solar cell panel covered by glass accompanied with battery and controller system. The battery stored electrical energy that was used by the blowers to improve the air circulation. The drying pan containing samples was only put onto the first tray in the middle during the experiment. Drying of celery was conducted in 3 different days between 9.00 am until 16.00 pm with ambient air temperature ranged between 30-35^{o}C resulting in different averaged temperatures within the drying cabinet. The air temperatures were monitored by reading the thermometer (Figure 1D) at the same time with sampling i.e. every 1 minute for the first 30 minutes, followed by every 2 minutes until 1 hour and then every 3 minutes until constant sample weight was attained. The air temperatures were then averaged.

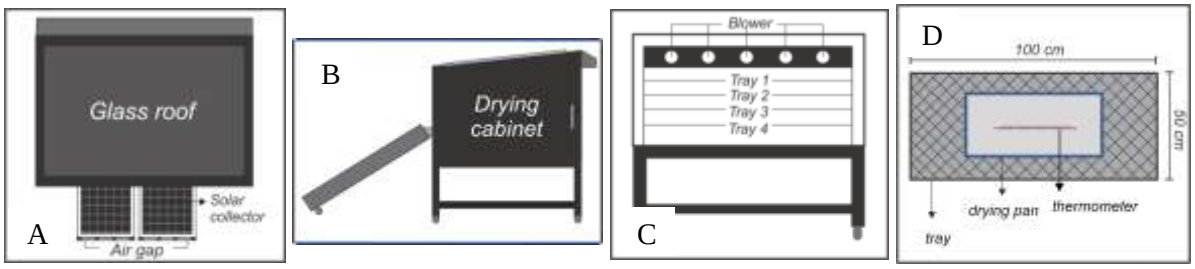


Figure 1. The self-designed PV/T solar dryer. A) Top view; B) Side view; C) Inside the drying cabinet; D) Air temperature measurement around the drying pan.

Drying was also conducted using oven (Venticell 111 Model, Medcenter, Germany) and vacuum oven (BOV-30V Model, Biobase, China) at controlled temperature of 49^{o}C corresponding to the optimum averaged temperature obtained in the solar dryer. Vacuum pressures of 10, 40, and 70 KPa were varied during drying at 49^{o}C in the vacuum oven. Drying was carried out until constant weight of sample was attained within the tolerance of ± 0.005 g.

Results were presented as drying curves whereby free moisture content (X) were monitored versus the drying time [10]. Free moisture content were gained from the moisture content at certain time (X_t) deducted by equilibrium moisture content (X^*).

$$X_t = \frac{W_t - W_d}{W_d} \quad (1)$$

where X_t = moisture content at certain time (kg H_2O/kg dry weight); W_t = sample weight at certain time (kg); W_d = sample dry weight (kg) obtained after sample weight was constant after a certain time.

$$X = X_t - X^* \quad (2)$$

where X = free moisture content (kg H_2O/kg dry weight); X_t = moisture content at certain time (kg H_2O/kg dry weight); X^* = equilibrium moisture content (kg H_2O/kg dry weight).

The drying curve characteristic was also represented by the drying rate (R) versus X.

$$R = \frac{-L_s}{A}\frac{dX}{dt} \quad (3)$$

Where R= drying rate in kg H_2O/m^2.min; Ls = sample dry weight (kg); A = sample surface area (m^2);dX/dt is the slope of linier trend line of X *vs*. t for the constant rate period, where as dX/dt for the falling rate period was calculated using the equation (4) which was the slope of exponential function model as shown in equation (5).

$$\frac{dX}{dt} = \frac{a}{t} \quad (4)$$

$$X_t = a \times \ln t + b \quad (5)$$

Finally, the loss of moisture content in %wet basis was calculated as follows.

$$\text{Moisture Loss (\% wet basis)} = \frac{W_i - W_f}{W_i} \text{ x } 100\% \quad (6)$$

where W_i= initial sample weight (g); W_f= final sample weight (g).

2.3 Determination of chlorophyll content

Celery leaves were pounded in a mortar with pestle. Afterwards 3 ml acetone solution was added into 0.02 g of celery leaves powder followed by water addition up to 25 ml in a volumetric flask. An aliquot of 8 ml was taken 3 times into different centrifuge tubes. Centrifugation was conducted for 20 seconds at 3200 rpm in a centrifuge (Shanghai, China) to separate the sediment with supernatant. The supernatant was decanted into a filter to remove out the suspended solid particles. Clear supernatant liquid of 2 ml was mixed with 3 ml acetone prior to absorbance test in a spectrophotometer (Lambda EZ 150, Perkin Elmer, USA). The absorbance values were measured at λ= 665 nm and 649 nm. Both chlorophyll A and chlorophyll B contents were calculated using the equation proposed by Wintermans and De Mots [11, 12]. Total chlorophyll content in mg/L was the sum of chlorophyll A and chlorophyll B. The absorbance measurements were conducted in triplicates at each wavelength.

3. Results and Discussion

The drying characteristics of celery leaves in the PV/T solar dryers measured at 3 different averaged temperatures were depicted in Figure 2. It was obvious that the higher the temperature the shorter the time required to reach the equilibrium moisture content indicated by the constant sample weight. The higher drying temperature also resulted in the higher drying rate. This was in line the previous drying study on rhizomes [6, 11]. The averaged temperatures measured in the vicinity of tray 1 where the drying pan was located during the experiment was within the range of 43–55^{o}C which were relatively high compared to the ambient air temperature. The increased temperature was due to the generated thermal energy derived from the solar energy. The heat transfer mechanisms involving radiation, conduction, and forced convection influenced the overall transfer of thermal energy into the drying cabinet. The first tray received the highest thermal energy via solar energy radiation [6] through the glass roof while heat conduction occurred along the dryer walls. The solar radiation impinged into the solar panel was converted into thermal and electrical energy. The force convective mechanisms occurred as the results of self-driven blower was induced by electrical energy produced by the PV/T solar dryer. The blower induced an external force which accelerated the convective heat transfer. The simultaneous thermal and electrical energy derived from solar energy seemed quite efficient in improving the drying rate inside the solar dryer.

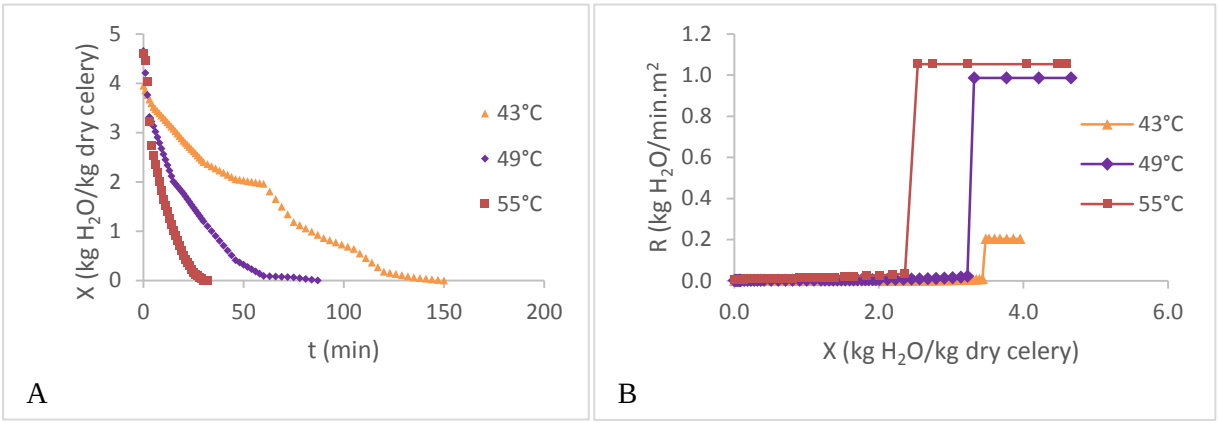


Figure 2. Drying curves characteristics of celery leaves at different averaged drying temperatures in the PV/T solar dryer. A) Free moisture content *vs.* time; B) Constant drying rate of celery leaves *vs.* free moisture content

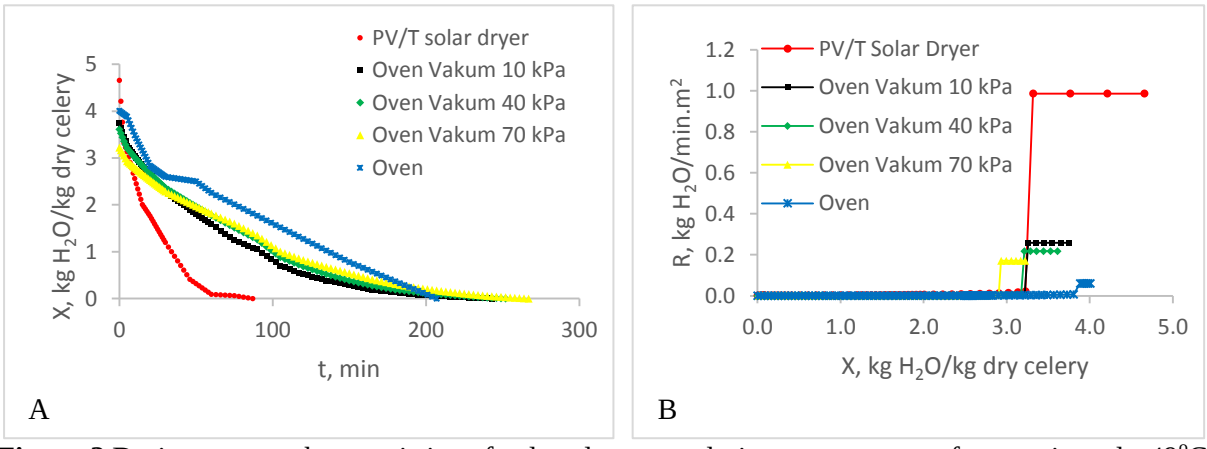


Figure 3. Drying curves characteristics of celery leaves at drying temperature of approximately 49^{o}C in various dryers. A) Free moisture content *vs.* time; B) Constant drying rate of celery leaves *vs.* free moisture content

The drying performance in the PV/T dryer was compared with those in conventional oven and vacuum oven dryers as could be seen in Figure 3. It turned out that the highest drying rate (Figure 3B) and thus the shortest drying time (Figure 3A) was obtained upon drying using the PV/T solar dryer at the approximately similar drying temperature of ~49^{o}C. The constant drying rate of ~16 times and ~4 times higher compared to those of oven and vacuum oven respectively as seen in Table 1. The constant drying rate obtained from this PV/T solar dryer was much higher with the order of about 2 compared with the previous developed solar dryer without self-driven blower [6]. The lower constant drying rate obtained by using the conventional dryers (< 0.3 kg H_2O/min.m^2) was due to the lower rate of convective heat transfer in contrast to the PV/T solar dryer (~1 kg H_2O/min.m^2). This was also reflected by the highest moisture loss of about 82% and shortest drying time of about 87 min obtained upon celery drying in PV/T solar dryer.

The celery drying in the oven required a shorter time compared to that required in the vacuum oven though the constant drying rate obtained in the vacuum oven was higher than that obtained in the oven. The oven was equipped with a small blower enabling the air circulation and forced convective heat transfer mechanism which accelerated the drying process. In the vacuum oven, the vacuum pressure played a significant role in lowering the boiling point of water in spite of quite low convective heat flow inside the chamber. The lower pressures tended to reduce the drying time although only fair differences were noticed.

Table 1. Comparisons of drying time, constant drying rate, moisture loss and chlorophyll content during drying of celery leaves in various dryers at various drying conditions.

Types of dryers	Drying condition		Drying time (min)	Constant drying rate, (kg H_2O/min.m^2)	Moisture loss (% wet basis)	Total chlorophyll content (mg/L)
	P (kPa), Boiling point(°C)	T (^{o}C)				
PV/T solar dryer	101.35 (100°C)	43	150	0.204	79.76	5.71 ± 0.027
	101.35 (100°C)	49	87	0.986	82.1	5.42 ± 0.040
	101.35 (100°C)	55	32	1.054	82.07	5.37 ± 0.020
Oven	101.35 (100°C)	49	207	0.060	79.3	5.48 ± 0.064
Vacuum oven	70 (89.64°C)	49	267	0.171	76.2	7.51 ± 0.086
	40 (72.45°C)	49	252	0.217	78.2	7.74 ± 0.022
	10 (45.81°C)	49	243	0.259	78.9	7.85 ± 0.110
Fresh celery	-	-	-	-	-	9.45 ± 0.015

Finally, the chlorophyll content in the dried celery was determined to study the retention of a sort of bioactive content after the drying process. The total chlorophyll content decreased of about 17-40% after the drying process as depicted in Table 1. This huge decrease in chlorophyll content could be caused by the milling process generating higher heat effect for the dried samples compared to fresh samples. The highest total chlorophyll content was retained in the samples dried using vacuum oven whereas chlorophyll content of celery dried in PV/T solar dryer was similar with that dried in the oven regardless the length of drying time. Slow drying process accompanied by the water evaporation at a much lower temperature seemed slow down the chlorophyll deterioration. Chlorophyll seemed to be

sensitive towards drying temperatures as well as drying rates. The experimental results implied the great potential of PV/T solar dryer in substituting the use of energy intensive conventional dryers such as oven and vacuum oven. The renewable and cheap solar energy should be more intensively and optimally used for enhancing the sustainable process particularly in drying process of herbs or plants in the tropical country.

4. Conclusions

Drying of celery leaves in the self-designed PV/T solar dryer seemed superior in comparison with the other conventional drying methods such as oven and vacuum oven dryer in terms of constant drying rate, drying time, and chlorophyll content of final dried celery though operational temperature was hardly controlled. The drying temperature was highly dependent on the sunlight intensity. The higher the drying temperature was, the higher the constant drying rate and thus the shorter the drying time was. The constant drying rate of celery leaves in the PV/T solar dryer was approximately16 times higher and 4 times higher compared to those obtained from oven and vacuum oven at drying temperature of about 49^{o}C. The relatively high constant drying rate combined with short drying time was due to the predominant forced convection facilitated heat transfer mechanism created by solar driven blowers besides heat conduction and heat radiation mechanisms. The celery weight reached a constant weight within 87 minutes which was almost half of the required time within oven and vacuum oven without deteriorating the chlorophyll content. The chlorophyll content in PV/T solar dried celery leaves ranged from 4.1–5.7 mg/L which was a bit higher compared with those obtained using oven and vacuum oven. The abundant and renewable solar energy captured by a PV/T solar dryer seemed quite promising for various drying purposes in an efficient and cheap way.

Acknowledgements

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Kinetics oxidative degradation of chitosan in formic acid with the presence of hydrogen peroxide

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Abstract. The chitosan degradation in formic acid solution with the presence of hydrogen peroxide was investigated in this work. Temperature and reaction time had a significant effect on reducing the molecular weight of chitosan, and it is clear that decreasing the molecular weight faster at the first 15 minutes of reaction time. Therefore, the molar concentration of chitosan in the solution increased with temperature and reaction time. The reaction order was determined from the molar changes of chitosan on reaction time and found followed -0.1 reaction order to the molar concentration of chitosan. The Arrhenius equation was used to study the correspondence influence of reaction temperature on the degradation reaction rate constant. The results suggest that the values of degradation rate constant increased with higher reaction temperature. The value of activation energy was determined under the experimental operating conditions examined to be 99.8 kJ/mol. The FT-IR spectra demonstrated that there was no change of chemical structure of chitosan before and after the degradation reaction.

1. Introduction

Chitosan is generally accepted as a product derivative of chitin that ordinarily acquired from crustacean shell through partial deacetylation reaction using base or enzyme [1]. Chitosan has a different structure compared to chitin concerning some acetyl groups present in chitin have been replaced by atoms H. Hence, chitosan will have a varying degree of deacetylation (DD) with a chemical name as (1⇅4)-2-amino-2-deoxy-β-D-glucan.

As amino-polysaccharides, chitosan is extensively utilised for some purposes with great features regarding biocompatible, antibacterial, biodegradable, nontoxic, and environmentally friendly. Accordingly, chitosan is utilised in numerous applications, for example, in foods, biomaterials, medicine, cosmetics, and pharmaceutical products [2-6]. However, low solubility in water is the characteristic of original chitosan derived from the shell of shrimps as it has high molecular weight. These properties make the original chitosan has a limited utilisation in particular for medical applications. Therefore, it is necessary to obtain a chitosan product through the degradation process that accomplishes its higher solubility and preserves its biological properties. Oligomer chitosan with high solubility in solvents can be achieved through degradation reactions via several techniques. The degradation can be carried out by a chemical method using acids [7-10], high impact energy [11-13], and enzymatic [14-15].

Recently, acetic acid has been widely implemented in oxidative degradation using hydrogen peroxide as an oxygen carrier. However, there is little attention to the exploitation of formic acid as an acid solvent in the chitosan degradation with the utilisation of hydrogen peroxide. Formic acid may

show better performance than acetic acid as a solvent when combined with hydrogen peroxide. The utilisation of hydrogen peroxide and synergised with formic acid has been widely employed, as shown in another type of oxidation reaction called epoxidation reaction [16-17]. Hence, this work aims to study the influence of reaction temperature and time on chitosan degradation and determine the kinetics of chitosan degradation in the formic acid solution with the presence of H_2O_2.

2. Materials and methods

2.1. Materials

The feedstock of chitosan with an average molecular weight of approximately 3300 kDa and a degree of deacetylation of 96.31% was used in this research. This chitosan was obtained from Xi' An Lukee Bio-Tech Co. Ltd. Hydrogen peroxide, formic acid, acetic acid, sodium hydroxide, and ethanol absolute were supplied by Chem-supply as laboratory reagent grade.

2.2. Feedstock preparation of chitosan solution

The starting of chitosan solutions were prepared in a glass reactor with dissolving chitosan to obtain 10 g/L chitosan in 1% formic acid solution. A calculated amount of formic acid solution was dissolved in the water to obtain 800 mL 1% formic acid solution. Following this, 8 grams chitosan dissolved in this acid solution and stirred with low rotation speed overnight to ensure chitosan has been soluble thoroughly.

2.3. Experimental setup and procedure

The chitosan degradation was carried out in a 1-L glass reactor equipped with a magnetic stirrer, condenser and thermocouple. The reactor was located on a heating plate and connected with temperature control, whose temperature could be maintained ±1^{o}C. The reaction temperature was set by adjusting the temperature controller connected to the heating plate, and a calculated amount of hydrogen peroxide was added when the desired reaction temperature achieved with a final concentration 1% (w/v) in the mixture. The degradation reactions were run at several isothermal conditions and samples were taken at certain reaction times. After the degradation reaction, the samples were collected and cooled to terminate the reaction. It was then neutralised with 2 M NaOH solution to pH 8-9. The neutralised solution was then filtered off to separate solid phase (low molecular weight of chitosan) and liquid phase (oligomer chitosan soluble in the water). After that, the solid phase was washed with water until the remaining washing water was neutral. The following step, the remaining impurities in the solid phase was removed using ethanol. Finally, the solid was vacuumed and then dried at 60^{o}C to remove the water content. The solid product was analysed to determine its molecular weight using the viscometric method, and FT-IR was performed to monitor the formation and disappearance of functional groups of original and low molecular weight of chitosan.

2.4. Analytical methods

The viscosity-average molecular weight of chitosan (M_v) was measured using an Ubbelohde viscometer with a capillary diameter of 0.36 mm at 30^{o}C. The several dilute solutions of chitosan in 1% acetic acid solution (C) were measured its flowing time (t_s) and the solvent acetic acid (t_0) in duplicate for each. The specific viscosity of the dilute chitosan solutions (η_{sp}) was calculated from relative viscosity (η_r) according to the following equation (1):

$$\eta_r = \frac{t_s}{t_0}, \quad \eta_{sp} = \eta_r - 1 \tag{1}$$

Huggins equation (2) was performed to determine the intrinsic viscosity (η) from the known value of specific viscosity (η_{sp}):

$$\frac{\eta_{sp}}{C} = [\eta] + k[\eta]^2 C \tag{2}$$

by plotting $\frac{\eta_{sp}}{C}$ vs C, the intercept at $C = 0$ was obtained as the intrinsic viscosity (η) [8]. The M_v value was determined through the Marck-Houwink equation (3):

$$[\eta] = K.M_v^a \tag{3}$$

The value of K and a for chitosan in 1% acetic acid solution are 0.0474 mL/g and 0.723, respectively [18]. Those values of K and a are constant and defined as the Mark-Houwink constants.

2.5. Kinetics model

Kinetic model of chitosan degradation has been developed according to the rate of chemical reaction definition. The degradation rate is expressed as the number of moles of cutting off the glycosidic linkage in the chitosan chain to yield the two pieces [19] according to the following equation (4):

$$R = \frac{d[M]}{dt} = kM^n \tag{4}$$

M is known as the molar concentration of chitosan (mol/L). The properties k and n represent the reaction rate constant and reaction order, respectively. In this case, the reaction order (n) typically has a negative value as with the increasing of chitosan solution concentration, the degradation rate will decrease. The molar concentration of chitosan can be calculated through equation (5):

$$M = \frac{C}{M_n} \tag{5}$$

Then, the solution of the differential equation (4) is described in equation (6):

$$M_t^{1-n} - M_0^{1-n} = (1-n)kt \tag{6}$$

where M_t is chitosan concentration at a certain reaction time (t) and M_0 is the initial concentration of chitosan. It is obvious that the value of C as the solution concentration remains constant (g/L), but the molar concentration (molarity in mol/L) each time increases with the reducing number of molecular weight through the degradation process. The M_n value is the number-average molecular weight can be calculated from the M_v value through equation (7) below:

$$M_v = \left[(1+a)\Gamma(1+a)\right]^{\frac{1}{a}} M_n \tag{7}$$

where $\Gamma(1+a) = \int_0^\infty e^{-t}t^a dt$ and the value of M_v is obtained from equation (3) above.

3. Results and discussions

3.1. The influence of reaction temperature and time on the molecular weight of chitosan

The reaction temperatures of degradation were varied at 40, 50 and 60^{o}C for 120 min reaction time to study the influence of reaction temperature on the chitosan degradation. The corresponding of viscosity-average molecular weight (M_v) was plotted on a logarithmic scale in correlation with reaction time t at the different reaction temperatures, as depicted in figure 1. The results indicated that the M_v value decreased with the addition reaction time. The reaction temperature similarly demonstrated a substantial effect on chitosan degradation indicated by a significant reducing the molecular weight of chitosan. The corresponding rate of decrease for M_v value of chitosan in percentage was 98.26, 99.40, and 99.83% respectively for 120 reaction time from the initial M_v value of chitosan of 3300 kDa. The M_v value of chitosan dropped to 57.4, 19.8, 5.6 kDa for 120 min, respectively. Interestingly, the most significant reduction of M_v value was achieved at the first 15

minutes of reaction time with the corresponding rate of decline in percentage for M_v value was 94.33, 96.58, 98.47% respectively.

Figure 2 shows the correlation between the molar concentration of chitosan (M_t) vs reaction time (t) and the result indicated that the molar concentration of chitosan increased with the rise of reaction time. This finding implies that a random scission of glycosidic linkage occurred and results in a lower number-average molecular weight of chitosan. Therefore, it will increase the molar concentration of chitosan with additional reaction time.

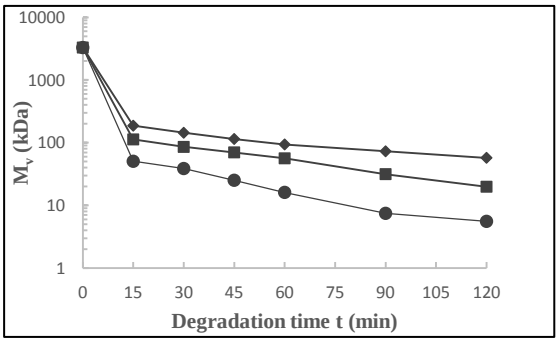


Figure 1. The influence of reaction temperature on the viscosity-average molecular weight of chitosan (M_v) for different temperatures: (♦) 40°C; (■) 50°C; (●) 60°C.

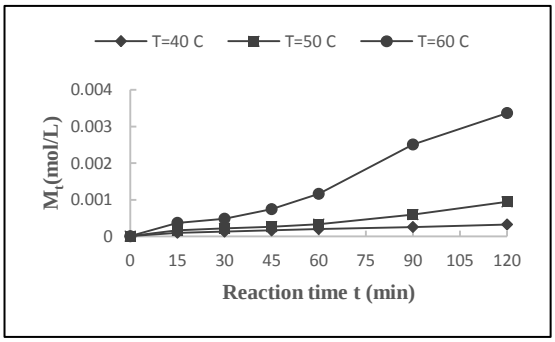


Figure 2. The molar concentration of chitosan vs time.

These results confirm a previous finding stated that reaction temperature plays an essential factor for chitosan degradation [20]. The experimental results conclude that hydrogen peroxide in the formic acid solution may accelerate chitosan degradation during the degradation reaction. The reaction mechanism of chitosan degradation is mainly under the attack of powerful oxidant, namely, hydroxyl radical [21]. The reaction step is illustrated as follows, R-NH_2 first produces R-NH_3^+ in acid solution and decomposition of H_2O_2 also occurred as shown in equation (8) and (9) then summarised as a total reaction in equation (10). The reaction mechanism of chitosan degradation with hydrogen peroxide in the acid solution is as follows [21]:

$$\text{R-NH}_2 + \text{H}^+ \leftrightarrow \text{R-NH}_3^+ \quad (8)$$

$$\text{H}_2\text{O}_2 \leftrightarrow \text{H}^+ + \text{HOO}^- \quad (9)$$

$$\text{H}_2\text{O}_2 + \text{R-NH}_2 + \text{H}^+ \leftrightarrow \text{R-NH}_3^+ + \text{HOO}^- + \text{H} \quad (10)$$

The hydroxyl radical (HO*) is easily produced from the decomposition of hydroperoxide anion as it is not stable, and the reactions in equation (11) and (12) take place.

$$\text{HOO}^- \rightarrow \text{OH}^- + \text{O}^* \quad (11)$$

$$\text{H}_2\text{O}_2 + \text{HOO}^- \rightarrow \text{HO}^* + \text{O}_2^{*-} + \text{H}_2\text{O} \quad (12)$$

Eventually, the hydroxyl radical (OH*) attacks the glycosidic linkage in chitosan to produce oligomer chitosan according to the reactions in equation (13) and (14).

$$(\text{GlcN})_m - (\text{GlcN})_n + \text{OH}^* \rightarrow (\text{GlcN}^*)_m - (\text{GlcN})_n + \text{H}_2\text{O} \quad (13)$$

$$(\text{GlcN}^*)_m - (\text{GlcN})_n + \text{H}_2\text{O} \rightarrow (\text{GlcN})_m + (\text{GlcN})_n \quad (14)$$

3.2. Kinetics degradation of chitosan

Some different rate models have been suggested regarding polymer degradation [19, 22, 23]. However, in this paper, the reaction rate was modelled as a function of molar concentration with a negative order n according to equation (4) [19]. Utilising equation (6) as the solution of the differential equation (4), the reaction order (n) can be determined by performing trial and error of the n value on plotting $\left[M_t^{1-n} - M_0^{1-n}\right]$ vs t. The n value of -0.1 showed the best fit of the curve with the kinetic

model. The finding of this study indicated that chitosan degradation followed -0.1 reaction order corresponding to the chitosan concentration.

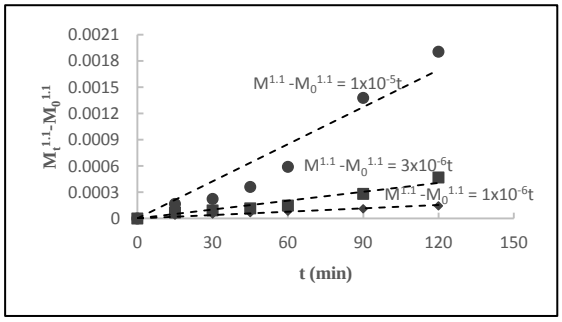


Figure 3. The changes of the molar concentration of chitosan fitted with -0.1 reaction order for different temperatures: (♦) 40°C; (■) 50°C; (●) 60°C.

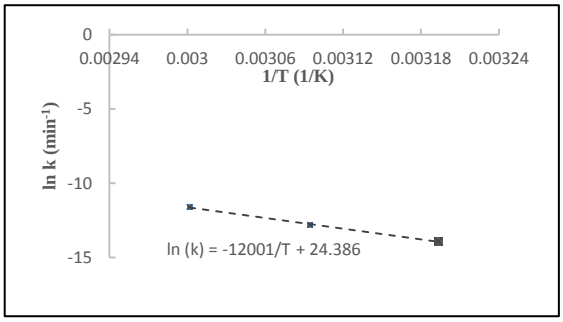


Figure 4. Plot Arrhenius to determine the rate constant

The changing for the molar concentration of chitosan was modelled according to -0.1 reaction order indicated a good fit with a coefficient of correlation $R^2 \geq 0.921$ (figure 3). The value of rate constants (k) for different temperatures: $9.1x10^{-7}$(40°C), $2.7x10^{-6}$(50°C), $9.1x10^{-6}$(60°C) $(mol/L)^{1.1}$/min. These rate constants are higher than compared to using sonolysis method with additional of Fe(III)/H_2O_2 in acetic acid solution with the value of k is in the range 1.538 – 4.923 x 10^{-9} $mol^{1.7}L^{-1.7}.min^{-1}$ for additional H_2O_2 between 0.0 – 1.2 mL [23]. They also reported that the reaction order was -0.7 using the same model used in this paper. This results showed that the chitosan degradation rate increased with reaction temperature indicated by the higher value of k as the temperature increase (figure 4). From the plot between ln(k) and 1/T, the value of activation energy (E_a) was obtained to be 99.8 kJ/mol. This activation energy value is considerably higher than that for degradation using electrochemical with electrode Ti/Sb-SnO_2 (E_a = 43.61 kJ/mol) and close to the value stated for acetic acid and H_2O_2 (Ea = 88.5 kJ/mol) [20, 24].

3.3. FT-IR spectra of degradation products

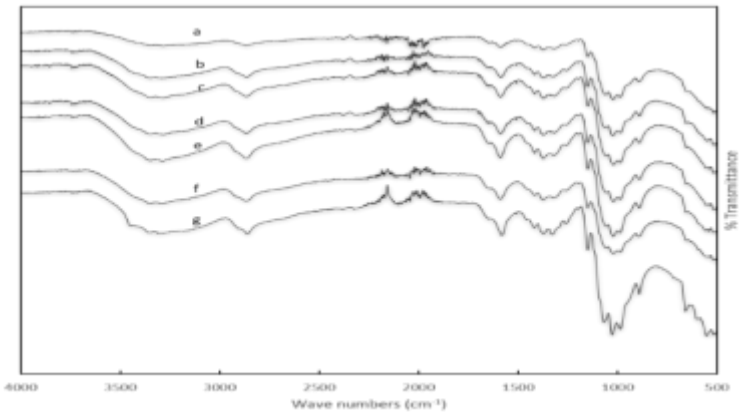


Figure 5. FT-IR spectra of chitosan for degradation at 60°C with reaction time 0 min (a), 15 min (b), 30 min (c), 45 min (d), 60 min (e), 90 min (f), 120 min (g).

The FT-IR spectra of chitosans for different reaction times at a reaction temperature of 60°C is described in figure 5. The peak which appeared at around 3368 cm^{-1} was referenced as the stretching vibration of N-H and O-H [25]. The peaks at 1648 cm^{-1} and 1324 cm^{-1} were assigned as amide I and amide III, respectively [26]. The peaks, as indicated at about 1597, 1156 and 1079 cm^{-1} were amide II,

C-O-C, and C-O, respectively [25]. The β-D-(1④4) glycosidic bond shown at the peak in the range 1158-895 cm^{-1} [27]. The results of FT-IR spectra confirmed that there is no formation of a carboxylic group during the degradation reaction as there was no peak appeared at 1735 cm^{-1} attributed to the carboxylic group [28]. The results suggest that the chemical structure of initial chitosan and depolymerised chitosan remained the same and no significant difference with the increasing of the reaction time of degradation. Hence, it can be concluded that with the utilisation of H_2O_2 in 1% formic acid, there is a primary reaction occurred with the cutting off the β-glycosidic linkage, and no side reaction occurred with the formation of the carboxylic group during the chitosan degradation.

4. Conclusions

Oxidative degradation of chitosan in formic acid solution utilising hydrogen peroxide as an oxidising agent had been done and resulted in lower molecular weight of chitosan. The reaction time and temperature have a significant effect on the degradation reaction and decreasing faster occurred at the first 15 minutes. The degradation followed -0.1 reaction order to the molar concentration of chitosan and the activation energy is 99.8 kJ/mol. The chemical structure of chitosan remained identical during the degradation reaction and indicated only primary reaction occurred with the cutting off the β-glycosidic linkage to produce lower molecular weight of chitosan.

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A decision tree algorithm for predicting amount of batik tulis lasem production by decision support system to support financial feasibility

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Abstract. Decision Support System for financial feasibility of the *Batik Tulis* Lasem Industry can process input data based-on Assumptions Value, Investment Costs, and Operational Costs into output in the form of recapitulation of Fund Sources, Projection of Profit and Loss and Projections of Cash Flows and value determinants of business feasibility such as: Net Present Value (NPV), Internal Rate of Return (IRR), and PayBack Period (PP). By this application, the researchers did a simulation asumtion value of *Batik Tulis* Lasem amount production. It was used 9 categories of *Batik Tulis* Lasem products, such as: *Batik* 1 Color Cheap, *Batik* 1 Color Medium, *Batik* 1 Color Expensive, *Batik* 2 Colors Cheap, *Batik* 2 Colors Medium, *Batik* 2 Colors Expensive, *Batik* 3 Colors Cheap, *Batik* 3 Colors Medium, and *Batik* 3 Colors Expensive. Simulation results are used as data in this study. The purpose of this study is to classify financial feasibility based-on the number of products produced. The algorithm used is Decision Tree. The data used is 100 records. Rule generated from the Decision Tree algorithm has an accuracy value of 95%. From the resulting the Decision Tree, there are 3 important rules can be taken in determining the amount of production.

1. Introduction

Batik Tulis Lasem Industry is located in Babagan Village, Lasem, regency of Rembang, Central Java. There are many *Batik Tulis* productive houses in Babagan. Productive houses in Babagan are owned by indigenous people and Chinese [1]. One of the well-known *Batik Tulis* industries is the productive house of Sumber Rejeki. It is owned by Sri Winarti, an indigene. She also become the chairman of the Sarwo Endah -*Kelompok Usaha Bersama* (KUB). At the Sarwo Endah gallery, each member can showcase and market their products[2].

To facilitate the *Batik Tulis* Lasem industry in analyzing financial feasibility in the context of submitting capital assistance, the researchers built a Decision Support System for the financial feasibility of the *Batik Tulis* Lasem Industry. This system can process input data based on Assumption Values, Investment Costs, and Operational Costs to be output in the form of recapitulation of Fund Sources, Projected Profit Losses and Projections of Cash Flow and the value of determinants of business feasibility such as: Net Present Value (NPV), Internal Rate of Return (IRR), and Pay Back Period (PP). From the three values produced, it can be determined the feasibility to add capital loan.

The next problem is how much production must be produced to meet the targets that are feasible or not feasible for the *Batik Tulis* production industry. In *Batik Tulis* industries managed by Sri Winarti, a production period is given a minimum of 150 products. *Batik Tulis* product itself is classified based on several things, such as materials, colors, motifs, prices, and etc. How many products must be produced by each product classification? Here, the researchers limit the classification of products into 9 categories: *Batik* 1 Color Cheap, *Batik* 1 Color Medium, *Batik* 1 Color Expensive, *Batik* 2 Colors Cheap, *Batik* 2 Colors Medium, *Batik* 2 Colors Expensive, *Batik* 3 Colors Cheap, *Batik* 3 Colors Medium, and *Batik* 3 Colors Expensive.

In this paper, the researchers present data simulation using 9 product categories, structure analysis decision tree that applied in Rapid Miner tools, and then the design of hierarchical trees and use them for predicting the amount of production. This prediction result will be used as data input on The Financial Feasibility by Decision Support System to determine financial feasibility status and real amount of production for each category in the *Batik Tulis* gallery Sarwo Endah as one of the feature for decision tree models. It increases the accuracy of amount prediction.

2. Literature Review

There are many algorithm for the classification technique had been used in the fields of data mining. These algorithm are decision tree, rule-based method, memory-based learning, Bayesian Networks, Neural Network and Support Vector Machines. A comparative study has been implemented using three classification algorithms are Support Vector Machine (SVM), Fuzzy-SVM, and decision tree [3]. In the other hand the researchers also shows a comparative study between decision tress and KNN for classification technique[4].

Based on the both of comparative study previously, decision tree algorithm has variation in produced results, because the results depend on method to choose best attribute and criteria used to grow the tree. Decision Tree used to predict a class for a given attribute and KNN algorithm only used to find similar value. Based on the research by A. Trabelsi et al., Decision tree algorithm can be used to solving classification problems with attribute values and class label that applied on data imperfection [5].

In other research, this algorithm can applied to multi criteria inventory classification (MCIC) based on supervised classifiers [6]. The training data using a sample items from simulating inventory control system. Many other problems using Decision tree to make a model classification to evaluate the productive potential of biometric during harvest the sugarcane crop [7]. The classification technique aims to a prediction that accurate for oil production in order to operations effective cost [8]. A. Tike and S. Tavarageri develop research to predict prices into a medical price prediction system [9]. N. Nwulu compares decision tree with machine learning algorithms such as Random Forest, linier regression, and Gradient-boosted trees to prediction the crude oil price and the result experiment achieves high accuracy[10]. In The agriculture field, M. Shakoor et al. using supervised machine learning to prediction agricultural production on farming in Bangladesh [11].

Next research, S. Rajeswari and K. Suthendran develop classification model for agricultural data of the soil fertility level. This model is activated on Design of Smart Information System (DSIS) using Global Positioning System(GPS) to identify the user location [12]. In the healthcare domain also using decision tree for prediction of heart disease and produce prediction with high accuracy and sensitivity[13]. In drilling industry decision tree algorithm used to predicting lost circulation that applied to develop smart system for estimating amount of lost circulation, and this algorithm most accurate method relative to other method are ANN, ANFIS and MLP-NN [14]. From the various research about implementation decision tree algorithm previously, so in this research will used Decision tree algorithm. If we look the data will be used is more appropriate with decision tree. Next to measure prediction accuracy in this research, now available open source software is rapid miner [15]. The software can show performance of the classification models with accuracy measure.

3. Methodology

The Method of the research can be seen in Figure 1.

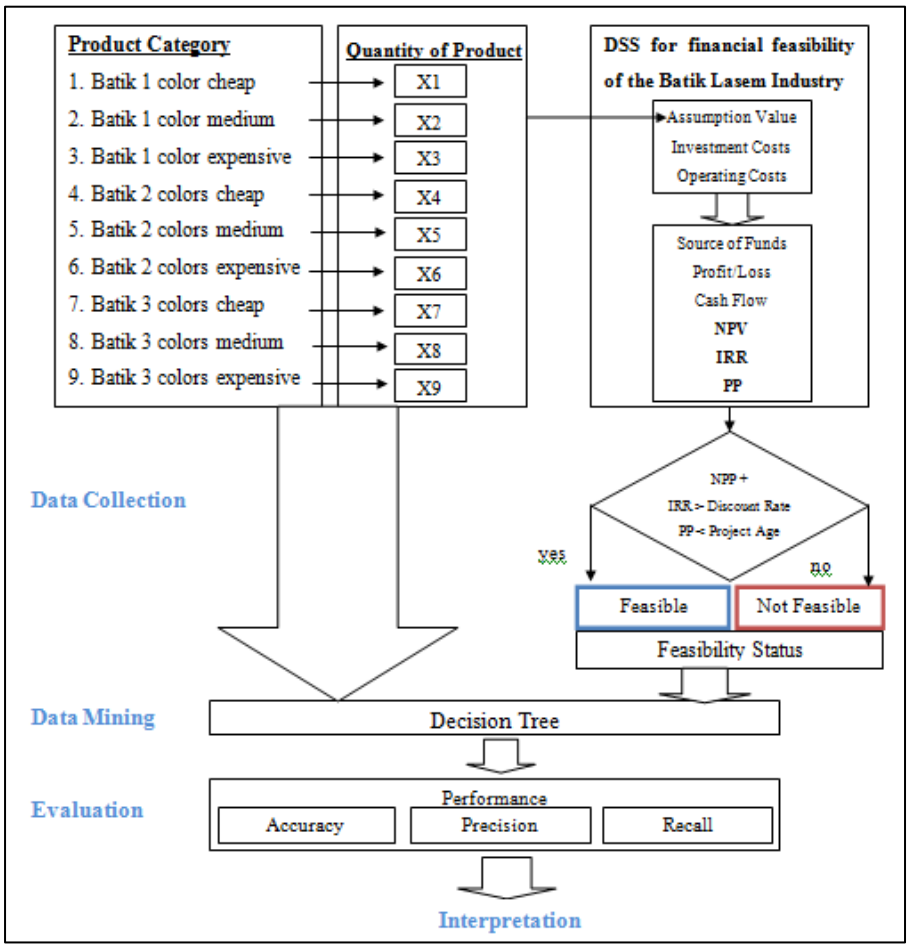


Figure1. The Research Method of Decision Tree

The research steps are as follow:

1. Data Collection

   The Data is collected by conducting simulations using the Decision Support System application for the financial feasibility of the *Batik Tulis* Lasem Industry. The variables used consist of 2 types of variables: class variable and independens variables. Feasibility Status is class variable and other variables are:

   a. quantity of product from *Batik* 1 color cheap
   b. quantity of product from *Batik* 1 color medium
   c. quantity of product from *Batik* 1 color expensive
   d. quantity of product from *Batik* 2 colors cheap
   e. quantity of product from *Batik* 2 colors medium
   f. quantity of product from *Batik* 2 colors expensive
   g. quantity of product from *Batik* 3 colors cheap
   h. quantity of product from *Batik* 3 colors medium
   i. quantity of product from *Batik* 3 colors expensive

2. Data Mining

   In processing data mining, the algorithm used is Decision Tree. Tree formation is done by using the index gini criteria.

3. Evaluation
   Evaluation is done to determine the value of accuracy, precision, and recall of the algorithm used.
4. Interpretation
   Interpretation is done by analyzing the tree formed from the data mining process by Decision Tree. The analysis is used to take the decision.

The determination of class variable of Feasibility Status was done by some tools [16]:

a. Net Present Value (NPV)
   If NPV positve, the Feasibility Status is Feasible. The other, the Feasibility Status is Not Feasible.
b. Internal Rate of Return (IRR)
   If IRR > Discount Rate, the Feasibility Status is Feasible. The other, the Feasibility Status is Not Feasible.
c. Payback Period (PP)
   If PP < Project Age, the Feasibility Status is Feasible. The other, the Feasibility Status is Not Feasible.

4. Results and discussion

The data used in this study were 100 records. Data obtained from simulations of the Assumption Value of the production of *Batik Tulis* Lasem. The simulation application uses the Decision Support System for the financial feasibility of the *Batik Tulis* Lasem Industry. Simulation is done by entering the number of *Batik Tulis* Lasem productions which consists of 9 categories, such as: *Batik* 1 Color Cheap, *Batik* 1 Color Medium, *Batik* 1 Color Expensive, *Batik* 2 Colors Cheap, *Batik* 2 Colors Medium, *Batik* 2 Colors Expensive, *Batik* 3 Colors Cheap, *Batik* 3 Colors Medium, and *Batik* 3 Colors Expensive. The results of value NPV, IRR, and PP can be seen in Simulation Data in **Table 1**

Table 1. Simulation Data

Batik 1 color			*Batik* 2 colors			*Batik* 3 colors			Financial Feasibility			Feasibility Status
Cheap	Medium	Expensive	Cheap	Medium	Expensive	Cheap	Medium	Expensive	NPV	IRR	PP	
20	20	10	20	20	10	20	20	10	1.110.840.137	150,48	0,61	Feasible
20	15	15	20	15	15	20	15	15	1.357.807.604	151,11	0,515	Feasible
.												
.												
.												
90	50	10	0	0	0	0	0	0	-70.389.345	135,56	3,936	NotFeasible

Data of 100 records consisted of 57 records with Feasibility Status are Feasible and 43 records with Feasibility Status are Not Feasible. From this, the Data Mining is processed using the Decision Tree algorithm. The criteria is index Gini. Data mining processing uses Rapid Miner tools. Figure 2 shows the structure of the analysis Decision Tree in Rapid Miner. Figure 3 shows the Tree of Decision Tree Result.

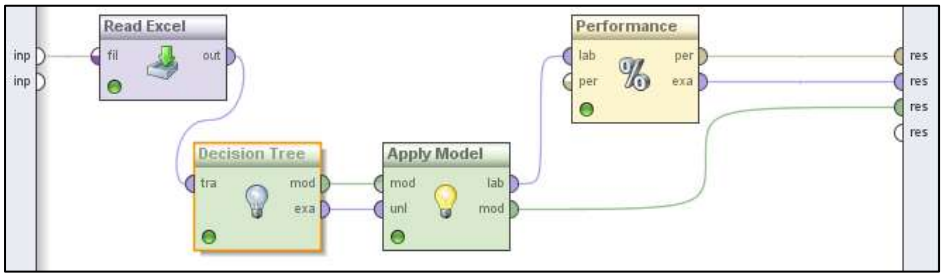


Figure 2. Analysis Structure of Decision Tree

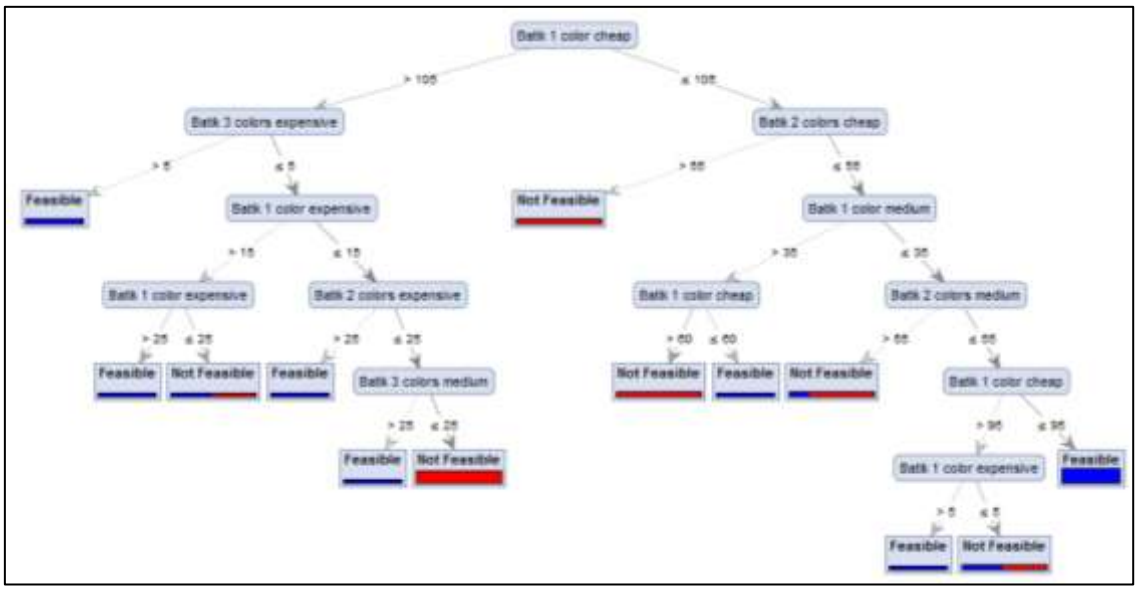


Figure 3. The Result of Decision Tree

accuracy: 95.00%

	true Feasible	true Not Feasible	class precision
pred. Feasible	52	0	100.00%
pred. Not Feasible	5	43	89.58%
class recall	91.23%	100.00%	

Figure 4. Evaluation Result of Performance Value

Figure 4 shows the results of the evaluation of the performance values of the Decision Tree algorithm. Accuracy value is 95%, class precision for Feasible prediction is 100% and class precision for Not Feasible prediction is 89.58%. The class recall value for true Feasible is 91.23% and the class recall value for true Not Feasible is 100%.

5. Conclusion

The research is using the Decision Tree algorithm. For the conclusion of the research, there are 3 rules produced to determine the number of products that must be produced by *Batik Tulis* Lasem industry players. To obtain Feasibility Status equal to Feasible, in a production period there are 150 products, at least must comply with the following rules:

1. If *Batik* 1 Color Cheap are produced with a minimum number of 106 products, it also must be produced *Batik* 1 Color Expensive and or *Batik* 2 Colors Expensive and or *Batik* 3 Colors Medium with a minimum number of 26 products.

2. If *Batik* 1 Color Cheap are produced with range 96-105 products, it also must be produced *Batik* 1 Color Expensive with a minimum number of 6 products.
3. If *Batik* 1 Color Cheap are produced with a maximum number of 60 products, it also must be produced *Batik* 1 Color Medium with a minimum number of 36 products.

Acknowledgments
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Smart urban farming using arduino in residential area

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Abstract. At present time, the need to get nutrition from vegetables is very important, especially with the urban community life patterns that tend to be busy and more often consume fast food for their daily food and with the development of IoT and the need for fresh vegetables it is necessary to make research related to hydroponic cultivation with IoT technology assisted also the problem to measure the right pH, ppm, and the temperature for good hydroponic media. Then in this study a hydroponic plant monitoring system was developed using Arduino. This system is equipped with temperature sensors, level of acidity and alarm as a reminder to re-add nutrients to plants. With this system, it is expected that people will be easier to monitor hydroponic plants during their busy life. This study shows high accuracy of pH and ppm by using Arduino and sensor for the hydroponic system. The measurement results between using sensors and manual measurements showed results with an error value of 0.44% for pH measurement, 0.71% for ppm measurements and 0.59% for temperature measurements.

1. Introduction

The existence of green land in a house will make the atmosphere of the house becomes cooler and more comfortable. In addition, cultivation activities can avoid stress from the routine work that exists. However, limited and narrow land is one of the most common obstacles for citizens living in cities from stress due to routine work. However, limited and narrow land is one of the most common obstacles for citizens living in cities. great for planting activities.

Hydroponics is a system of agricultural cultivation without using soil media, so hydroponics is an agricultural activity run by using water as a medium to replace the soil [1].

The making of hydroponic system prototype begins by designing the structure and arrangement of the rack which will be used as plant growing medium. The hydroponics system is designed to be based on the Nutrient Film Technique (NFT) system which is a hydroponic cultivation model by putting plant roots on a shallow layer of water. Water is circulated and contains nutrients according to the needs of plants [2].

This design is based on site survey results and discussions between the Proposing Team and Partners. After conducting location and discussion survey, it was finally agreed that the design of the hydroponics system to be made is shown in figure 1.



Figure 1. Model reference, process of making hydroponic system, and process of making hydroponic system.

2. Related Works

There are many previous researches related to urban farming and using new technologies like IoT, Thu Ya Kyaw [3] has proposed smart aquaponics system has demonstrated to be a self-sustainable, cost-effective, and eco-friendly urban farming that can attract commercial farmers and home gardeners.

Their proposed system can continuously monitor and control water quality, light intensity, and fish feed; automatically send early warnings in form of email, SMS, and push notification; and rectify system abnormality without human interference.

Somchoke Ruengittinun [4], proposed a Hydroponic Farming Ecosystem (HFE) that uses IoT devices to monitor humidity, nutrient solution temperature, air temperature, pH and Electrical Conductivity (EC).

The HFE is made to support non-professional farmers, city people who have limited knowledge in farming and people who are interested in doing vertical planting in very small areas in the city such as building tops, balconies of small rooms in high-rise buildings, and in small office spaces.

Jumras Pitakphongmetha et al [5], using sensors coming in a greenhouse as Wireless Sensor Networks System are one efficiency of technology used in agricultural development by sending data to the cloud and controlling values such as temperature, light, etc. The results of this study will be useful for the farmer and related organizations applying in the farm.

3. Methodology

The data acquisition unit continuously collects data using two sensors. pH level sensor detects water pH level in the fish tank, and ppm measures component concentration (ppm) of a flow on a stream or equipment. The design diagram is shown on figure 2.



Figure 2. System Diagram.

At first, the data are gathered by the sensors, which is communicated with the Arduino and then the data are fetch to the raspberry pi which connected to the area WIFI and then upload the result to the cloud. The main goal for the cloud server is to store the collected data from the data acquisition unit. User can view current pH and ppm on the hydroponic system by using their computer or smartphone with data connection to access web application.

The schematic diagram for Arduino and connection to all the sensors and LCD is shown on figure 3. The component used in this study are LM35 temperature sensor, DHT11 humidity sensor, Gravity pH and TDS analog meter, buzzer, RGB led, breadboard, and LCD are shown in figure 4 (a, b, c, and d respectively). The results of the series of all sensors and Arduines can be seen in figure 5.

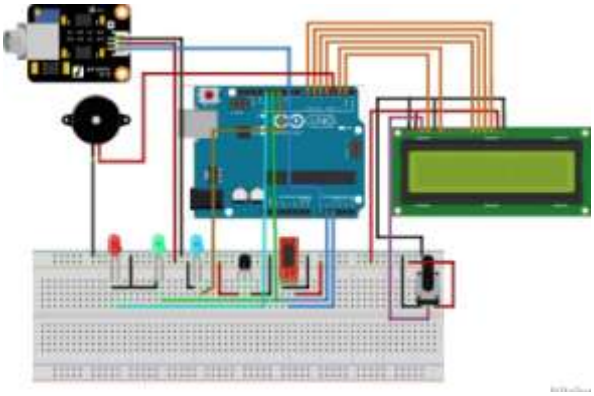


Figure 3. Schematic Diagram.

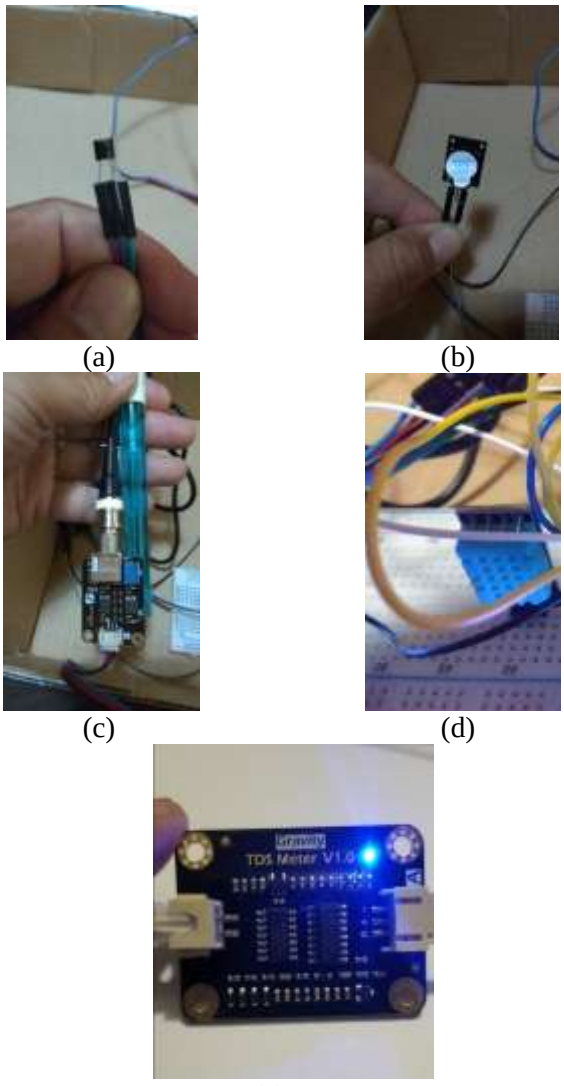


Figure 4. (a)Temp sensor. (b) Buzzer. (c) pH sensor. (d) Humidity sensor. (e) TDS sensor.

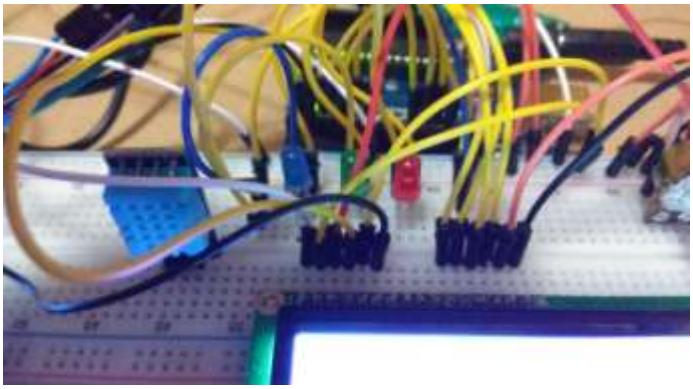


Figure 5. All the sensors and equipment connected.

4. Result

According to the system diagram shown in figure 3, all the hardware components are carefully installed and tested before deployment. The proposes system tested with different scenarios like adjusting the pH and ppm components on current flow of water.



Figure 6. The sensor are placed on the top of the water nutrition box.



Figure 7. The LCD panel shows the current pH and TDS in the water nutrition.

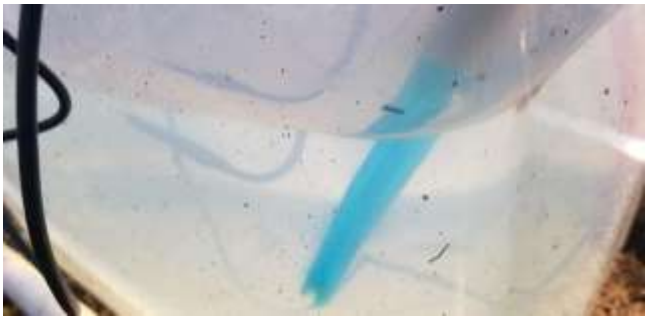


Figure 8. Both sensors are submerged into the water nutrition.

As we can see in the figure 6, the hydroponic system is placed in the simple green house to protect the plant form the environment. Figure 7 shows the current pH and TDS in the water solution; the sensor is using battery its modular and equipped with buzzer speaker so if the pH or the TDS are above certain threshold the speaker will buzz. Figure 8 Shows both the TDS and pH sensor are submerged in the water solution.

Table 1 shows the difference in measurement and validation results of pH, ppm and temperature using sensors and manual measurements in 5 trials.

Table 1. Sensor and manual measurement results.

Trials	**pH**		**PPM**		**Temperature**	
	pH Meter	Manual	TDS Meter	Manual	LM35	Manual
1	5.502	5.50	1401	1400	20.1	20.0
2	5.510	5.60	1404	1400	20.2	20.0
3	5.50	5.49	1400	1410	20.1	20.2
4	5.511	5.50	1420	1400	20.0	20.1
5	5.411	5.400	1415	1400	20.1	20.0

The difference in measuring results between using sensors is because the sensors installed on the system use battery power and there are conversions from analog to digital. If the battery used in the situation is good, the results obtained are not too far from the results of manual measurement.

5. Conclusion

We have presented a prototype system for urban farming hydroponic using Arduino board and sensor. The experiment was carried out by implementing a system design made on hydroponic growing media placed in a greenhouse. The measurement results between using sensors and manual measurements showed results with an error value of 0.44% for pH measurement, 0.71% for ppm measurements and 0.59% for temperature measurements. This proves that using sensors and Arduino can help the community to develop urban farming. In addition, the system can sound an alarm if a value is less or exceeds the specified threshold for temperature, ppm and pH.

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Towards power supply efficiency in IoT for image-based transmission scheme

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Abstract. Regular image transmission on Closed-Circuit Television (CCTV) systems requires good network, especially for transmitting high quality digital image. However, sending high quality digital image through limited bandwidth needs several precautions and treatments, like which image to be sent, how the image will be sent and when. Without these precautions and treatments, in return it will results in energy inefficiency. The main purpose of this research is the power supply efficiency towards high quality digital image transmission scheme for autonomous CCTV. This research considers individual but consecutive images transmission rather than video transmission to limit the processing time and power. This research focuses on high quality digital image transmission from a CCTV to collector node through Narrowband Internet of Things (NB-IoT) network. To improve the lifetime of the power supply of the CCTV, this research conducts performance measurement comparing on several digital image compression and transmission algorithm to find optimal bandwidth usage to arrange which data to be sent based on several conditions. The arranged data are sent to the collector node through NB-IoT. The output of this research is the best digital image compression and transmission algorithm to deliver optimal bandwidth usage which in return will reduce power usage in future WSN.

1. Introduction

Surveillance System is one from many possible solutions delivered by the emerging technology called Internet of Things (IoT). An IoT heat map graph in 2018, as depicted in figure 1, shows the details about the fastest growing areas in IoT applications and Security and Surveillance is one application or use case that is in hot area, especially in Government, Education, and Social Services. For this application, it is common to use Closed-Circuit Television (CCTV) in any smart city and smart home for surveillance purposes.

However, CCTV system sends the surveillance data stream in video format, which leads to lower resolution compared to using still images. User tends to stream videos without noticing that the surveillance data stream most likely sends the same image frame repetitively, which are unnecessary. There are several limitations with regular CCTV, they are:

1. CCTV captures and sends surveillance data in video format. This format is not recommended when we want to zoom in, for example, to recognize faces, due to the usual distance between CCTV and the objects;
2. CCTV relies its power supply from Digital Video Recorder (DVR) through copper wire. This scenario is still susceptible to crime, by cutting the cables someone will be able to turn off the CCTV;

3. CCTV uses copper wire to transfer its surveillance data to the DVR. This scenario may limit the distance between CCTV's installation site to the DVR.

These three limitations are the problems to make autonomous CCTV. In this research, autonomous CCTV has several characteristics:

1. Instead of sending surveillance data in video format, autonomous CCTV sends high definition images with resolution at least 1280x720 pixels (HD 720);
2. To minimize dependency on power outlet or DVR, autonomous CCTV relies its power source solely from batteries;
3. To minimize dependency on cable wiring, autonomous CCTV transfers surveillance data using wireless connection.

This autonomous CCTV will have several advantages, like:

1. User can install this autonomous CCTV anywhere without worrying about cable wiring installation, because it depends on batteries and transfer surveillance data using wireless connection;
2. User can install autonomous CCTV at any time without worrying about distance and routing mechanism to transfer surveillance data;
3. Autonomous CCTV might not need a DVR to work since it connects directly to The Internet;
4. Autonomous CCTV has the intelligence capability to send a specific high definition digital image and how to transfer it.

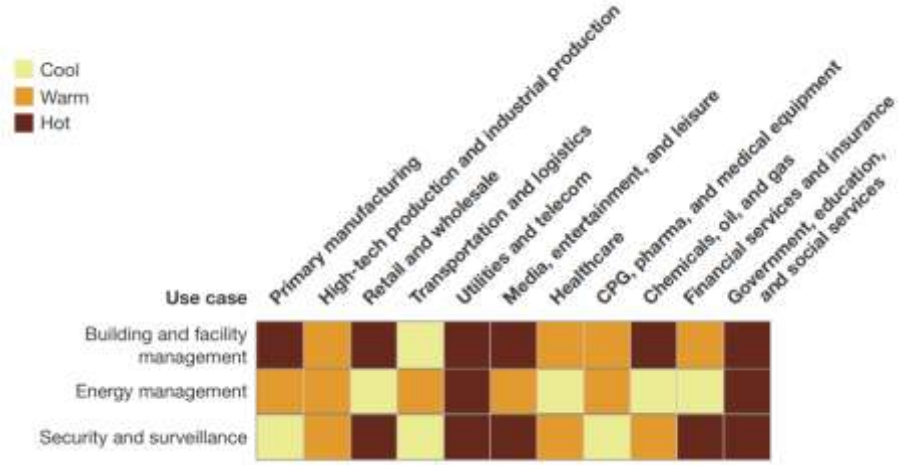


Figure 1. IoT heat map 2018 [1].

This research focuses on answering the first problem, which is how an autonomous CCTV could send high definition or high-resolution image through a wireless connection using Narrowband IoT (NB-IoT) technology. However, sending the surveillance data using high resolution still images requires higher data rate compared to using video streaming, especially when using NB-IoT that only provide bandwidth of 250 kbps. Because autonomous CCTV must provide higher power efficiency, due to its use of battery for power supply, this research conducts several scenarios to fulfil the fourth characteristic, the ability to choose which image to be sent. In author point of view, this autonomous CCTV is an application of autonomous IoT that has the intelligence capability [2].

2. Related works

Several similar researches have been done in this topic; however previous researches use the term Wireless Multimedia Sensor Network (WMSN) to describe a video based IoT. This research uses a new term of autonomous CCTV to distinguish the difference with a broader term, the WMSN, where the autonomous CCTV shares several characteristics of the WMSN [3]. One of the shared

characteristics is the energy efficiency in transmitting the image [4-6], the concern of data size [7], and how to transmit the image [8-9].

The various types of transmission schemes have been studied in many kinds of WMSN systems. There are two approaches in image transmission scheme:

1. Some of WMSN systems use auto delete feature after a certain period to transmit data, only when it is required;
2. Other systems use the compulsory of removing redundant features in an image data, before the image data transmitted to optimize the power consumption reduction.

The power consumption reduction is done with the consideration of using available bandwidth to fit the data and keep the processing cost low.

For the Narrowband Internet of Things (NB-IoT) itself, it currently discussed by technology company and telecommunication provider because of its benefits [10]. NB-IoT can connects to devices efficiently and simpler with established networks. It also provides very low power consumption, easy deployment into existing cellular network architecture and lower component cost. The drawback is its low bandwidth, which is only capable of delivering maximum 250kbps.

Table 1. Narrowband IoT (NB-IoT) characteristics as 3GPP Release 13.

	LTE Rel-8 Cat-1	LTE Rel-12 Cat-0	LTE Rel-13 Cat-M1	NB-IoT Rel-13
Downlink peak rate	10Mbps	1Mbps	1Mbps	250 kbps
Uplink peak rate	5Mbps	1Mbps	1Mbps	250 kbps
Duplex mode	Full	Half or full	Half or full	Half
UE bandwidth	20MHz	20MHz	1.4Mhz	0.18Mhz
Max. Transmit power	23dBm	23dBm	20 or 23 dBm	23dBm
Relative modem complexity	100%	50%	20-25%	10%

3. System Design

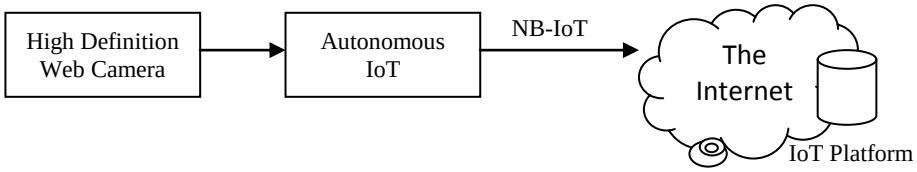


Figure 2. System topology.

The complete system of an autonomous CCTV is shown in figure 2. This research evaluates the process inside the autonomous IoT before the surveillance data are transmitted to the IoT platform using NB-IoT. The evaluation uses two tests, the first test is using the difference between two consecutive images and the second test is using the difference between an examined image with a baseline image (an image where there is no other moving object except the natural environment). Each test is going through 10 trials, where one trial includes 60 comparison images.

High resolution image samples are taken from Youtube.com with the title of: Royal Wedding: Time-lapse footage shows Windsor crowds - BBC News. Authors use 600 samples of high-quality digital images with resolution 1280 x 720 pixels and 24-bit depth. All this sequence of images is pre-processed using simple edge detection algorithm, in this research authors use Sobel algorithm, so it can be easily implemented on hardware platform like development board such as Arduino. This image pre-processing is to help calculate differences between images. The difference calculation is done using the Sobel-edged images. Using the difference calculation, the last process is to choose which image to be sent through NB-IoT channel. Figure 3 explains this process.

To determine which image to be sent, authors use a polynomial equation based on the difference function. Based on the polynomial equation, authors try to find a straight-line equation where its slope (gradient) gives a significant difference.

The image with highest gradient indicates the high number of differences in the image. From the 10 trials, there has to be only one image to be sent in order to meet the NB-IoT data rates in 250 kbps. And the rest of the images are not sent through the NB-IoT.

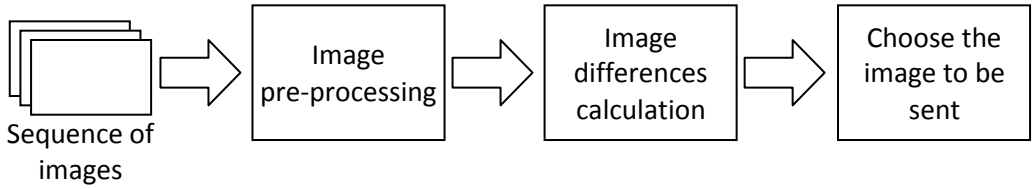


Figure 3. Image process steps to choose which image to be sent.

4. Result and Analysis

The initial step is differentiating the two images by calculating the total pixel differences after the edge detection method applied. The image comparison utilized two approaches to calculate the total pixel differences which are image differentiation with initial image baseline and consecutive image.

Table 2 below shows the lowest and the highest total pixel differences in the percentage of 10 trials with the two approaches. Each trial includes 60 images to analyze. Starting from image number 88 to 687 with 600 samples in total. The results below are used for the next step, which is defining the polynomial equation from each trial, since each image sequence produces a different equation. The first derivation is used to calculate the image with highest gradient value. Therefore, the highest gradient value becomes an indication of which image to be sent to the cloud.

Table 2. Total Pixel Differences (%).

Trial	With Initial Image Baseline		Consecutive Image	
	Lowest Differences (%)	Highest Differences (%)	Lowest Differences (%)	Highest Differences (%)
1	7.13	9.20	5.79	8.41
2	6.88	8.60	6.10	8.53
3	6.29	8.54	5.93	7.76
4	6.71	8.24	5.98	7.32
5	6.67	8.08	6.16	7.90
6	6.60	8.02	6.38	7.33
7	6.58	7.75	5.93	7.20
8	6.56	7.92	6.03	7.18
9	6.64	8.54	6.42	7.63
10	6.99	8.46	6.56	7.70

Table 3 shows the image number to be sent to the cloud as a final process in conjunction with the number of capacities needed to transmit the image. Column 60 means there is no next image to select in the y matrix of a particular trial, so the image assumed to be ignored. In order to transmit a single high-quality image data through NB-IoT networks, 9 out of 10 trials need to be in an idle condition or no image transmits to the cloud. Therefore, to send a single image, data can be splitted into several parts in a single sequence. Since trial 1 to trial transmits all the data which can not fit with the networks used, there is no images transmitted.

Table 3. Image to be sent with gradient equal to one

(a) Image with Baseline. (b) Consecutive Image.

Image to send		
Trial	Image with Baseline	Capacity Needed (bits)
1	Column 60	drop
2	149	1,831,528
3	209	1,719,576
4	269	1,959,640
5	329	2,169,024
6	389	2,241,672
7	449	2,463,560
8	509	2,595,160
9	Column 60	drop
10	629	2,486,720

(a)

Image to send		
Trial	Consecutive Image	Capacity Needed (bits)
1	132	1,804,504
2	149	1,831,528
3	228	1,763,928
4	Column 60	drop
5	340	2,193,496
6	419	2,305,152
7	496	2,582,432
8	535	2,665,592
9	569	2,795,960
10	Column 60	drop

(b)

To be able to send a single data through the NB-IoT networks, let the gradient for both approaches set to be equal to 0.1130 for an image with baseline and 0.0821 for the consecutive image.

Table 4 shows the final results of a single image data to be sent through the NB-IoT Networks which are image number 209 for an image with baseline and image number 149 for the consecutive image.

Table 4. Image to be sent

(a) Image with Baseline (gradient equal to 0.1130). (b) Consecutive Image (gradient equal to 0.0821).

Image to send		
Trial	Image with Baseline	Capacity Needed (bits)
1	-	-
2	-	-
3	209	1,719,576
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-

(a)

Image to send		
Trial	Consecutive Image	Capacity Needed (bits)
1	-	-
2	149	1,831,528
3	-	-
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-

(b)

Defining the frequency of the images process added after the edge detection method applied as a second proposed method for this research. Table 5 shows the result of the image to be sent with frequency images process after selected the specific gradient value for both approaches.

Table 5. Image to be sent
(a) Image with Baseline (gradient equal to 8.9973). (b) Consecutive Image (gradient equal to 8.3240).

Image to send		
Trial	Image with Baseline	Capacity Needed (bits)
1	-	-
2	-	-
3	-	-
4	-	-
5	-	-
6	-	-
7	449	2,463,560
8	-	-
9	-	-
10	-	-

(a)

Image to send		
Trial	Consecutive Image	Capacity Needed (bits)
1	-	-
2	-	-
3	-	-
4	-	-
5	329	2,169,024
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-

(b)

Table 5 shows the result of a single image data to be sent through the NB-IoT networks which are image number 449 for an image with baseline and image number 329 for the consecutive image.

5. Conclusion

From the complete process of image-based transmission scheme, the proposed method is to find the efficient imaged-based transmission scheme for CCTV systems using NB-IoT networks. The data used in this process are 600 samples of a high-quality image in JPEG format. The edge detection method is used to differentiate between images and use image frequency ass the additional process for the second proposed method. The result is lists of the total pixel differences between the two approaches. The approaches used are image with baseline and consecutive image. Defining the polynomial equation of each trial is needed to decide which image to be sent with highest gradient value. The number of a gradient can be changed depends on the y matrix value from each trial in order to only have a single data on each approach in a sequence. The capacity of selected images will be checked to be sent as a final process. If the capacity meets the NB-IoT specifications, the image can be sent to the cloud. While the image with insufficient capacity will go back to the process where the system defines the right gradient number to select the image with capacity that fits NB-IoT networks.

The final image to be sent for the first proposed method is image number 209 for an image with baseline comparison and image number 149 for the consecutive image. Furthermore, the image to be sent in second proposed method is image number 449 for an image with baseline comparison and image number 329 for the consecutive image. Based on [9], changing the transmission mode can be the reference to calculate the approximation power supply life on IoT system with NB-IoT networks. The right transmission mode can prolong the power supply life up to 10 years and can be changed depends on the data transmission mode used in the IoT system. However, the evaluation of the real performance of the system still needs to be conducted in further research.

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E-commerce for Japanese pop-products in Indonesia: the sign of decline stage

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Abstract. Japanese pop-culture has shaken the world through creative products such as pop music, drama, animation, comics, fashion, and characters. Big Japanese firms have established their e-commerce overseas. Many local small online stores in the targeted overseas market actively sell those pop-products to end customers. In the Indonesian online market, small online stores present themselves in an owned web-store (mostly in dotcom domain) and personal blog sites. However, little is known about their characteristics to formulate a strategy for their survival. This study aims to characterize Indonesian small online stores of Japanese pop-products, to compare stores placed in dotcom and blog site domains, and to propose practical recommendations. A web content analysis method was employed, and a sample of 93 stores was generated systematically online. The results show that dotcom stores are likely to sell fashion products while blog site entertainment. Various ordering methods are provided for customer convenience, but dotcom stores tend to have shopping carts than blog site stores. This study reveals that personal blogs as shopping channels are declining. Therefore, it is suggested that blog site stores adopt alternative growing online channels, such as joining the marketplace and social media shopping. While owned web stores are still prestigious, this study also suggests the dotcom stores adopt other shopping channels which are entering the marketplace and engaging social media shopping.

1. Introduction

Asian popular culture products (pop-products) from Japan and South Korea such as music, drama, TV programs, fashion, food, animated films, have shaken the world. Both governments developed their popular culture (pop-culture) products as part of the top priority economic policy. The terms “Cool Japan” and “Korean Wave" are famous names to represents such policies in business practices and academic literature. Academic literature often links Cool Japan with pop-culture diplomacy [1]. Studies on pop-culture products have been emerging [2], [3]. Cool Japan refers to Japan's economic policy to advance the content industry to develop global competitiveness [4]. Cool Japan is a concept used by The Japanese Ministry of Economy, Trade, and Industry (METI) to promote cultural and creative industries as a strategic economic sector since 2010. These cultural and creative industries are targeted to boost the Japanese economy and to maintain Japanese influence overseas. The Japanese pop culture and related creative products such as J-pop music, manga, anime, street fashion, film, cuisine, and cuteness characters have been favorite overseas. Similarly, the term Korean Wave (or Hallyu in Korean) refers to

the spread of Korean pop-culture across East and Southeast Asia and other countries [5]. Identical to Cool Japan, the Korean pop-culture includes music, dramas, films, and other Korean cultural products.

The role of the Japanese Ministry of Economy, Trade and Industry (METI) in Cool Japan Initiative is to facilitate private company expanding its business overseas. A document titled "Cool Japan Indonesia project" from the METI website indicates the project outline as follows:

> *"Understanding the market trends of Japanese goods, contents, etc. and supporting matching with local companies in Indonesia, …, We will also develop a scheme to widen overseas sales taking advantage of what is expected to be the growing field of electronic commerce."*

In South Korea, the Ministry of Culture played the major role for Korean Wave development, in which one of them is the shift of government policy from regulation to promotion [6].

The potential e-commerce in Indonesia is enormous as the number of internet users is 143 million in 2018, and is ranked the 5th (after China, India, US, and Brazil) in the world [7]. The number of internet users in this developing country is potential for e-commerce. In the context of Indonesia, a few big e-commerce firms especially online malls (or marketplace) exist to sell a variety of products (e.g., Tokopedia, Bukalapak, Lazada, Blibli) including some Japanese pop culture products. Besides, a considerable number of small and even personal businesses emerging online stores can exist as being a web store, joining a marketplace, or using social media sites.

A preliminary study indicated that small online stores in Indonesia are majority characterized by having dotcom (.com) domain instead of co.id, and some portion utilized social sites such as Blogspot and other social media for selling goods. In the current digital business era, more entrepreneurs establish small or individual online stores, and understanding the business characteristics is essential for business survival. Both groups of the company are rarely observed in term of their role within the context of Cool Japan. Understanding of business characteristics is important to strategy formulation. This paper focuses on Japanese pop-products and aims to characterize Indonesian small online stores of Japanese pop-products, to compare stores placed in dotcom and blog site domains, and to propose practical recommendations. The unit of analysis is a small online store, in Indonesia, selling Japan pop culture products as a part or an entire product offering.

2. Method

This study employed content analysis to review online stores selling Japanese pop-products. Content analysis is a technique that facilitates the systematic and objective identification of some contents available in online store sites. Features or contents are codified; therefore, the data collected is treated as quantitative data. This procedure confirms the protocol recommended by Stemler [8]. The targeted population is online stores in Indonesia, which sell Japanese pop-products. As the expected sample frame of a relevant directory is not available, a sample should be generated. The four-step procedure has been conducted in this study. Step 1 is a *sampling process*. Search words "Japanese product" (in Indonesian words) were inputted in Google search, then all 'look like' relevant sites were recorded. This step was repeated until the results are irrelevant or reaching maximum page 20. Afterward, each URL address was opened and checked for its existence and relevancy. Step 2, *preliminary exploration*, was aimed to identify products sold and all alternative channels for ordering. This step was performed using the top 30 sites. Based on the findings, a table in excel worksheet was created to cover those all alternatives. Furthermore, Step 3, *data collection*, is to explore each site and record the data in a table. The investigation of each site is focused on four aspects: the profile, operation, and marketing. Finally, *Step 4, data analysis*, is to transform data in the spreadsheet into SPSS datasheet for better coding, labeling, and analysis. Data were analyzed with descriptive statistics covering frequency table, cross-tabulation, and odd's ratio.

3. Findings

The final number of the sample used in this paper is 93 online stores, which have site domain of dotcom or blog sites. The results are presented in the following three parts.

3.1 Profile of online stores

Table 1 shows that online stores in dotcom are dominant (85%), and an only small number are placed in blog sites (15%), which are blogspot.co.id and blogspot.com. Furthermore, those stores are categorized into two groups. The first group is named "dotcom" to represent all online stores with a ".com" domain. The second is called "blog site" to describe the stores placed in Blogspot.

Table 1. Site domain of online stores.

Domain	Frequency	Domain	Frequency
.com	79 (85%)	dotcom	79 (85%)
.blogspot.co.id	13 (14%)	blog site	14 (15%)
.blogspot.com	1 (1%)		
Total	93 (100%)	Total	93 (100%)

3.2 Site domain vs. product sold

Products sold by online stores could be categorized into eight, as shown in table 2. The clothing, bags/shoes/accessories, and mixed fashion (a combination of both categories) contribute about a half of total online stores. Beauty & health products, such as cosmetics, are also major product category. These categories are all products worn to the body. The other four, which are drama/movie, music, comics, and characters, represent pop-culture entertainment. Therefore, these are further grouped into fashion and entertainment, as shown in table 2.

Table 2. Site domain vs. Products sold.

Product	dotcom	blog site	category
Clothing	23 (29%)	0 (0%)	
Bags, shoes, accessories	13 (16%)	0 (0%)	Fashion
Mixed fashion	3 (4%)	0 (0%)	
Beauty & health	11 (14%)	2 (14%)	
Drama, movie	9 (11%)	6 (43%)	
Pop music	2 (3%)	2 (14%)	Entertainment
Comics	6 (8%)	3 (21%)	
Character product	12 (15%)	1 (7%)	
Total	79 (100%)	14 (100%)	

The cross-tabulation analysis was performed between two groups of the product category against two groups of site domain. The results depicted in table 3 indicates a significant association between the site domain and type of products sold $\chi^2(1) = 11.586$, $p<0.001$. The Cramer's V statistics (0.353) represents a medium association between the type of site domain and product category sold. Based on the odds ratio, dotcom sites are 12.5 times more likely to sell fashion over pop-culture entertainment items than blog sites. The reversed statement is also true that blog sites are 12.5 times more likely to sell entertainment over fashion items than dotcom sites.

Table 3. Cross-tabulation fashion vs pop products.

Products		dotcom	blog site	Total
Fashion	Count (%within domain)	50 (63%)	2 (14%)	52 (56%)
Entertainment	Count (%within domain)	29 (37%)	12 (86%)	41 (44%)
Total	Count (%within domain)	79 (100%)	14 (100%)	93 (100%)

Statistics: N=93; Chi Sq. = 11.586, df=1, p= 0.001; Cramer's V = 0.353, p= 0.001
Odds ratio= odds dotcom/odds blog = (50/29) / (2/12) = 12.480

3.3 Domain vs. ordering method

E-commerce transaction conducted in online shopping is unique in Indonesia. While standard textbooks, such as Turban's Electronic Commerce, indicate online ordering via a shopping cart, small online stores provide more than one methods to suit customer preferences. Table 4 indicates various methods used, in which short message (SMS) through mobile phone is the most method widely used. Interestingly, a shopping cart is not the main method, and less than half of online stores provide a shopping cart. Among the top-five methods, social media in BBM (Blackberry Messaging) and Whatsapp is utilized. Customers communicate personally with the online store's personnel. BBM is currently not being used as the company providing BBM has closed down its service.

Table 4. Alternative ordering method.

Ordering method	Used	Ordering method	Used
SMS	67 (72%)	WA	31 (33%)
BBM	45 (48%)	email	27 (29%)
cart	39 (42%)	Others <10	24 (26%)

A cross-tabulation analysis is performed for the top three ordering methods: SMS, BBM, and shopping cart. The difference between online stores in dotcom and blog site is observed in using the shopping cart but not SMS and BBM.

Table 5. Cross-tabulation domain type vs. shopping cart.

Ordering method		dotcom	blog site	Total
with cart	Count (%within domain)	39 (49%)	0 (0%)	39 (42%)
no cart	Count (%within domain)	40 (51%)	14 (100%)	54 (58%)
Total	Count (%within domain)	79 (100%)	14 (100%)	93 (100%)

Statistics: Chi Sq. = 11.903, df=1, p = 0.001; Cramer's V = 0.358, p= 0.001

The results shown in Table 5 indicates a significant association between the site domain and whether or not shopping cart is used as an ordering method χ^2 (1) = *11.903*, p<0.001. The Cramer's V statistics is 0.358 (p<0.001) and represents a medium association between the type of site domain and whether SMS is used as an ordering method. Odds ratio could not be calculated, as a cell has zero frequency. The table clearly shows that online stores in blog sites all have no shopping cart.

3.4 Marketing channel

The investigation of marketing channel covers the offer of becoming a reseller. Table 6 indicates a significant association between the site domain and whether or not those online stores have (offer) re-seller to sell their products. The statistics of cross-tabulation produce significant relationship with χ^2 (1) = *10.333*, p<0.001. The Cramer's V statistics is 0.283 (p<0.001) and represents a medium association. The table clearly shows that online stores in blog sites all have no reseller.

Table 6. Site domain vs. Reseller.

Marketing		dotcom	blog site	Total
with reseller	Count (%within domain)	29 (37%)	0 (0%)	29 (31%)
no reseller	Count (%within domain)	50 (63%)	14 (100%)	64 (69%)
Total	Count (%within domain)	79 (100%)	14 (100%)	93 (100%)

Statistics: Chi Sq. = 7.468, df=1, p = 0.001; Cramer's V = 0.283, p= 0.006

4. Analysis

The result of statistical analysis is summarised in **Table 7**.

Table 7. Summary of analysis.

Feature	dotcom	blog site
Fashion product	High	Low
Entertainment product	Low	High
Order by cart	High	Low
Reseller	High	Low

*Business seriousnes*s. Managing online stores with dotcom requires more efforts and resources than online stores in blog sites. Dotcom domain can be obtained quickly and instantly in which personal ID and company registration are not necessary. The owners need to pay the annual cost of domain name maintenance and hosting. The owners can design and sell many products as they can. On the other side, setting-up online stores in blog site are also simple by using standard personal accounts. On the other hand, the functionality, and space for selling goods through blog sites is limited. This difference might reflect the seriousness of the owners in entering the online business.

Pop-culture products. Fashion products are tangible, with various models and sizes. Generally, online stores need to keep some stocks. On the other hand, entertainment products are in the digital form. Blog site stores operate less simple online selling, and they are not interested in managing product inventory. This condition might explain why blog site stores tend to sell entertainment than fashion products.

Personal communication. It can be said that all customers have a mobile phone. The finding indicates that only about half of online store sites having a shopping cart. Shopping cart feature is less available in the blog site than dotcom stores. It might be explained that online store personnel facilitates communications with online shoppers before placing an order, and depend less on 'automatic' ordering via shopping carts.

Marketing. As the adoption of social media is growing, some persons use this media to market goods that do not belong to them. They implement reseller practice for a portion of a sales commission from other online stores. Online stores in dotcom indicate more severe and bigger size than those in blog sites. Therefore, those dotcom stores are more likely to offer reseller opportunity than blog site stores.

Organizational life cycle. Online stores in blog site were stimulated by the popularity of blogs as social media a few years ago when social media era emerged. The use of personal blogs among individuals has been growing as the media to express their opinions and activities. The number of people adopting has been increasing and reached its mature stage, followed by a decline stage. Internet users prefer other forms of social media. Similarly, the history of e-commerce in Indonesia indicates that web stores with a unique and easy to remember domain name expanded some years ago. The number of online web stores has been growing, reaching its maturity, and now declining. The finding indicates the phenomenon of an organizational life cycle, in which the effectiveness of the organizations relate the life cycle stages [9].

5. Conclusions

This study has found the existence of small online stores in blog sites, though only a small portion (15%) compared to those in the dotcom domain (85%). Overall, the finding might explain that dotcom stores are the relatively bigger size and more seriously managed than blog site stores. Dotcom sites look having more features than blog sites. The statistical analysis indicates some differences between both types. Dotcom stores are likely to sell fashion, while blog sites to sell pop-culture entertainment products.

This study has several practical implications. Small online stores in blog sites should exploit other online channels. E-Commerce on personal blog sites seems at the end of the declining stage of the organizational life-cycle. The e-commerce features in the individual blog pages are limited, that could make online shoppers leave those stores. Some online channels show their growing stages, such as marketplaces (or online malls) (e.g., Bukalapak, Tokopedia) and social media shopping (e.g., Instagram, Line). While joining a marketplace increase competition, it provides some advantages because the

marketplace manages marketing activities and ordering/payment process. Furthermore, using social media such as Instagram and Line provides new and broad market as young shoppers are at ease on those media.

Moreover, small online stores in dotcom could retain their website and develop more advanced features such as user-generated content that enable shoppers to provide the electronic word of mouth [10]. Similarly, these businesses should also adopt the growing online channels, which are a marketplace and social media, as presented earlier. Overall, small online stores should be more adaptable in changing e-commerce business model and online shopper preferences. Rakuten, the Japanese giant e-commerce, has closed its operation in Southeast Asia, including Indonesia because of that reason and stiff competition [11].

The findings of this study are limited to the content of web or e-commerce features among small online stores selling Japanese pop-products. The existence of small online stores might change at any time. Further study might explore how pop-product small online stores exist in the marketplace and social media.

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Enhancement of weighted centroid algorithm for indoor mobile non-cooperative localization system

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Abstract. Nowadays, indoor wireless localization is being challenged research by providing high accuracy of location information. However lower processing time, resistant to environmental condition, simple network topology are also become main concern. Non-cooperative localization based on RSSI allow the anchor nodes as the reference nodes communicate directly to the target node by exchanging the location data. High sensitivity of RSSI to the indoor environment, make difficulties in modelling propagation characteristic called as PLE. Incompatibility the PLE value can influence to the estimated position result. Weighted centroid localization (WCL) is feasible solution for RSSI-based that can obtain the target node location just by RSSI and anchor nodes coordinate without PLE value and estimated distance. While, the centroid determination of WCL give better estimation only to the centralized position of target node between all anchor nodes position. Therefore, we propose enhancement of WCL (eWCL) by replacing the weight based on RSSI with different estimated distance from WCL calculation. The simulation result show that using eWCL can reduce the error estimation around 60.42% compared to the WCL algorithm with 1.85 meters MSE value. Then, compared to the cooperative localization based on trilateration algorithm achieve 12.15% error estimation larger than eWCL at non-cooperative scheme.

1. Introduction

Location information about the sensor nodes is crucial requirement in enabling several applications of mobile wireless sensor networks, such as enviromental monitoring, disaster relief, site security, battlefield surveillance, home automation, assisted living, forest fire detection, and so on. According to its different applications, sensor nodes are deployed in indoor or outdoor environment. Sensor nodes could be equipped with a global positioning system (GPS) for determining its location, but indoor environment is inaccessible by GPS service. Thus, in the recent years, many researchers develop alternative technologies, and systems including schemes, algorithms for indoor localization with higher accuracy performance [1,2].

The commonly adopted technology in indoor localization are radio frequency (RF) spesifically WiFi, Zigbee, Bluetooth and cellular, while the non-RF system including cameras, inertial measurements, ultrasound signal. Among all available tecnologies, Received Strength Signal Indicator (RSSI) based on RF technology can be easily implemented to support indoor localization system due to some wireless communication modules are embedded in sensor nodes [3,4]. However indoor localization using RSSI are also easily affected by many factors such as multipath fading, interference, and attenuation from the environment condition [5]. Therefore, it is required suitable localization algorithm which should be resistant to environment influences and also fast calculated the estimated position related to the low computational system [6].

Basicly, the localization algorithm have been categorized into Range-based localization algorithm using distance approximation measurement to determine node position. The other one is range-free algorithm, which utilized the nodes connectivity and regardless the inter nodes distance to obtain the sensor nodes location. Some of range-based localization algorithm are trilateration, multilateration, while the example of range-free localization algorithm are centroid, multidimensional scaling (MDS), DV-Hop [7,8]. On other hand, according the communication mechanism inter nodes at localization system have been divided into non-cooperative refers that target node can communicate only with the connected anchor nodes which is suitable to the range-free algorithm. Then at cooperative scenario, all nodes can comunicate with each other in order to exchange some location information. Range-based localization within cooperative scenario show accurate location result than range-free algorithm at non-cooperative scenario, but it have non efficent realization in calculating estimated distance from RSSI [9]. RSSI measurement data have fluctuative value based on propagation characteristic which is called as pathloss exponent (PLE). PLE value have some indications especially at indoor environment which have inconsistence condition according to the building material and interior design. Incompatibility of PLE value can be influenced to the estimated distance calculation which is directly affected to the estimated position [10].

In order to overcome such problems, the enhancement weighted centroid localization (eWCL) as the part of range-free localization to improve the conventional WCL algorithm accuracy is presented in this paper. WCL uses a static degree factor which is the main parameter for determining the node location. Using estimated distance as static degree have been proposed at [3][11-14]. Due to the estimated distance degree is depend on the spesific PLE value, some researchers try to replace the static degree of WCL using the RSSI measurement data [6,15]. However the highest accurate estimated position of WCL algorithm when the target nodes position are only at the center of all connected anchor nodes. This condition will be difficult for randomic position of target nodes. Therefore we add the enhancement scheme based on different estimated distance (DED) which is adopted from [3]. To apply eWCL scheme, there are 18 anchor nodes (ANs) sending RSSI via Xbee S2 PRO module to the unknown node (UN) as the target. The WCL static degree is calculated only from three strongest RSSI measurement which have stable RSSI data replacing the static degree at[3]. The output from WCL will be improved using DED algorithm as the final estimation result of eWCL. Using non-cooperative scenarios, this proposed system will also compare with previous work that used trilateration algorithm at cooperative localization system [16]. To evaluate the performance of eWCL, this mobile non-cooperative localization system will be simulated using RSSI data measurement in a realistic condition.

2. Methodology

The adopted algorithms of this paper are WCL algorithm which is calculated the target location by using static degree from RSSI measurement data, and DED algorithm for improving the accuracy position from WCL algorithm that have better result only at centre position of target node to the ANs. Combining WCL and DED algorithm become an eWCL algorithm based on non-cooperative scenario will be repaired two main aspect problems at indoor RSSI based localization, minimizing propagation effect and reducing the estimated position error.

2.1. Weighted Centroid Localization (WCL) Algorithm

WCL algorithm is developed from centroid localization (CL) for improving its low accuracy. CL algorithm is only utilize RSSI from ANs ($i=1,2,3,...n$) whether the UNs ($j=1,2,3,..n$) is in the centre of ANs group. For example, if two UNs with different position received RSSI from the same group of ANs, the estimated position of UNs is almost same. Obviously this condition maybe not appropriate for the randomic UNs position. CL improvement is presented by using weight factor which is called as WCL algorithm. There are two approaches for calculating the weight factors of WCL algorithm. At the first, weight w_{ij} is defined as inverse of estimated distance d_{ij} based on g multiplier factor as shown in this following formula [3]:

$$w_{ij} = \frac{1}{(d_{ij})^g} \quad (1)$$

In this approach, the value of g should be at optimal value for getting the best estimated position result. The disadvantage of this weight calculation is using estimated distance as the main parameter. Estimated distance is determining from RSSI and PLE as the propagation characterictic value. The PLE value (n) should be in spesific for having better estimated distance result [16].

$$d_{ij} = 10^{\frac{RSSI_0 - RSSI_{ij}}{10\,n}} \tag{2}$$

$RSSI_0$ is the RSSI in 1 meters distance as the reference value of initial measurement, then the RSSI based its movement position is written as $RSSI_{ij.}$ The difficulties for determining the compatible PLE value which is always different based its environment condition is the main problem in this approach. Then the second approach of weight calculation is only using RSSI value of target node. The weight factor based on RSSI is derivative formula from formulas (1,2) that can be expressed as [6,15]:

$$w_{ij} = \frac{\sqrt{\left(10^{RSSI_{ij}/10}\right)^{g}}}{\sum_{i,j=1}^{n}\sqrt{\left(10^{RSSI_{ij}/10}\right)^{g}}} \tag{3}$$

The estimated position of UNs (x_i , y_i) based on WCL algorithm can be calculated using this following formula [2,3,6,15] :

$$P_{wcl(x_i,y_i)} = \frac{\sum_{j=1}^{n}(w_{ij}\ x\ (x_j\ , y_j))}{\sum_{i,j=1}^{n} w_{ij}} \tag{4}$$

Weight value implies the influence in calculating the UNs estimated position. Therefore previous research suggested the improved weight which can increased the accuracy when the UN position getting closer to the ANs [15]:

$$w'_{ij} = w_{ij}\ x\ {N_{AN}}^{2w_{ij}} \tag{5}$$

Its improvement performance based on the number of AN (N_{AN}) as the multiplier factor proposed solution as the enhancement of WCL algorithm. According to the formula (3-5), it can be seen that in obtaining the UN estimated position by just knowing the RSSI value and ANs coordinate, without PLE value parameters as shown previously at formula (1,2).

2.2. Difference of Estimated Distance (DED) Algorithm

The high accuracy result that have been proposed before by [15] still distribute at center area of UNs with ANs group communication. Weighted factor just reduce the error estimation without adjust the displacement position of UNs. So we adopted previous work in [3] by adding difference of estimated distance (DED) to denote the distribution of accuracy evently all each UNs position.

At the early step of DED is calculate the estimated distance between ANs to the UN. The estimated distance is obtained from WCL estimation to the each ANs ($d_{m=1,2,\ldots N}$) . Then for adapting the weighted factors of WCL, DED algorithm use β as degree factors derived as this following formula.

$$\begin{aligned}
f(x_k, y_k) &= (x_j, y_j)\ x\left((d_{m+1} - d_m)^{\beta} + (d_{m+1} - d_m)^{\beta} + \frac{1}{d_m} + \frac{1}{d_{m+1}}\right)\\
f(x_{k+1}, y_{k+1}) &= (x_{j+1}, y_{j+1})\ x\left((d_{m+1} - d_m)^{\beta} + (d_{m+2} - d_{m+1})^{\beta} + \frac{1}{d_{m+2}} + \frac{1}{d_{m+1}}\right)\\
f(x_{k+2}, y_{k+2}) &= (x_{j+2}, y_{j+2})\ x\left((d_{m+2} - d_m)^{\beta} + (d_{m+2} - d_m)^{\beta} + \frac{1}{d_{m+2}} + \frac{1}{d_m}\right)
\end{aligned} \tag{6}$$

The estimated position of DED algorithm (x_{ded},y_{ded}) can be calculated as:

$$x_{ded}, y_{ded} = \frac{f(x_k, y_k) + f(x_{k+1}, y_{k+1}) + f(x_{k+2}, y_{k+2})}{2\ x\ \left((d_{m+1} - d_m)^{\beta} + (d_{m+1} - d_m)^{\beta} + (d_{m+2} - d_{m+1})^{\beta} + \frac{1}{d_m} + \frac{1}{d_{m+1}} + \frac{1}{d_{m+2}}\right)} \tag{7}$$

In this DED scenario, there are three ANs as the reference for calculating each estimated distance. It can be added more ANs number to DED calculation depends on WCL modelling system. The connected AN numbers should be same with the number of estimated distance calculation which is influenced to the DED formulas (6-7).

2.3. Proposed Enhancement WCL Algorithm

In this system, we propose mobile non-cooperative localization using eWCL and DED as refinement algorithm for minimizing several problems in RSSI based localization. UN as the target node will move followed by RSSI data reception from the ANs group. Each group contain three nearest ANs to the UN which can be determined from strongest RSSI reception. Those RSSI data will be averaged for calculating the weighted factor of WCL algorithm.

According to the previous research in [6][15], weighted value based on RSSI is calculated by formula (3), while in this proposed system WCL algorithm will be calculated using β degree factor that adjust to DED algorithm parameters. The acceptable value of β in this system is 1 that have been observed before based on simulation process. This proposed WCL algorithm isn't increase the weight factor, but choose the highest weight value. Due to increase weight isn't significantly improve the accuracy performance. The weighted factor at formula (3) can be modified into this function as follows:

$$w_{ij} = max\left(\frac{\sqrt{\left(10^{RSSI_{ij}/10}\right)^{\beta=1}}}{\sum_{i,j=1}^{n}\sqrt{\left(10^{RSSI_{ij}/10}\right)^{\beta=1}}}, 3\right) \quad (8)$$

After getting the highest weight value from three strongest RSSI data, the UN estimated calculation based on WCL algorithm can be written using this following formula:

$$(x_{wcl}, y_{wcl}) = \sum_{j=1}^{N=3}(x_{j=1,2,3}\ , y_{j=1,2,3}) * \max(w_{ij}, 3) \quad (9)$$

WCL result as the initial estimated position will be processed again for having estimated distance calculation at formula (10) and also estimated position by DED algorithm (x_{ded}, y_{ded}) as shown at formula (6-7).

$$\left(d_{m(wcl\rightarrow AN_j)}\right) = \sqrt{\left(x_j - x_{wcl}\right)^2 + \left(y_j - y_{wcl}\right)^2} \quad (10)$$

Using simulation process based on data measurement and realistic scenario of indoor environment at third floor post graduated PENS building, this eWCL is achieved the accuracy improvement due to two parts involve weighted based RSSI measurement and its estimated location have been repaired using DED algorithm.

3. Results and Discussion

In this section will be presented the design system of mobile non-cooperative localization system and the RSSI measurement procedure. There are two main parameters for analyzing this eWCL algorithm performance, those are error estimation and the processing time requirement.

RSSI measurement phase was taken from signal transmission of Xbee S2 Pro module at 3rd floor of applied postgraduate PENS building as the observation environment. There are 18 ANs (anchor node) as the reference node at 2.4 meters height was sending RSSI to the UN (unknown node) as the target node at 0.9 meters height. The main concept of mobile non-cooperative localization is allow UN will be served by all deployed ANs when it move continously. For minimizing the variative RSSI data measurement and fluctuative weight calculation, the number of RSSI data which will be processed only three strongest RSSI data. RSSI Measurement is taken by UN displacement position every 2 meters based on each 53 positions assumption as shown at figure 1. In sending RSSI data to the UN is also followed by AN coordinate. The weighted calculation and estimated position determination including WCL and DED algorithm are conducted at UN. After the location estimation obtained, UN send the final estimation result to the server for monitoring the target location.

The success level of the proposed eWCL algorithm for improving accuracy performance in estimated position is presented by comparing the MSE (mean square error) result of WCL algorithm, existing enhanced WCL algorithm, and also cooperative localization based on trilateration algorithm. MSE result as the error estimation of this system can be analyzed in overall data using cummulative distribution function (CDF), as well, as illustrated at figure 4.

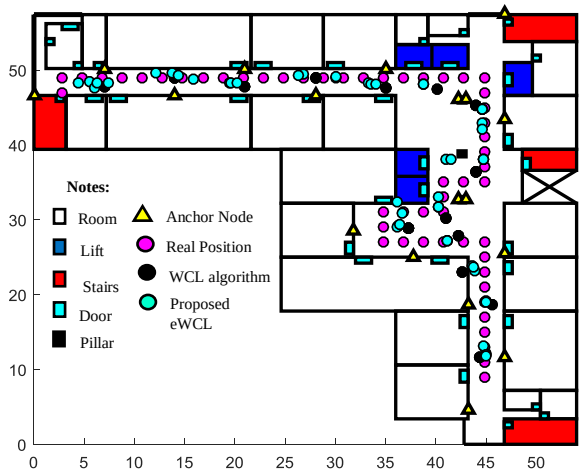


Figure 1. Estimated Position of WCL and proposed eWCL comparison.

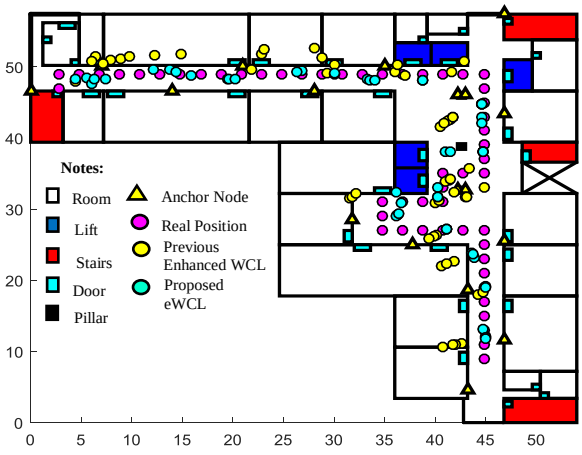


Figure 2. Estimated Position of previous enhanced WCL and proposed eWCL comparison.

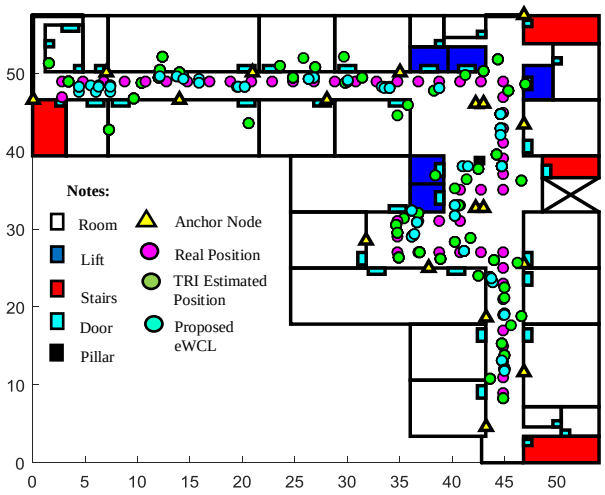


Figure 3. Estimated position of trilateration and proposed eWCL comparison.

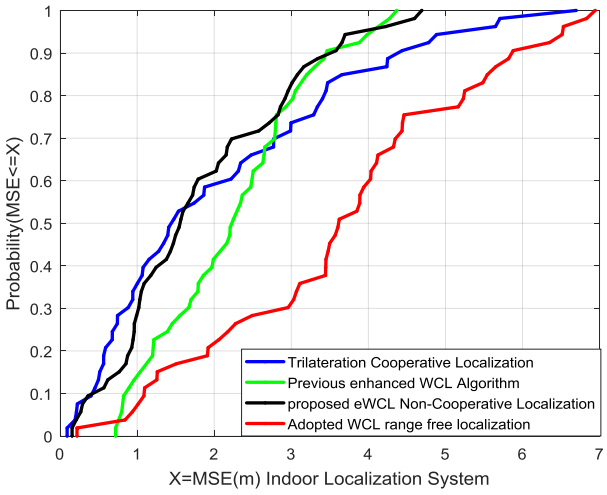


Figure 4. Error CDF graph comparison at applying eWCL algorithm.

Table 1. Performance comparison of several algorithms at cooperative and non-cooperative localization.

Localization Scheme	MSE Average (m)	Processing Time (s)
Trilateration Cooperative Localization	2.08	0.014
Adopted WCL range free localization	3.64	0.042
Proposed eWCL Non-Cooperative	1.85	0.059
Previous enhanced WCL Algorithm	2.26	0.044

The MSE comparison at figure 4, shows that proposed eWCL algorithm is the best scheme which has lowest error estimation at range of 0.15 meters up to 4.7 meters. Whereas the previous enhanced WCL algorithm is achieved MSE at 0.72 meters up to 4.37 meters which is higher at CDF 0 until 0.9 but lower MSE result at above 0.9 CDF value. Although at the range of MSE comparison between proposed eWCL and previous enhanced WCL have small difference in MSE average value calculation, our proposed eWCL algorithm still achieve the smallest error at 1.85 meters as listed at table 1. Compared with the cooperative scheme based trilateration algorithm, its cooperative scheme has higher range error estimation up to 6.67 meters. It prove that range free algorithm with non-cooperative scenario can be choiced scheme for indoor localization if using the appropriate method as well as eWCL algorithm. This is because the original WCL algorithm still have higher error range up to 6.95 meters.

The processing time performance of this system was measured by Matlab type R2016a simulator tools at Toshiba satelite core i7 M840 laptop spesification. According to the simulation result show that proposed eWCL algorithm was took up around 4 times longer than using trilateration algorithm. The difference processing time was not significantly influence when this algorithm apply at small device of node, due to the processing time still under 1 seconds and the sensor device technology development today have been quite good processor and capacity. Therefore in indoor localization, the accuracy performance still main priority at design system.

4. Conclusion

In this paper, we propose range free algorithm for mobile non-cooperative localization using eWCL algorithm. There are two estimated location process in this system. WCL algorithm as the initial calculation is obtaining the position based on weighting the connected anchor nodes coordinate. Using only RSSI parameter and anchor node coordinates at weighted value calculation can be minimized the unstability estimated distance calculation by spesified propagation index. The output of WCL estimation which is only accurate at centroid position, is effectively improved by DED algorithm. The comparative analysis show that our proposed eWCL could decrease around 1.12 times better than cooperative localization based trilateration algorithm. Although it was required 0.047 seconds additional time for computation.

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E-commerce development using object oriented analysis and design (OOAD), a case study in Marenggo Natural Dyes Batik SME in Indonesia

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Abstract. Marenggo Natural Dyes Batik SME is a business that produces batik and tritik fabric with natural dyes that have a high selling price. This high selling price makes products of Marenggo SME attractive to the upper and foreign segments. With marketing only done through exhibitions, products from Marenggo SME are less exposed to the intended segment. These problems make the owner want a media campaign that has a wider reach and a sales media that can reach the desired market at a low cost. E-commerce as an media that functions as a medium for disseminating, buying, selling, and marketing is the right choice for Marenggo SME to be used as a means of promotion and marketing. The e-commerce system of the Marenggo SME was built with the Object Oriented Analysis Design approach. In the analysis section, the current system identification is carried out. In the design section begins by categorizing user needs which are then described using UML diagrams. This study used class diagrams, sequence diagrams and activity diagrams. From this process 2 types of users, 6 types of scenarios and UML diagrams are produced that provide an overview of the design of e-commerce systems in this Marenggo SME.

1. Introduction

By implementing an information system, trading can be done anywhere as long as it has a supporting device. The information system applied to this trade includes all transactions carried out by third parties. Trade that utilizes this information system is then referred to as e-commerce. E-commerce is the exchange of information between companies with external stakeholders (third parties that have certain agreements with companies) through electronic media [1]. From 1998 to 2000 it was the year when e-commerce began to be applied by many companies in marketing their products. E-commerce itself is currently being implemented by SMEs (Small and Medium Enterprises) [2]. One of the impacts of e-commerce implementation on SMEs is increasing profits and communication with third parties [3], increasing business efficiency and profits in terms of market competition [4]. In addition, the application of e-commerce can be a means of promotion, branding and information gathering [5].

Marenggo Natural Dyes Batik SME (Marenggo SME) is a business that produces batik tritic fabrics using natural dyes. This natural coloring makes batik that are produced by Marenggo SME that has been established since 2010 has a high artistic value and selling value.This makes products from Marenggo SME in demand by the upper and foreign segments. This is also reflected in the turnover earned by Marenggo SME reaching IDR 75 million with 50 products sold each month. This makes the

Marenggo SME into the category of small class businesses referring to the Law of the Republic of Indonesia No. 20 of 2008.

This study aims to develop an e-commerce system for Marenggo SMEs to become a medium of sales and promotion. By implementing e-commerce can also increase the efficiency and effectiveness of the business itself [6]. The development of this e-commerce system uses the object oriented analysis & design (OOAD) approach. Object oriented analysis is an analysis that emphasizes the discovery and translation of objects or concepts in the problem domain [7]. OOAD is an effective method of analyzing and capturing user needs and designing a system as a whole [8]. Using OOAD can also improve maintenance, reusability and modifiability of the system designed [9]. OOAD is used in analysing the current system, namely the sales system carried out by Marenggo SMEs and design of e-commerce systems using an object-oriented approach. UML diagrams are used in this analysis and design process. Design is built considering the ease of use, which is an important factor in e-commerce systems [10].

The structure of this paper consists of several parts, which after this section are design research where in this section will be explained about the analysis of the current system and the design of the Marenggo SME e-commerce system. Conclusions will be presented in the last part of this paper.

2. Research Design

2.1 OOAD (Object Oriented Analysis and Design)

Related to the object itself, regarding the concept of object, which can provide data, in the form of fields, often known as attributes; and codes, in the form of procedures, are often known as methods. The object features object procedures that can access and modified some of the related object data fields [11]. In this study, OOAD will be used to design the e-commerce of Marenggo SME.

2.1.1 Map the initial condition of the system. At this stage, the process is carried out on the processes in Marenggo SME, especially in the process of selling products. This concerns the system to be designed is an e-commerce system that is centered on product sales. After observing, the current system of sales system of Marenggo SME is then described as a diagram, namely an activity diagram.

2.1.2 Determine user requirements. At this stage, what type of user is involved in the system and the requirements of the user are defined, both functional and non-functional requirements. This user's requirements are obtained from interviews with SME owners and also from the sales process that exists at Marenggo SME. This is needed so that in the e-commerce system design process can meet the requirements of users, both users who access the front-end system and the back-end system of the e-commerce system Marenggo SME.

2.1.3 Identify User Scenarios. After understanding the user's requirements, the next step is to change these requirements into scenarios that can be done by users in this e-commerce system. This scenario is an activity that will be carried out by users who use the system.

2.1.4 Selecting Classes and Objects. In selecting classes and objects, it is necessary to pay attention to previously identified scenarios. This is intended to make the design process of the e-commerce system easier in designing the existing scenarios.

2.1.5 Identification of Attributes and Class Operations. At this step, the attributes and operations required by previously identified scenarios are made into an appropriate classes. In accordance with the appropriate class, the attributes and operations created must match the class functions.

2.2 Object Oriented Design.
At this stage, models are developed that connect between classes and objects that have been previously linked and also connects to the scenarios that have been tailored based on user requirements on the Marenggo SME's e-commerce system. The models are made using UML (Unified Modeling Language) diagrams.

3. Result and Discussion

3.1 Current System Conditions
Before starting the design, an observation is conducted on the selling process in the Marenggo Natural Dyes Batik SME to find out the existing sales flow. Observations were made on one of the stockists owned by the Marenggo SME, which is located in front of the Marenggo SME workshop. In addition to observations, interviews were also conducted with SME owners to find out the business processes of the Marenggo SME as a whole. The business process and buying and selling process are then visualized by using one of the diagrams in the Unified Modeling Language (UML), namely activity diagrams. Figure 1 shows the flow of the Marenggo MSME product sales process.

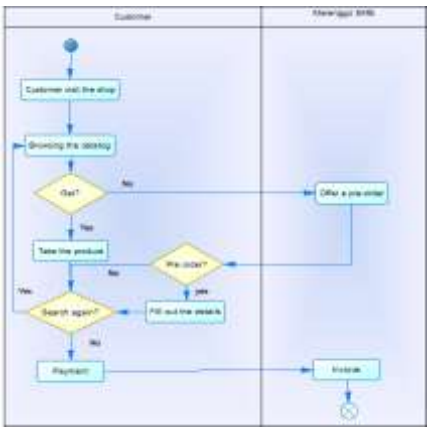


Figure 1. Product sales process.

3.2 Determine user requirements
In the e-commerce system that will be built, user requirements are obtained from interviews with Marenggo SME owners. From the results of the interview, there are two types of defined users, namely end users (visitors or customer) and administrators. The visitor's needs are to be able to access information about the Marenggo SME, namely the location of the Marenggo SME, the history and the profile company of the Marenggo SME. The second requirement from visitors is to make purchases on Marenggo SME products, starting from searching for products, seeing product details to making purchases on these products.

The next user is an administrator. The administrator's requirements are to be able to change / update existing information on the system such as adding new content, adding / changing existing products and changing the design of the e-commerce system. The second requirement of the administrator is to be able to supervise the system, such as sales activities, manage user lists and perform maintenance.

3.3 Identify User Scenarios
The identification of user scenarios for the Marenggo SME e-commerce system consists of five (5) scenarios, namely product entry scenario, user registration, product purchase, product editing, product deletion. These scenarios are based on user requirements that are mentioned before.

3.4 Selecting Classes and Objects

From identifying user scenarioswe get five (5) scenarios that used toform a class. The first class is user class that comes from user category.Thesecond class is admin class comes from the user category. The third class is customer class comes from the user category. The fourth class is product class comes from the product category. The fifth class is order classes are from product purchase categories. And the last class is shopping basket class comes from the product purchase category.

3.5 Identification of Attributes and Class Operations

Identification of attributes and class operations can refer to class scenarios that have been determined in each class. Then from these classes, the attributes and operations can be made. The first class is a user class, where the attributes of the user class are username, password, login status and type of user (admin / customer). While the operation of this user class is the login and logout operation. The second class is product class, attributes of product class are product codes, product names, information, prices, photos, number of products, weight of products and categories of products. For operations in this class are products, see details, select products and search products. And the last class is order class, this orderclass is a class used to record product orders made by customers. This class has attributes that are order, date send, date of order and payment status. Operations in the order class are added by order.

3.6 Object Oriented Design

Object-based design is a stage that is carried out after the analysis phase. Object-based design uses the Unified Modeling Language (UML).

3.6.1 Use Case Diagram. Use case diagram is the result of a translation of the results of the analysis in the user scenario analysis phase. In the design of the e-commerce system there are 2 use case diagrams, namely the product search use case shown in figure 2 and the product order use case shown in figure 3.



Figure 2. Product search.



Figure 3. Product order.

3.6.2 Sequence Diagram. Sequence diagrams are part of structure diagrams. This sequence diagram describes the interaction between objects based on time lines. Sequence diagrams illustrate how and what functions are carried out by an object. In the Marenggo SME's e-commerce system there are 2 sequence diagrams, namely the product search sequence diagram shown in figure 4 and the product ordering sequence diagram shown in figure 5.

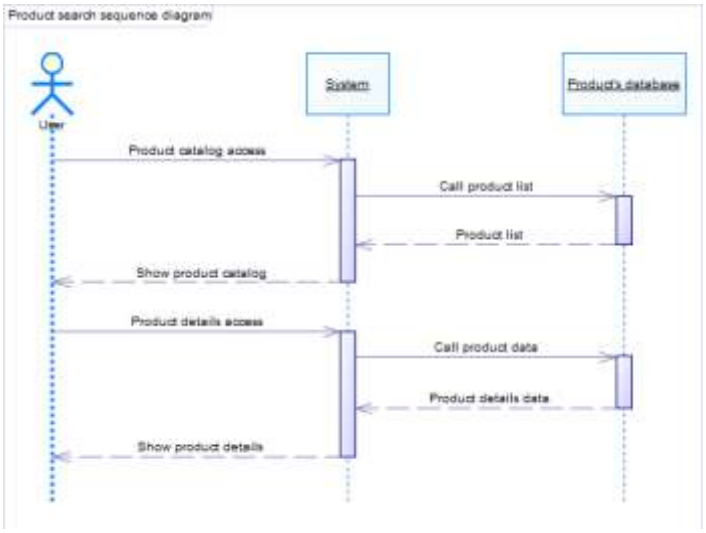


Figure 4. Product search sequence diagram.

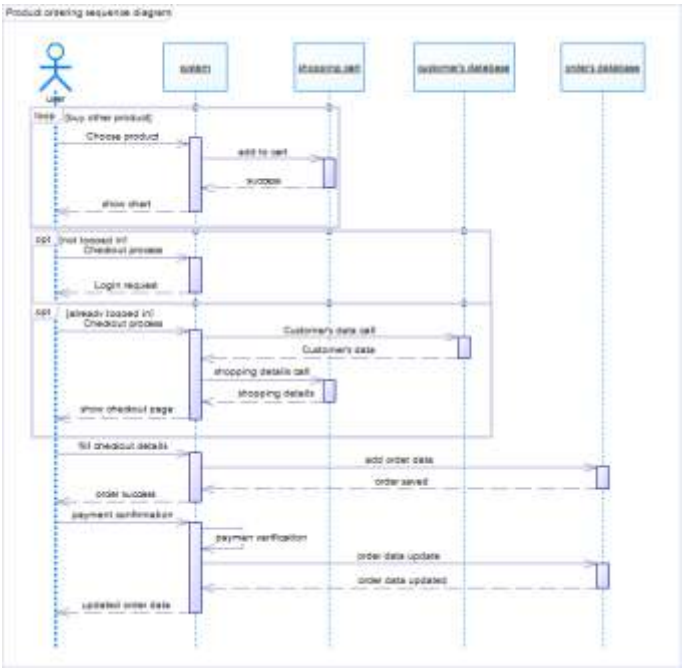


Figure 5. Product ordering sequence diagram.

3.6.3 Class Diagram. In this Marenggo SME e-commerce system has one class diagram. This class diagram on the Marenggo SME e-commerce system shows the relationships between existing classes. Figure 6 is a class diagram of the Marenggo SME e-commerce system.

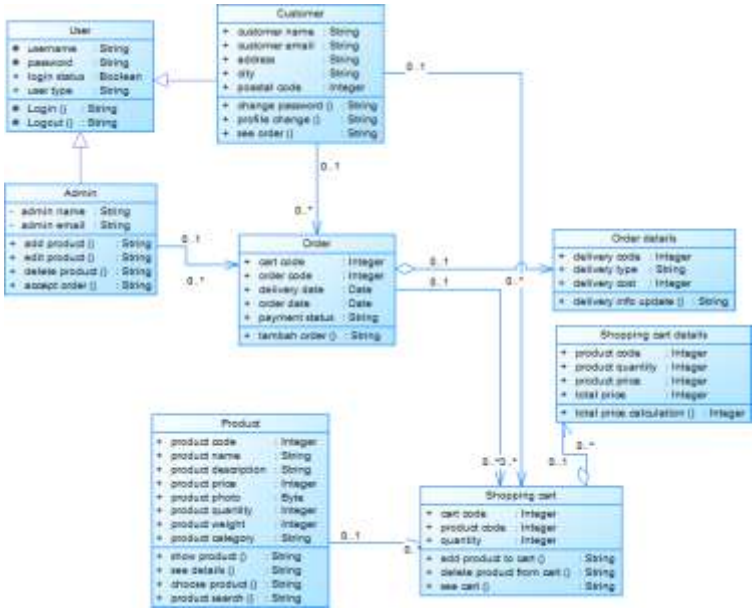


Figure 6. Product ordering sequence diagram.

4. Conclusion

This research has succeeded in using OOAD in designing an e-commerce system at the Marenggo Natural Dyes Batik UMKM. The implementation of the OOA concept has been carried out in the process of analyzing e-commerce systems at Marenggo Natural Dyes Batik SME with the stages of mapping the initial conditions of the system, determining user requirements, identifying User Scenarios, selecting Classes and Objects, and identifying Attributes and Class Operations.Object-oriented design for e-commerce system design in Marenggo Natural Dyes Batik SME produces designs in the form of use case diagrams, activity diagrams, class diagrams, and sequence diagrams.The results of the analysis and design are references to the developers of the Marenggo Natural Dyes Batik UMKM e-commerce system in carrying out the development process.

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Anchored instruction ITS: a novel approach to make learning programming interesting and effective

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Abstract. Learning programming is known to be troublesome to the students in the computer science department. The problem is originated in the students' inability to understand the logic in developing the program. Many teachers advise the students to practice writing the program to improve the students' skill. However, many students do not enthusiastically follow this advice due to the unattractive activity in writing the program as well as the lack of help when they have problem in writing the program. In this research, we proposed a system that increases the attractiveness of the program development activity and able to provide help when the student have problem in it. These goals are performed by integrating an anchored instruction in an Intelligent Tutoring System (ITS). The attractiveness of the anchored instruction and the effectiveness of the Intelligent Tutoring System were analysed using a pre- and post-test, and a survey. From the tests and the survey, we found that the anchored instruction can increase the students' interest in practice programming; the Intelligent Tutoring System can help the students in writing the program and improve their knowledge in programming (24.67% improvement). The research shows that anchored instruction Intelligent Tutoring System can be used as an alternative approach to make learning programming interesting and effective.

1. Introduction

Teaching and learning programming are known to be hard [1, 2, 3]. In order to have a good knowledge in programming, students should practice writing computer program. Unfortunately, many students find that writing the program for the given exercises are not interesting and too difficult. Students often have problems in understanding the logic of the program to be made. As a result, many students do not spend enough time and effort to practice programming.

Some works have been performed to make learning programming becomes interesting. Some of the works incorporate games in the learning and some others involve the usage of modern technology such as mobile devices. The incorporation of game in learning programming can be in the form of creating games [4] or playing games to understand computer programming topics [5].

In this research, we investigate another approach of making learning programming become interesting using anchored instruction. Anchored instruction has been used to motivate students and make learning becomes more interesting by emphasizing generative learning anchored in meaningful contexts [6,7]. In anchored instruction, the learning activities are designed around a story or situation that includes a problem. The students are expected to use their knowledge and skills to solve a certain problem posed in the story.

Anchored instruction has successfully been used to increase the students' motivation in learning mathematics, science, and statistics, but never been tried in the programming domain. It is interesting to know if anchored instruction can also be used to increase the student interest in learning programming.

The usage of anchored instruction in learning programming can be optimized if the system can also help the students to understand the logic of the program to be developed. Providing an individual tutor that can help students in their specific problem can make learning becomes more effective [8]. However, it will be resourced impractical to provide as many tutors as the number of students. One possible solution is to create a system that can provide specific help to the students' problems as if a human tutor will do. This system is called an Intelligent Tutoring System.

An Intelligent Tutoring System (ITS) is a computer program that can tailor its assistance and teaching to the student current knowledge [9]. Some ITSs have been built in the programming domain, for example: PHP ITS [10], J-LATTE [11], and JITS [12]. Unfortunately, there was no evidence that these ITSs were designed to make learning programming interesting.

An ITS that can assist the student individually and make the learning process becomes interesting is a good candidate to change the student perception that learning programming is hard and dull. This paper proposes a novel approach to make learning programming becoming interesting and effective by incorporating anchored instruction in an Intelligent Tutoring System. The pedagogy that we use in our Intelligent Tutoring System requires the students to write programs to learn programming.

2. Previous work on anchored instruction and Intelligent Tutoring System (ITS)

Anchored instruction is an instructional framework of which the instruction is anchored or situated in the context of meaningful problem-solving context to overcome the inert knowledge problem [6]. It is the context that makes learning becomes interesting because it reflects the true nature of problems in the real world.

In anchored instruction, the learning activities are designed around a story or situation that includes a problem or issue. Some works that utilize the concept of anchored instruction can be seen in Prado and Gravoso [6], and also in Kumar [7]. The usage of anchored instruction in this research increased the students' interest to the subjects, decreased their tensions in learning, and improved their skill in problem solving

Intelligent Tutoring System works like a human tutor. The system can predict the student current knowledge and use the information to provide the most suitable instruction or exercise. The ITS can also interpret the student responses and offer hints to help the student to understand the material or to complete the given exercise. Therefore, the ITS can be considered as a private computer-based tutor.

Some ITSs, such as JITS, J-LATTE, or PHP-ITS have been built in the programming domain [10-12]. JITS were created to help students in their first programming course to learn programming in Java. JITS was designed to recognize any small Java program and offer intelligent feedback when there is no authored solution available [12]. As a result, JITS can only produce a syntax error correction or assistance system. These features may not give additional assistance to the students because these features are already provided in many compilers.

Other ITSs, such as J-LATTE and PHP ITS provide assistance to the students when they have problem in the syntax and logical error. Assisting students to understand the logic of the program is important because many students have problems in understanding the logic of the program or how to fix a logical error in the program development. J-LATTE and PHP ITS start the tutoring process by giving some programming questions to the students. After selecting a certain question, the students can write the program on the developed application. Some buttons are provided to let the students choose some actions, such as submitting the program or requesting help.

PHP-ITS was created to help students learn PHP. PHP-ITS used predicates as a set of constraints to check if the students' programs have achieved the expected goal or not. The goal itself is divided into several sub-goals. These sub-goals are used to give specific feedback to the students. Although JITS, J-LATTE, and PHP ITS were created to help the students in learning programming,

they were not designed to make the learning process become interesting. The learning process in the ITSs are similar to the one in the classroom, which some students consider uninteresting. Many exercises were presented without context and were not designed to inspire the students of their possible use to solve real world problems.

3. Anchored instruction ITS

Having a potential to make learning become interesting, anchored instruction can be used as the pedagogy in the developed Intelligent Tutoring System, named CSharpTutor. Some aspects that make learning becomes effective were also included in the design of CSharpTutor. The anchored learning in CSharpTutor was implemented using a role playing.

In the role playing, the student has a role as a programmer who works in a company. When the student starts CSharpTutor in Visual Studio, a greeting from a virtual Head of Development is displayed. The Head of Development will ask the student to show his capability in writing programs for some given cases to be accepted or to get a better position in the company.

The program for the case given by the Head of Development can be written by the student in Visual Studio directly. Unlike any other existing ITS, CSharpTutor was developed and integrated with Visual Studio, the development environment that is used by the targeted students. This integration enables CSharpTutor to read the student code in Visual Studio directly and gives advice about how to create the program for the given case.

As an ITS, CSharpTutor tries to understand the student program and provides feedback upon the student request to the logical error in the program. Understanding the logic of the student program was performed using first order logic. The solution of the case was represented into goal and sub goals in the first order logic representation. The student program was parsed and translated to predicate logics. The predicate logics were checked if they can satisfy the goal or sub goals. This information was used to give feedback to the student or to advance the student to the next case.

The following is the example of the goal that must be satisfied by the student program to convert the temperature value from Celsius to Fahrenheit:

```
goal←  var(CelsID, celsius),
       val(CelsID, Cels),
       var(FahrID, fahr),
       val(FahrID, valFahr),
       eq(ValFahr, 9.0/5.0 * Cels + 32),
       print(FahrID)
```

After completing a program for a case given by the Head of the Development, the student can submit his work to the Head of the Development, and the Head of the Development will assign another case to be solved by the student. The submission can be performed through CSharpTutor. After several correct program submissions, the Head of the Development will promote the student to a higher position in the company. With this promotion, the student will be given a new case that needs more advance programming skill.

There are three levels that exist in CSharpTutor. The topics assigned for each level are:

- Level 1: variables, assignment, and input output statements
- Level 2: simple condition
- Level 3: nested condition, repetition, and one-dimensional array

We also named the level with a certain position in IT company, such as Junior Programmer, Senior Programmer, and Analyst Programmer. The story about being a programmer and to achieve a higher position in the company are chosen because many students enrol the computer science department with an expectation to be able to work in a programming-related working area when they graduate later. Aligning the role playing with the student expectation can increase the student interest and motivation in learning programming.

CSharpTutor contains 16 cases that can be completed by the student. However, the student may not be asked to complete all cases in CSharpTutor. Based on the student model that was developed

when the student submitted his/her programs, CSharpTutor can suggest the most suitable tasks for the student current knowledge. For example, if the student makes unnecessary mistake in writing the program for a case in certain level or ask too much help from CSharpTutor then CSharpTutor will use this information to update the student model. The student model is also updated based on the student submitted program. Using this student model, CSharpTutor will select the next case that should be given to the student.

The topics are represented as variables in Bayesian Network along with other variables created from the cases' sub-goals. The Bayesian Network is used to estimate the probability of the student knowledge of a certain topic. Using Bayesian Network, CSharpTutor can update the belief for the variables in the network based on the new evidence. For example, if the evidence shows that the student can write the program for a certain case correctly, we can use Bayesian Network to increase our belief that the student knows the topics that are related to that case.

All cases in CSharpTutor are connected to a certain context. Having an exercise in a context encourages and motivates students to complete the exercise because they can see the "real" application of the program that they made [13]. It is necessary to change the real cases to simpler version to make them on par to the student knowledge. CSharpTutor does not have any out-of-context tasks that commonly be seen in many programming books such as "swap the values in two variables" or "find the average of *n* numbers", etc.

The assistance in CSharpTutor is designed to be adaptive and multilevel. In this case, CSharpTutor checks the condition of the student program using code analyser [14] to determine the sub goals that cannot be accomplished by the students and display the appropriate assistance to the student. The assistance is displayed in multilevel. When the student has the problem for the first time, a general level assistance will be displayed. A more detail level of assistance will be given if the student keeps having problems with the same issue. CSharpTutor also provides a minimal feedback by just responding "yes/no" when the student asks if his/her program is correct or not. This feature is provided to encourage the student to find the solution him/herself before he/she asks the detail help from CSharpTutor. All of this helps can be obtained by pressing a certain button in CSharpTutor.

4. Methods used to measure the effectiveness and the interestingness of anchored instruction ITS

In evaluating the effectiveness and the interestingness of anchored instruction ITS, 36 students in Programming class were voluntarily tried CSharpTutor. Before the students started CSharpTutor, they must answer 20 multiple choice programming questions that are used a pre-test. These questions are presented again in random order as a post-test. In addition to these data, CSharpTutor also recorded the submitted students' programs, the information about which tasks that were completed, the date and time the students wrote the program, the length of time needed to complete a program (omitting the idle time that is the time when the students did nothing in the development environment), and the number of help requested by the students. All of these data were used to measure the effectiveness of CSharpTutor. On the other hand, the interestingness of the anchored instruction ITS was measure through a questionnaire. This questionnaire must be filled by the students after they have completed the post-test.

5. Result and discussion

5.1. The effectiveness of CSharpTutor in helping student learn programming

The effectiveness of CSharpTutor in helping the students learn programming is evaluated by analysing the students pre- and post-tests. The students' average score in pre-test is 64.17 and the students' average score in post-test increase to 80 (24.67% improvement). A one-tailed paired t-test with a 95% confidence interval was used to check if the average score in post-test is significantly better than the average score in pre-test (see Table 1). The null hypothesis for this test is: the students' scores in post-test are not higher than the students' scores in pre-test. The p-value of one tailed paired t-test can be found by dividing the p-value of two-tailed paired t-test by 2, that is 0.00007. This p-value shows a strong evidence that we can reject the null hypothesis. This means that the students' average score in post-test is significantly higher than the students' average score in pre-test.

This finding shows that anchored instruction ITS can be used in an ill-defined domain such as programming and produces as effective result as the one in the well-defined domain [6,7]. The integration of anchored instruction to an ITS is necessary to check the correctness of the student program and use it to advance the story in the anchored instruction. The ITS is also needed to provide assistance to the student in writing the program.

Table 1. Paired t-test of the students' post-test and pre-test.

	Mean	Std. Dev.	Std. Error Mean	95% confidence interval of the difference		t	df	Sig. (2-tailed)
				Lower	Upper			
Pair 1. Post Test – Pre Test	15.83%	18.80%	3.13%	9.47%	22.20%	5.05	35	0.000015

We also measure the contribution of CSharpTutor in supporting students to learn programming. Some statements in a questionnaire that we used to measure this aspect are:

- CSharpTutor assistance is helpful
- The number of tasks given in CSharpTutor is ideal
- In overall, CSharpTutor helps the students in learning programming

Most student responded positively to the statements above. 67% of the students agree or strongly agree that CSharpTutor assistance is helpful. The number of tasks in CSharpTutor is considered ideal or almost ideal by 77% students. Because of the adaptive tasks used in CSharpTutor, the students who can do well in the pre-test and can submit correct codes, get fewer tasks to be completed than the students who do the opposite. This positive feedback shows that the students are satisfied with the usage of adaptive number of tasks given in CSharpTutor. When the students were asked about the overall performance of CSharpTutor in helping them learn programming, 92% of the students agree or strongly agree that CSharpTutor can help them learn programming.

5.2. The interestingness of anchored instruction ITS

We also used questionnaire to measure the interestingness of anchored instruction ITS. We use a five level Likert scale that range from strongly disagree, agree, neutral, agree, and strongly agree. The following statements were used in the questionnaire:

- The role playing in CSharpTutor is good
- The approach of giving a higher level goal in writing the program is good
- The approach to learn programming by writing program is good
- The approach of giving the students a chance to develop answers themselves by providing multilevel help is good

From the questionnaire, 75% of the students agree or strongly agree that the role playing approach is good. 25% of the students give a neutral opinion, and none of them disagree or strongly disagree. The students also give positive responds when they were asked about the approach of giving higher level goal to be achieved when they write a program. Writing a correct program is now becoming an intermediate goal to achieve higher level goal that is being promoted to a better position in the company. 89% of the students agree or strongly agree with this approach. Again, none of the students disagree or strongly disagree.

All students (100%) also agree or strongly agree that the best way to learn programming is by writing programs. An interesting approach such as the one used in CSharpTutor can encourage the students to practice programming. Most of the students (97%) also agree or strongly agree that the students should develop the answers themselves before they get help from CSharpTutor. This is performed in CSharpTutor through a multilevel and a "yes/no" help.

6. Conclusion and further work

The findings from this research indicate that anchored instruction ITS can effectively help student learn programming. In addition, learning programming in anchored instruction ITS make the process of learning itself become more interesting. The usage of the ITS become the key point in making the success of the system. The ITS guides the students to understand the logic of the program to be written.

Other factors that were included in CSharpTutor also give contributions to the success of CSharpTutor. These factors are the integration of CSharpTutor to the development environment to minimize the cognitive overload, the usage of case based exercises that provide an idea of the real world application of the program, the adaptive feedback to help the students to understand the logic of the program, and the multilevel feedback to give the students a chance to think the solution themselves.

For further work, the story on the anchored learning can be changed to another story that is still in the students' interest, for example to the one that includes modern technology or science fiction. The ITS can be extended to another development environment or to another mode in Visual Studio such as to Windows Forms or to Windows Presentation Foundation (WPF) application. The topics in the ITS can also be added to a more advanced topic such as method and class. A more extensive evaluation can be conducted by increasing the number of participants and the usage of cohort to compare the result.

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Requirements analysis for the disaster logistics inventory information system to improve the effectiveness and efficiency of handling emergency response periods

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Abstract. The exact specifications of system requirements are very important factors in the system development process. Any deficiency at this stage will affect the quality of the output of the information system developed. Therefore, system analysts must focus on how requirements are defined and modeled. Building a new information system is a complex process that consists of many steps that must be done before the final product is prepared for the customer. It is important to meet the needs and expectations of customers to maintain project sustainability in the future. There are several approaches to develop new information systems in which different strategies, methodology, modeling techniques or life cycles can be used. This study aims to analyze the need for the development of a website-based disaster logistics inventory information system. This research produces an analysis of information system requirements both from functional and non functional aspects. Based on functional analysis obtained the minimum specifications that must be owned by information systems, while the non-functional analysis obtained the minimum data needs to run a website-based disaster logistics inventory information system.

1. Introduction

Mount Merapi is one the most active mountain in the world for its relative short periodic and high intensity of eruption around 3 - 7 years [1]. The biggest eruption of Mount Merapi occurred in 2010 with 3 times bigger eruption power than the previous one with the launch of glowing cloud with the radius of 14.5 km. According the Badan Nasional Penanggulangan Bencana (BNPB) - National Emergency Response - Mount Merapi eruption occurred lasted for 14 days since October 26, 2010. Based on the data of BNPB on the eruption of Mount Merapi in 2010, it recorded 277 deaths and missing, 186 injured and 159.977 people were evacuated.

According to PVMBG, the type of Mount Merapi eruption was cyclical and it would reoccur in a certain period of time, so that Mount Merapi has a periodic potential disaster. Therefore, the local government must be ready in handling the eruption [2, 3, 4, 5, 6]. The local emergency response (BPBD) Sleman area, Special Region of Yogyakarta is government institution that has the duty to deal with the disasters occur within the province of Special Region of Yogyakarta.

Management of relief items for disaster victims from the start of procurement or shelter assistance, inventory, and distribution is part of Humanitarian Logistics (HL) [7]. There are 4 things that must be considered in handling HL, namely a) the uncertainty of distribution routes (road conditions), security, changes in facility capacity, and uncertainty in demand for logistics needs; b) communication and coordination difficulties due to disruption of communication, involvement of many parties both government, civilians and NGOs, and there is no access to real-time and accurate request information;

c) efficient and timely distribution is difficult; d) limited resources so that they cannot overcome the scale of the disaster [8].

One obstacle in the disaster logistics process in Indonesia is the limited access to information on the needs and supplies of relief goods. Delay in access to information causes the handling of disasters to be ineffective and inefficient. For example, related parties are often late to know the scale of the disaster, the number and type of assistance both goods and services needed, and the distribution of locations of refugees [9]. For this reason, the Regional Disaster Management Agency (BPBD) in charge of handling disasters in the regions needs to have an integrated inventory information system (IIS) between the center of the aid post in BPBD Sleman Regency and all refugee camps. The IIS needs to be equipped with an inventory database per item / type of relief item, so that the relevant parties can find out the type and amount of relief items available in the main warehouse. In addition, IIS can be used as a medium of communication between the BPBD, donors, and those responsible for refugee barracks (users). Donors can find out the type of relief items needed so they can provide assistance according to the needs of victims, while users can provide data on the needs of relief items in each barrack. Thus, the distribution of disaster relief items can be carried out according to their needs, namely in terms of time, number, and type.

2. Research Methods

2.1. Humanitarian Logistics (HL)

Various types of disasters need to be managed by different solutions. Logistics is the most important element in humanitarian assistance efforts. How to manage the logistics of humanitarian assistance will determine whether the disaster management operation is a success or failure? However, logistics is often the most expensive activity of any disaster aid. Based on the study, it is estimated that the logistics costs for disaster management are around 80% of total costs in disaster relief [10].

Logistics management for disaster management is known as humanitarian logistics or often referred to as humanitarian aid logistics. Humanitarian logistics is an activity of planning, implementing, and controlling the flow of humanitarian aid in an efficient, cost-effective and humanitarian aid supply supported by information regarding the distance and location of the main warehouse and refugee barracks in order to reduce the suffering of disaster victims [11]. Optimizing the logistics performance of humanitarian assistance requires that all relationships between parties or actors involved in disaster management be managed through an integrated approach efficiently and effectively in coordinating inter-organizational performance, eliminating redundancy, and maximizing the efficiency of the entire emergency supply chain.

Disaster management is often described as a process consisting of several stages, namely: mitigation; preparation; response; and reconstruction [12]. The four stages are called the disaster management cycle. The involvement of disaster logistics management at the preparation, response and reconstruction stages as presented in figure 1.



Figure 1. Disaster management cycle [12].

2.2. Stakeholders in Humanitarian Logistics

Humanitarian logistics includes a number of activities and involves many parties, starting from preparation, planning, procurement, transportation & distribution activities, storage, tracking, and

customs clearance. Stakeholders in humanitarian aid logistics activities are [13]: a.) Domestic and foreign donors, government, companies, citizens and NGOs; b.) National NGOs, PMI, and BNPB / BPBD; c.) Transportation service providers: land, air, sea, river and railroad; d.) Warehousing service provider; e.) Transportation management company; f.) Customs and Excise; g.) Relief recipient.

2.3. Inventory Information System

The system is a series consisting of two or more components that are interconnected and interact with each other to achieve goals. Systems are usually divided into smaller sub-systems that support larger systems [14]. Meanwhile, information is data that is presented in a certain form to help make decisions [15]. So, the information system is a combination of the components that collect, process, store, and provide the output of every information needed in business processes, Information systems in the form of applications consisting of software, databases and related manual processes [16].

The inventory information system provides detailed data about items of goods available, suppliers, quality of goods, the number of items that must be ordered and the number of items that have expired [17]. Information systems for disaster relief goods inventory are needed to facilitate access to information between stakeholders so that handling disaster logistics becomes more effective and efficient [9].

3. Requirements Analysis

3.1. User Characteristics

Characteristics of users are parties who will carry out activities on this information system. These entities are super-admin, admin refugee posts, and donors.

- Superadmin is the head or employee of the natural disaster management agency whose task is to manage and supervise the logistical assistance contained in the posts when natural disasters occur. Superadmin can manage user data, user assistance posts, users of refugee posts, goods, refugee posts, aid posts and transaction reports contained in the system.
- Admin of the refugee post is an employee / volunteer who is in a refugee post whose duty is to manage the demand for goods / logistics materials and validate the items that have been received.
- Donors are parties involved in providing voluntary assistance to the community, whether individuals or groups of people without aiming to benefit from their activities.

3.2. Device Requirements

The need for minimum specifications on the Merapi relief inventory information system consists of the needs of minimal specifications for hardware, software and brain ware.

Hardware used as a means of support in the form of:

- Computers with minimum specifications of Intel Pentium IV processors, 512 MB (Random Access Memory) and 80 GB Hard disks.
- Monitor, keyboard and mouse.
- Modems or similar devices to connect computers to internet networks.

The software needed to run the information system created is:

- Microsoft Windows XP as the minimum operating system on a computer or other similar operating system.
- Web browser to run information systems.
- XAMPP is software that includes the Apache program as a web server, MySQL as a database server and PHP as a web programming language.

3.3. Functional Needs

Functional requirements are needs related to the business processes of the system made. From the observations made, the functional requirements in the system are made, here is a list of system functional requirements.

- The system can add, change, delete and display user data in refugee posts carried out by Superadmin

- The system can add, change, delete and display user data to donors carried out by Superadmin.
- The system can add, change, delete and display relief items data carried out by Superadmin.
- The system can add, change, delete and display data on refugee posts conducted by Superadmin.
- The system can display reports on the sending of relief items carried out by Superadmin, and the admin of the refugee post
- The system can display data reports on receipt of relief items carried out by Superadmin and admin of refugee posts
- The system can add, change, delete and display the data on aid items carried out by Superadmin, admin of refugee posts and donors
- The system can add, change, delete and display the data requested by the refugee post
- The system can add, change, delete and display data requests from refugee posts conducted by Superadmin
- The system can add, change, delete and display delivery data carried out by the refugee post admin
- The system can add, change, delete and display the purchase of relief goods through the government funding budget carried out by Superadmin
- The system can add, change, delete and display imported goods received from donors carried out by Superadmin
- The system can display reports of items received and items sent during a certain period of time carried out by Superadmin.
- The system can add, change, delete and display items sent by donors.
- The system can add, change, delete and display data items that have been received by Superadmin by donors

3.4. User Menu Structure

The menu structure is the initial design for software applications and website systems that focus on interactions with users. In the user menu structure there are features that can be accessed by each type of user.

The structure of the login menu is a page for users to enter into information systems. Users can enter according to the user's access level. Access levels in this system include superadmins, admin and donors.

The superadmin menu structure that can be accessed after logging in to a superadmin user. Login is done by using an email and password from superadmin, then superadmin will enter the dashboard that has a menu list on the side. Menus that can be accessed by superadmin include:

a. Add, change and delete admin data for refugee posts and donors.
b. Add, change and delete system user group data.
c. Add, change and delete item category data.
d. Add, change and delete funding source data.
e. Add, change and delete warehouse data.
f. Add, change and delete post data.
g. Add, change and delete item data.
h. Add, change and delete inventory data.
i. Add, change and delete incoming order data.
j. Add, change and delete donation data.
k. Add, change and delete item request data.
l. View reports of incoming orders and goods requests.
m. View and change BPBD office data.
n. View and change account data such as names, emails and passwords.
o. Exit the system

The admin menu structure of the post that can be accessed after logging in with the email and password from the admin, then the admin will go to the dashboard which has a menu list on the side that matches the access rights. Menus that can be accessed by superadmin include:

a. See admin data for refugee posts and donors.
b. View data group system users.
c. Add, change and delete item category data.
d. View funding source data.
e. View warehouse data.
f. Add, change and delete post data.
g. Add and change unit item data.
h. Add, change and delete inventory data.
i. Add and delete item request data.
j. View and change BPBD office data
k. View and change account data such as names, emails and passwords.
l. Exit the system

Donor menu structure that can be accessed after logging in using e-mail and password from the donor, then the donor will enter the dashboard which has a menu list on the side. Menus that can be accessed by superadmin include:

a. Look at the item category data.
b. View warehouse data.
c. See post data.
d. Look at item data.
e. View inventory data.
f. Add and delete donation data.
g. View and change account data such as names, emails and passwords.
h. Exit the system

4. Conclusion

This research produces an analysis of information system requirements both from functional and non functional aspects. Based on functional analysis obtained the minimum specifications that must be owned by information systems, while the non-functional analysis obtained the minimum data needs to run a website-based disaster logistics inventory information system.

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Software verification and validation using statistical test: a systematic mapping study

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Abstract. Software quality management is the collection of all processes that ensure software products, services, and life cycles implementations meet organizational software quality objectives and achieve stakeholder satisfaction. One of the attributes in software quality is software reliability. This reliability of software can be measured by software testing, software bug, fault and failure detection, software debugging, etc. Software testing ensures the functionalities of programs built that they meet the requirement. Software bug, fault, and failure detection are to detect bug, fault, and failure in programs built. And software debugging is a process of locating and fixing or bypassing bugs (errors) in the code program. The scope of this research is about software testing. Our research focuses on Software Statistical Testing. Software statistical testing is a dynamic testing technique that exposes a software-based system to a simulation of its expected operational uses. Statistical testing generates test inputs by sampling from a probability distribution that is carefully chosen to exercise all parts of the software being tested. There are many approaches used to define effective and efficient software statistical testing. This paper describes the mapping of statistical software testing researches. The motivation in this research is to identify the evidence available on statistical testing and analyze trend in software statistical testing.

1. Introduction

Software testing can be described as a technique to check the reliability of software by executing it with certain test data. This software testing is also related to verification and validation. Verification is to ensure the correctness of the software development process. Validation is to check the software against the requirements. Verification sometimes is associated with the formal proof of correctness, and software testing is concerned with executing the software with the test data [1]. In software development, software testing can be the most costly and critical phase [2]. NIST (National Institute of Standard and Technology) reports that the cost caused by software defect is 59.9 billion dollars per year. This report estimates that 22 billion dollars can be saved by early defect detection. This report also shows that the correction cost is 80% of the overall cost of software development [2].

Efficient testing approaches are needed to solve those problems in order to reduce the costof software development. The effective testing approach is also needed to increase the coverage area of faults in the software testing process. The effective software testing can also affect the success of the software development process. And the statistical testing has been shown to be more efficient at detecting faults than the other methods such as random and structural testing.

Software statistical testing is software testing that use the probability distribution from random sampling data to decide the test case or test data. This distribution is carefully chosen to satisfy the

adequacy criterion based on the testing objective that expresses the functional or structural properties of software. The statistical testing is also used the functionality requirement review. The adequate criterion is defined from the structural of software under test (SUT).

The Evenod-Fosse and Waeselyck research can show that the test case generated by statistical testing is more efficient than test sets generated by uniform random and deterministic structural testing. There are many approaches in software statistical testing such as search algorithm, mutation-based, clustering, similarity, Bayesian network, and other algorithms.

This research is about the systematic mapping study of software statistical testing. The mapping process is based on Kai Petersen et al [3] that is also used in this research [4]. This research aims to identify the evidence available on statistical testing and analyze trend in software statistical testing. This paper organized as follows: the next section tells about related work on systematic mapping study. Section 3 defines the research methods. Section 4 analyses the result. Conclusions and discussion of future work are in section 5.

2. Related Studies

Research about Systematic Mapping Studies regarding to statistical software testing is not common. Afzal et al (Wasif, Torkar, & Feldt, 2008) performs systematic mapping study on non-functional and search based software testing. There are total 35 papers analyzed in this research. Those papers are published in the years 1996-2007. It is about 42,8% of studies deals with the execution time. This result is based on the experimental result and real world application. In this research is also found that to achieve the problem-specific objectives, it applied the diverse meta-heuristic search techniques. Generic algorithm is the most frequently used in meta-heuristic.

Based on the search result, it is known that the Systematic Mapping Study performed in software statistical testing is not common. This is the main contribution of our research to provide a systematic mapping about software statistical testing. This aims to map the research and identify the trend of algorithm in software statistical testing.

3. Research Method

The research method used in this paper is based on the guide by Kai Petersen et al [3]. The search libraries use in this research are http://www.sciencedirect.com/ and http://ieeexplore.ieee.org/. These two digital libraries are chosen due to the limitation of access from our institution. We define the keywords used in the search query i.e. statistical test, software statistical test, statistical testing, software statistical testing, and statistical software testing model.

There is a total of 1.831.271 papers in search results, which have not been further analyzed regarding title duplication. These papers are selected based on the inclusion or exclusion criterions. The initial result covers not only about software testing, but also about testing in another knowledge area such as chemistry, medical, biology, etc. The second stage is to identify each possible title candidates about statistical test. The total result from the first stage is filtered in this second page based on their tittle. This selection stage yields 42 study candidates. Then, each papers are classified depending on their type.

4. Result

In our study, we define two classifications. The first classification is based on Wieringa et al. [5]. Their research creates six categories of study based on its facet type. There are validation research ([6], [7], [8], [9], and [10]), evaluation research ([11], [12], [13], [14], [2], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], and [26]), solution proposal ([27], [28], [29], [30], [31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], and [43]), philosophical papers ([44] and [45]), and also experience paper ([46]). Validation research is techniques to investigate the novel research and have not yet been implemented i.e. experiment. Evaluation research is the implementation technique and an evaluation technique to show how the technique is implemented in practice (solution) and the benefits and the evaluation of implementation. This also includes identifying problems in industry.

Solution proposal is proposed solution to solve the problem. The proposed solution can be either novel or significant extension. There are also a small example or a good line of the argumentation. Philosophical papers is sketch the new way of looking at existing things by structuring

the field in the form of taxonomy or concept. Opinion papers is the personal opinion expression from somebody about certain technique in research wheter it is good or bad, or how something should been done. These researches do not depend on the related work and or methodologies. Experience papers is This paper is to explain the experience of the author about what and how something has been done. The second classification is based on the method used in statistical testing. From a total of 42 literatures, we found 10 categories. Those categories are described in table 1.

Table 1. Classification based on method used.

Category	Description	Literature
Memetic Algorithm	Memetic algorithm is an extended of genetic algorithm. This algorithm is a novel approach to integrate the local search and primitive values in a global search in test suites.	[38]
Kolmogorov-Smirnov	This Kolmogorov-Smirnov (KS) is usually used in system data transformation. This algorithm is commonly used to determine whether data can be assumed as a sample from independent seaquence and identically distributed random variables.	[32]
Bayesian Network	Node in Bayesian network represents a random variable. It denotes the occurrence of event. The nodes are connected by using directed edges. This edges represents the probability of causal relationship among events.	[44], [28]
Cluster	Clustering technique is a technique to generate test scenario from data test clustered. This technique is effective to decrease the huge test data. Each cluster consist different test scenarios and test data which is generated based on maximum probability distribution.	[27], [2], [36]
Similarity	This similarity algorithm is used to merging a test case pair that implies a constant reduction in the number of contained test case.	-
Mutation	This mutation algorithm also implement search algorithm to search the probability distribution. The low probability of test suite will become a mutant. This mutant will be selected as adequate candidate test case based on its probability.	[29], [40]
Search	Search algorithm is used to find probability distribution of test data.	[12], [31], [15], [10], [42], [26], [43]
Particle Swarm Optimization	This algorithm use random swarm search space as basic way of finding adequate test case. Each particle represents a candidate test case.	[22], [39]

Ant Colony Optimization	This Ant Colony Optimization (ACO)) algorithm is used to handle test data generation problem. Some strategies such as local, global transfer and pheromone update are used to improve the coverage capability of test suite.	[37]
Markov Model	This algorithm is used in Model-Based Statistical Testing. Markov-Model can be a discrete time function, finite state, time homogenous, and irreducible Markov Chain. The property in Markov Model is used to compute the information.	[18]
Other	Other methods are used in this category. Sometimes, this category is about survey or experience paper to the real project industry	[11], [6], [13], [30], [14], [16], [17], [46], [33], [19], [45], [34], [20], [7], [8], [21], [35], [23], [24], [9], [25], [41]

There are several method used in software statistical test. In our study, we found 10 categories of method used. There are only 30 literatures which can be classified into these categories. Another 24 literatures are classified into other category. Table 1 describes this classification type and the literatures belong. Guo et al, [27] proposed to develop a sample cluster approach from software testing which can be used automatically to predict how many cluster should be generated. Khan and Kausar [2] implemented Random Cluster Sampling technique to test data. To show the implemented technique, they have defined a test scenario for X Machine Microwave Oven specification and they generated sample from given data suite using Random Cluster Sampling technique.

Search Based Software Engineering (SBSE) is formulated in software testing to generate test data. Fraser et al. [12]'s research is about empirical analyze to the main problem in search algorithm. From the research it's known that the seed of test data for each test scenario is the important thing. Fraser observed three different seed technique which was implemented in different context. Their results provided evidence that a good choice of seeding techniques can lead to an overall improvement of the search result. Souza et al. [22] investigated the use of hybrid search techniques for the constrained test case selection problem. They implemented a Binary Constrained Particle Swarm Optimization (BCPSO), and two hybrid algorithms which integrated local search techniques to improve the performance of BCPSO. The hybrid techniques obtained better results when compared to their individual components.

The quality of generated test data will determine the effective software testing and it impacts to the reliability of software. Mao et al. [37] implemented Ant Colony Optimization (ACO) algorithm in generated test data. Their result shows that ACO has better quality test data than other algorithms such as: Local Beam Search, Simulated Annealing, or Genetic Algorithm. This algorithm is more stable and it can be compared to PSO algorithm.

5. Conclusion

There are total 42 papers published in 2012-2018 about software testing used a statistical approach. From those papers found, we can conclude as follows.

1. The percentage of each category from research type facet are 40,5% solution proposal and evaluation research, 11,9% validation research, 4,8% philosophical papers, 0% opinion papers, and 2,3% experience papers. Most of the literature is about solution proposal. Which most of them, explained the proposed solution of the problem happened in statistical software testing. Some of them are a novel approach.
2. This research also finds major literature using a search algorithm to optimize the statistical testing methodology. The percentage of literature using the search algorithm is 16,6%, 2,4% use a memetic algorithm, 2,4% use Kolmogorov-Smirnov, 4,8% use Bayesian network, 7,1% use cluster algorithm, 0%

use similarity algorithm, 4,8% use mutation algorithm, 4,8% use particle swarm optimization, 2,4% use ant colony optimization, 2,4% use Markov model and 52,3% use others techniques.

3. The most frequently used algorithm for a total of 42 studies is the search algorithm. The search algorithm is also used in other technique to generate the probability distribution. Search algorithm becomes the main algorithm to generate the probability distribution in genetic algorithm, cluster algorithm, mutation algorithm, Ant Colony Optimization (ACO) or other algorithms.

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Usability of multimedia-based technology in situational judgment test: literature review and survey on millennial generation

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Abstract. In predicting and determining people's careers, various instrumentation and tools can be used. Instrumentation with descriptive stories and role plays is suitable to describe the conditions and situations of respondents. Situational Judgment Test (SJTs) is one of the tools that are used to see a person's tendency to act in certain situations. The research topic of SJTs is increased in the last few years. Most of them explore and investigate the validity of SJT such as the scoring method. However, only a few topics discuss the form of SJTs tools and questions. This study investigates the benefit of using a computer-based test and exploration of multimedia-based technology to enhance SJT. This study examines kinds of literature about SJTs topic and discusses related technology in STJs nowadays. This study also analyses what various parameters of digital media like a type of media and device, affection of sounds in the video, the user experience with media, and duration of video are the parameter. This research also collects 209 respondents to find out interaction between millennial generations and multimedia nowadays. The aim of this paper is to improve STJs' contents using multimedia-based technology.

1. Introduction

Situational Judgement Tests (STJs) is one of psychology test to assess respond of the respondent according to a certain situation [1]. Usually, STJs is used as a prerequisite in the company's recruitment process. STJs has some items with various situations that respond must choose an action. Questions are usually written in narrative form. This is an example of STJs Questions: "You are sent to attend a meeting with the client. But, next week you have a project deadline. What do you want to do? A) Attend this meeting. B) Asked your supervisor about the priority of a project. C) Decline to attend this meeting". Respondent is asked to evaluate this situation according to the respondent's experience, competence, and knowledge.

Since the early 2000s, the Computer-Based Test (CBT) is founded in the USA [2]. The first generation of CBT is used in education and certification environment. Psychology is also affected by this invention especially for a psychology test. The Questions of the test is not only static question but also dynamic question like video, sound, and animation driven-by multimedia. Recent technology has made the development and delivery of the multimedia more practical. But there is one challenge in the early 2000s, we can't easily find and distribute audio, video, and animation because the computer and internet infrastructure doesn't develop evenly worldwide.

Nearly 2010s, development infrastructure and internet network increase rapidly [3]. Many companies compete to provide multimedia channel both free and paid subscriptions. Based on a survey of IT practitioner community, social media and internet usage rates are growing rapidly. This survey collects 143,26 million active internet users in 2017 (increase 7.9% from the previous year). Most of the respondent access website than contains multimedia content. This survey shows 5 top channel such as YouTube, Facebook, Whatsapp, Instagram, and LINE. Similarly, in Indonesia, media channel around the world has streaming to distribute their information with video and image. This Millenial Generations is the biggest multimedia consumer through internet. Multimedia in STJs can be assumed that the right solution for measuring situation judgment test.

This paper is designed to provide the reader with an overview of current research in STJs. For researchers, this paper shows the current media used in STJs. For practitioners, the paper provides an alternative solution to make STJs content more dynamically with multimedia. First, we introduce briefly about usability computer-based-test in STJs. Second, we collect the current data about interaction human with multimedia from the millennial generation. We chose this generation because STJs will be implemented on recruitment process which most of the participants are Millenial. With Multimedia STJs, recruitment process can be improved to assess interest of participants.

2. Related Studies

This section, we describe the knowledge of STJs, implementation STJs Computer-Based Testing in STJs case and examine multimedia parameters to enhance STJs.

2.1. Situation Judgement Test

Many researchers told about the history of STJs. Whetzel [1] explained that STJs is already used in 1926. The subtest called: "Judgement in Social Situations". The test applied to several environments like education and management. STJs as selection tools are used in the US and Europe. The main issue of STJs is to estimate the reliability of STJs. Based on Whetzel, there are many contributions to STJs research topics. Research concerning differences between responses instruction in STJs and STJs content. It's happened because of the lack of information in narrative textual and gap between the respondent's knowledge and the examiner's knowledge. The usability of multimedia like images can be minimalized this gap. With computer-based in STJs, the examiner can handle the heterogonous respondents. The examiner can make custom question group depends on the measurement goal.

2.2. Quality Measurement of Multimedia

Multimedia is information that has an interactive computer-based transition. These media combine two or more media components: textual, pictures, video, audio, motion, 3D object and psychology effect. The aim of multimedia is to simplify the communication between broadcaster and audience.

The quality of a multimedia product [4] divided into 2 types: internal parameter and external parameter. For 2-D images, the internal parameter can be easily measured. The dimension of images that will be produced is *Pixels*. The number of effects applied in original images is *Special Effects*. Images are typically composed set of layers, which have one or more text or images. This measurement is *Layer and Object/Symbol.* Another technique of internal parameters: contrast, gradation, edge sharpening, color vibrancy, and harmony. The external parameters are usually seen from the psychological effect of the audience. If the symbol or picture in the images very crowded, the audience confused and not interested. If the duration of video or audio is too long or too short, the message can't be conveyed to the audience. Nowadays, the usability of multimedia increases rapidly. The recent technology such: internet and IoT, make multimedia become primary needs.

Akhtar, [5] explained that there are 3 sections about "Quality Measurement in Multimedia": Quality of Service (QoS), Quality of Experience (QoE) and Quality of Perception (QoP). QoS is determined by technical of media such: frame-per-rate, bandwidth, file size, and dimension. QoE is determined by human cognitive e.g, habits, feelings, requirements and expectations. QoP is parameters to measure how human ability to analyze, synthesize and take action from multimedia content.

Each quality is designed to produce audio and video signals to be acceptable and pleasant to a human observer. Understanding how human observer view/hear, interpret and respond to visual/audio stimuli

would help to formulate the questioner especially STJ's question. Visual perception is the ability to interpret the surrounding environment that we see before. Visual attention is influenced by cognitive thinking. Auditory perception is regulated by two prominent elements: auditory masking and binaural hearing [6]. For a better assessment, we must know the factor that influencing audiovisual multimedia. First, **Human Influential Factors** based on physical/mental condition (gender, age), demographic and socioeconomic background. Second, **Technological Influential Factors** depends on the QoS of technical media such as file size, bandwidth, screen resolution, and framerate. Third, **Contextual Influential Factors** describes situational ambient properties to indicate how a user may perceive the multimedia content.

3. Research Method

In this research, we studied the literature and collected data from respondents with the survey.

3.1. Systematic Mapping Study

We used a systematic mapping study methodology to explore the latest research in STJ and exploration of multimedia to enhance STJ. This research method is based on the Guideline Systematic Mapping Study by Petersen [7]. We adapted and applied the systematic mapping approach to STJs research. The process begins from the definition of research questions, conducting the search for relevant paper, screening of paper, keywording using abstracts, keywords, and titles, and data extraction.

Research questions of this research:

- How many research papers about Computer-based in STJs?
- What does the topic and issue of Computer-based in STJs?
- What does the multimedia issue of Computer-based testing?

The search repositories are http://www.sciencedirect.com/ and http://ieeexplore.ieee.org/. These two digital libraries are chosen due to the limitation of access from our institution and related topics about software and psychology. The search keywords are defined as follows:

- Situational Judgment Test ("situational judgment test" OR "situational judgment test")
- Computer-Based-Test in Situational Judgement Test ("computer-based test" AND "situational judgment test")
- Multimedia in Computer-based Testing ("multimedia" AND "Computer-based testing")

All of the keywords are used as a search query in two repositories to find journals or articles related to topics. Range finding literature between 2015-2019. The search result can be shown in table 1.

Table 1. Search result of this research

Keyword	IEEE Xplore		Science Direct		Sub-Total	Paper Selections
	Conference	Journal	Chapter Book	Reference Work		
Situational Judgment Test	3	72	5	25	105	12
Computer-Based Test in STJs Test	3	2	0	1	6	3
Multimedia in Computer-based Testing	3	17	1	3	20	2
Total						**17**

After finding this data we screening for relevant paper based on abstract, keyword, titles and journal. The various journal according to this research is Computer & Education, Computer in Human Behavior, Procedia Computer Science, Learning and Instruction, Individual Differences, Human

Resources Management Review, International Journal of Intercultural Relations, Organizational Dynamics, Learning and Individual Differences.

3.2. Collecting Data

To collect the information from the millennial generation, we make a questioner about interaction with media. The question according to this framework (Table 2). This framework is based on the Quality Factor of Multimedia Assessment.

Table 2. Survey Framework

No	Parameter	Description
1	Human Factor: age	information about the respondent's age
2	Human Factor: sex	information about respondent's sex
3	Human Factor: culture influence	information about respondent's culture and way of thinking
4	Technical Factor: Form of Device/Media	Technical Information about the model of media, screen resolution, etc.
5	QoE: User Experience with Media	Quality of Experience: interactive, addictive, pleasant, level of accessibility, etc
6	QoP: Human Interaction with Media	Knowledge of respondent with the media environment

4. Result and Discussion

4.1. Answer Research Question: How many research papers about Computer-based in STJs?

As of January 2015, the total number of a research paper contains "Situational Judgment Test" and "Usability Computer-Based Test" is 17 based on ScienceDirect and IEEE Xplorer.

4.2. Answer Research Question: What does the topic and issue of Computer-based in STJs?

Keyword "Situational Judgment Test" and "Situational Judgement Test" has similar results in ScienceDirect. Researchers have shown that STJs can be applied in many cases: military [8, 9], workplace [10] [11], education environment [12] [13] [14] and social phenomena [15]. There are also analyze the process and tools of STJs with new personality measurement and media [11] [16] [17] [18] [19]. Kiessling developed and validation CBT based on STJ to assess student's communication skill [20].

Research "Situational Judgment Test" in IEEE Explorer extends a lot of implementation that applied media in STJs. Chen developed a machine to simulate automated personality perception [21]. Personality perception can be grabbed by video-based STJs. With the invention of Chen, STJs can be more innovative in role-playing with video support. The other research, Reinerman-Jones purposed a new approach to assessing complex decision making with STJs concept. [22]. Arini used the STJs to cluster people regarding the trust behavior in Sinabung's eruption [23]. Airi makes a survey and clusters the people with STJs that to build a conceptual model of trust behavior in Indonesia.

4.3. Answer Research Question: What does the multimedia issue of Computer-based testing?

Multimedia give examiner power of creativity to make questions. Basu [24] explained that multimedia can explore the perceptual skill of the participant. The student can integrate these visual items with analysis and problem-solving skill. In this Basu case, the teacher can make 3D images as the question of 3D mathematics. [25]. The challenges in this research are: adaptive testing based on participant skill, develop CBT with the wireless device and designing effective multimedia so the assets can be reusable.

4.4. Result of Survey: Respondent's Profile

This survey collects 209 respondent's data. The distribution of respondents in this STJs: 73 respondents studied in Engineering, 136 respondents studied in Psychology. The gender ratio between male and female is 34, 45 %: 65,55%. The dominating age of respondent is 19-20 years old with 108 respondents. 67% of the respondent's social influence was dominated by East Java.

4.5. Result of Survey: Form of Digital Media in STJs

Evaluation form that fits with STJs according to total participants (explained with order): 1) Multiple-choice with a narrative case study (52,1%) ; 2) Essay with anything type of question (50,7%) ; 3) Multiple-choice with Interactive Videos (50,2%); 4) Multiple-choice with audio (40,1%). Based on the participant's discipline, "Essay with anything type of question" and "Multiple-choice with a narrative case study" are favorite for Psychology students. But for Engineering students, "Multiple-choice with a narrative case study and interactive videos" is the favorite one. For engineering students, "essay" isn't the favorite one.

To assess behavior human according to describe a certain situation, more than 50% of participants argue that "Online Application" and "Online Games" are fit to measure personality. With games, the participant is unconsciously assessed by the system. This concept usually calls Gamification. The key to making successful gamification is how to improve user engagement.

4.6. Result of Survey: Quality of Experience with Media

Respondent explains that images and video can help them to understand the information. More than 70% agree with this statement. If only a narrative statement, participants not strong enough to understand the intent of the problem. Participants assess the effect of using audiovisual to equalize the examiner's perception is influential. Participants need a private environment in listening to this media. 75% of participants prefer to use a headset/headphone when listening to audio/video rather than using a loudspeaker. They can easily be distracted with another sound that not related to the test. 60% of participants feel that 15-40 seconds video is enough to describe the event or situation.

4.7. Result of Survey: Quality of Perception with Media

Nowadays, the millennial generation is more critical in consuming audiovisuals than the previous generation, especially images or videos. 50% of participants will guess first the meaning of an image rather than directly accepting the information from the image. The number of colors in an image for some people does not interfere with concentration. This depends on the perceptions of each participant.

5. Conclusion

Based on the literature survey, multimedia can improve the form of questions form. The question can describe easily and clearly with multimedia. Audio and video are media that are suitable for question makers in describing situations. Millennials generations are also very familiar with audio and audio technology. They is easier to understand the meaning of an image and video than with description text.

To build a multimedia STJs that suitable for Millenial Generation, we should give a privacy and a convenient atmosphere test. Millennial Generation Concentrations are more easily disturbed by sounds that are not relevant to the test. Millennials have no problem using smartphones or computers in the test. Each test device is equipped with a headset so that the sound from the video or audio reaches each participant. The duration of the video needs to be considered so that the participants do not spend time working on one particular question.

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Employing game technology as positive influence on conveying positive message and train positive behavior: case study racism and tolerance issue

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Abstract. The usage of multimedia technology for education had long been performed. However, the practice usually restricted on the hard skill subject. For the soft skill subjects, it is important not to teach the subject straight forward to young people, since they might find it boring and unappealing. Hence game might be the right media to work on that matter. This research attempted to propose the usage of multimedia technology in the form of game application to teach about soft skill subject, that is about racism and tolerance issue. While the solution created evidently succeed to convey messages, its influence on correcting behavior cannot be fully confirmed.

1. Introduction

The rapid development in multimedia technology made it a decent tool to employ in many interests including in the area of education. Numerous researches had been conducted to prove the significant succeed of employing multimedia in education fields. The rich feature in multimedia technology offer plenty opportunities to be explored. The adoption of 3D model for example, not only escalate attractiveness and desire for learning, furthermore it could build a certain simulation features which give more lively description of the subject [1]. Additionally, the usage of multimedia technology features supports multisensory learning which create more efficient learning [2].

While the advantages of multimedia technology for education purpose had been discovered as proven by previous researches, its utilization fall more on the field of hard skill learning. This phenomenon fit with the strongest point of multimedia technology which create a better portrayal on even the abstract subjects. Thus, it is reasonable to employ multimedia technology to teach mathematic, newton laws, biology, chemistry, accounting, economy, and other science subjects.

Having said that, the opportunity to explore the usage of multimedia technology is still wide open, therefore this paper proposes to analyze whether multimedia technology could be employed in a soft skill education pack. Rather than use the rigid education application, game technology which offer more fun, attractiveness and interactivity, while at the same time give the impression to be less formal seems more suitable to deliver soft skill learning for young audience.

The subject picked for the case would be about discrimination and tolerance. Discrimination is actually a global issue which far from being resolved. A simulation on villain shooting had been conducted for the police officer and regular people to measure the sign of discrimination on the decision making [3]. The disturbing result show that people tend to associate a certain race to bad behavior though the police officer after spent more time to think it over still come to the right judgement at the end. In Indonesia, flourished by the existence of social media, certain events and occurrences indicate that discrimination is still a major problem here [4]. Therefore, this research

would try to examine the usage of multimedia technology to influence people towards discrimination matter.

2. Methodology

This research conducted by exploring the tendency of multimedia technology utilization in education field while elaborate the opportunities which rarely explored especially on the area of game development combine with education. Additionally, a survey has been conducted to obtain teenage and young people attitude on game playing as well as their tolerance attitude. The result would be applied to shape the education game proposed. Validation of the research would be conducted following the implementation phase.

3. Games as Education Media

Straight forward education pack in which an application bluntly throwing teaching material, simulation and some exercise is a popular media which make a use of multimedia technology for the learning purpose. While it is evident that this approach quite effective to boost learning curve on science subjects, it might not be the best approach for soft skill education, since soft skill is not thing that can be learnt by reading material and exercise on it. Soft skill subject is about shift of thought, the willingness to change and one could excel it through experience. The media which best suit these characteristics might be a game application since game always associated to excitement, thus audience would voluntarily play it and at the same time unintentionally learn the subject. Their experience in playing the game expected to shift the behavior and on the long terms will lead to excellence of conduct.

For decades, there had been debates among researchers on how damaging the influence of video games towards the active players. In 2010, Anderson and his team argue that violent video games intensify aggressive perception and manner while at the same time reduce empathy and prosocial conduct [5]. This claim has been disputed in 2017 when Hilgard and colleagues reanalyzing the research and try to minimize publication bias [6]. The conclusion of this research went to the other direction when they conclude that there is merely minor influence of violent video games on aggressive behavior. Whereas this claim again rebuke when another research used a different methodology to deal with publication bias and evidently accuse that violent video games still be a major concern for the society [7]. And yet another research report that there is no evidence support the claim of connection between aggressive level and violent video games for a decent exposure [8].

All those findings mostly concern on the negative aspect of video game, is video game especially the violent one would eventually lead player post behavior to be more aggressive and less compassionate. Albeit some exploration spot on the positive value generated during the video game playing activity, but usually the positive aspects only relate to the attentional and perceptual skills [9]. It is not surprising and very common due to the nature of every game itself which mostly demand full concentration. Another advantage mentioned refer to the nature of video game player to be able to learn anything related to the instruction on the action game which in return enhance the flexibility sense of the player as well [10]. Whereas Lueke and his colleagues make a hypothesis that violent video games not always bring negative aspects for the player, on the contrary they presume that it may raise heroic attitude which increase the eagerness to help other people depends on the story exposed on the game [11]. However, the research conducted cannot showing any evidence that support their hypothesis. These findings raise a research problem on how is the state of game technology that could be useful to convey good preaching and in return build positive behavior on its player.

4. Cooperativeness versus Competitiveness

Cooperative games by design considered give better influence for the player rather than competitive games. Cooperative games believed could evoke the altruist sense that make the game player likely act as a helping hand towards each other [12]. Even when the game is a violent video game, the cooperative manner could reduce the negative effects such as the aggressiveness behavior [13]. The reduction on the aggressive level surprisingly reach up to the same level as the non-player, that means a player of cooperative violent video games might have the same aggressive level with the one who is not playing the game. This phenomenon offers promising opportunity to resolve the problem of conveying a good message inside a game.

Having said that, cooperative games need more commitment than the competitive one, either a casual game or an online competitive game. Cooperative games demand all the group member involved and be there at the same time. The term AFK or away from keyboard give the sign of an

inactive player which sometimes bring a bad result for the team. In this case it would be simpler to adopt a competitive game to reach more player, while at the same time embrace the cooperative manner which would be attempted here.

5. Analysis and Design

A survey had been conducted to figure the audience's likeness on video game and their daily conduct regarding different races. Fifty respondents from teenage and young adult group of age participate on this survey. Regarding their preferences of game category, respondents requested to pick games they enjoyed the most, each respondent was able to pick more than one game if they find it hard to pick since they are both favorable. Their preferred games would then be categorized and separated. Based on this survey, the adventure game gain more favor with 48% respondent find it favorable. Casual and action gain the second and third favorably genre respectively with 42% and 36%. Regarding on their preferences of inner circle friends related with the race, 46& respondent apparently have a more than acquittance from a different race which might show the average level of tolerance. Having said that, the result should be elaborated more since there are not enough information regarding their reason of preferences.

The next phase would be to design an adventure games following the favorable genre picked from the previous survey. An adventure games need a good story, fortunately Indonesia's culture preserves plenty good legends, and one of them are suitable with the theme of discrimination and tolerance. The legend of Balingkang from the island of Bali tell the story of unacceptance races and cultures which lead to destruction. Another survey to the previous respondents conducted to inspect their familiarity with the story of Balingkang. It turns out only 10% respondents were familiar with this legend, another 20% stated that they have heard of it and another 70% never know about this legend. This legend has corresponding theme and a good conflict that make it suitable for the adventure game which will be developed.

There would be two importants chapter on the design phase, they are the assets design and the gameplay design. The assets designed should perfectly portray the cultures mentioned in the legend of Balingkang, that is Balinese and Chinese culture. Figure 1 show the design of a Balingkang palace which shows characteristic of Chinese culture combined with the characteristic of Balinese culture.

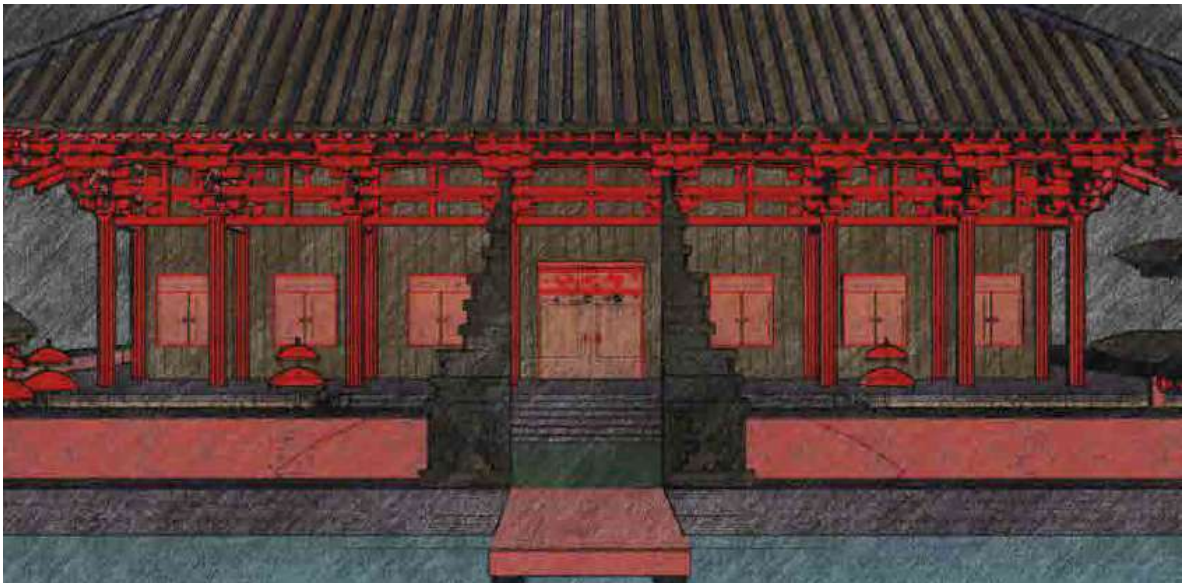


Figure 1. Balingkang Palace

The gameplay designed should both engaging and able to convey the message of diversity. This game is designed not as a cooperative adventure games, hence it should attain the cooperative manner. The cooperative partner would be created inside game to replace the original human partner. In order to convey the message, there are certain scene and task created inside the game. On the first level,

there would be a scene show a mother teach about diversity and tolerance to her child. On the next levels there would be scenes where player might need to finish task which cannot be done alone, or the player need to decide to help certain character or not. The game should push player to find partner and teach them to find appropriate partner not base on the race. There would be consequences on each decision and the consequences would appear immediately on the screen. These designs hopefully could convey the message and lead to attitude changing.

5. Implementation and Testing

The implementation phase started by creating the visual assets in 2D and 3D which then followed by putting them all together inside the asset folder to make them accessible from Unity since the game would be created using Unity. Figure 2 show a scene after the implementation taking place.



Figure 2. Game Legend of Balingkang

After the verification taking place, the result of the implementation would be validated by evaluate it to the teenage respondents. The respondents, without any explanation about the theme of the game and the morale messages required to play Legend of Balingkang until the last part or until the game is over whichever came first. Player behavior and decision were observed and analyzed to confirm the impact of this game on player's attitude toward different race. To strengthen the validation, after finishing their games, players were questioned regarding their experience and their opinion.

Regarding the assets design, most respondents could recognize the touch of Chinese and Balinese culture on the design. This result validates the succeed of the asset design which make a decent game objects that match the story.

On the parts where player requested to help some non-player characters (NPC), most of the players were willing to help regardless the race of the NPC. Only less than 25 percent players overlook the request. When questioning about such attitude, their answers show that they were in hurry and too excited to go to the next phase of the game.

On the other parts where player need to gathering people to help finishing a task, all respondents choose NPC from different races. Players stated that their only concern were about finishing the game, therefore they would pick the best NPC possible based on their strength and qualification without any regard about the race.

Since all respondents already show positive attitude toward racism, it cannot be measured whether the game succeeded to train positive attitude. However, when questioned about messages contemplated after playing the games, all respondents come up with a message about tolerance to diversity. This result might show that the gameplay created on this game had been succeeded to convey the message of tolerance. Moreover, since all the respondent stated that they would be more

tolerance on their daily life, even though the direct result of the usage of competitive game to create more positive behavior cannot be measured accurately, it is enough to say that game can be employed to convey a positive message and somewhat train the player to have more positive attitude.

5. Conclusion

In conclusion, while it is possible to employ the cooperative manner inside a competitive game to create a game which can be used to convey message and train the thought of the player, the direct connection between game training and behavior changing is still hard to be fully confirmed. However, the message about racism is positively accepted, therefore a game is an effective media to convey message and might lead to changing behavior. Further researches are required to fully confirmed the direct relation.

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FSM based virtual camera control for earthquake evacuation simulation

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Abstract. The development of 3D animation technology has been rapidly advanced, making the process of creating simulation involved large number of objects in real-time scenario and produce a dynamic 3D environment possible. Earthquake evacuation plan is one type simulation that involves large number of object and dynamic 3D environment. To provide clear information to viewers how the evacuation should be done when an earthquake occurred in a multi-story building, cinematography plays an important role in providing such information so that the viewer does not miss important information when an earthquake occurred. In this paper, we present a fully automated, real-time system that is able to capture events occurred in emergency simulations in machinima virtual world, select relevant shot based on finite state machine and cinematography principles, control the virtual camera such that the events of interest are properly captured and implemented camera shake and camera blur to make occurring event look more realistic, and also implement crowd simulation using steering behaviour for the crowd. To illustrate how the system works in practice, we also describe the application of automatic cinematography for earthquake simulation.

1. Introduction

Although current technology has reached a point where the level of realism in 3D animation and simulation is extremely high, history of filmmaking has shown the importance of cinematography to better engage with the audience. Audiences have become accustomed to certain conventions used in film, and they expect these conventions in any form of visual entertainment.

In a recent form of digital art, machinima, virtual cinematography becomes more important than before. However, implementation of cinematography techniques in interactive environment is difficult to control automatically. Cinematography depends on storytelling as whole, while in interactive virtual world, the story is developed almost immediately. Because of this immediate reaction in accordance to scene elements, common camera idioms in cinematography, include framing, composition, motion, etc., can become too complex to be handled by automatic camera control in virtual environment.

In composing the visual properties of a shot, a cinematographer may vary the size of a subject in the frame or the relative angle or height between camera and subject. Shot sizes include extreme close-up, close-up, medium, long, and extreme long in which a subject's size in the frame appears progressively smaller or more distant. A filmmaker can also use editing decisions such as shot duration and the frequency of cuts to artful effect [1].

Many researchers have focused on integrating cinematographic principles into automatic camera control. These approaches provide sophisticated control to a user. Christianson et al. [2] divide cinematography into simple fragments in a “Declarative Camera Control Language”. They also develop a “Camera Planning System” that partitions a character’s movement into individual actions.

He et al. [3] encode a finite state machine that controls the camera's position and parameters. Burelli et al. [4] use Artificial Potential Field (APF), a robot motion planning technique, to control both the location and orientation of the camera. Markowitz et al. [5] use reactive decision-making algorithm, Behavior Tree, to perform predefined camera task according to actors' state. Some research also use virtual camera for animation production, machinema and simulation [6] [7] [8] [9].

In the case of computer-based simulations for emergencies several researchers have conducted research for this, such as Gwen et al. [10] have reviewed the 22 models of evacuation and categorized them into three main categories: optimization, simulation and risk management.

In addition, EXODUS is one type of evacuation models were successfully applied to the case of evacuation of the building [11] and mass transport [12]. In general, EXODUS and several other evacuation models can only handle cases of evacuation by doing computation of several variables that are given to predict outcomes of real cases not for real-time interaction.

With the help of 3D animation, especially now the development of more advanced 3D animation so that the results we are seeing more and more close to reality, viewers can experience a virtual emergency that are difficult, expensive and dangerous to reproduce in the real-world scenario.

Some systems that have used the help of 3D animation to simulate emergency cases are simulated car accident with fire and toxic gases in the tunnel [13], smoke hazard in underground railway stations and schools [14], as well as the airport evacuation [15].

The paper is organized as follows. In Section 2, we describe the proposed camera control system for earthquake simulation in machinima created world, and in Section 3, we apply the system to a full earthquake evacuation simulation scenario in a multi-storey building. Finally, in Section 4, we conclude the paper and outline future research directions. Formatting the title, authors and affiliations.

2. Methodology

In this research, the proposed system consists of two main workflows. The first workflow is used to control the camera to capture the shot based on cinematography principles during simulation, and the second workflow is used to control crowd behavior during an earthquake simulation. Overall proposed system shown in Figure 1.

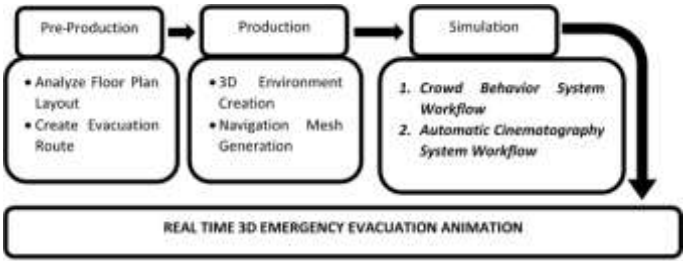


Figure 1. Proposed system for Real Time 3D Emergency Evacuation Animation.

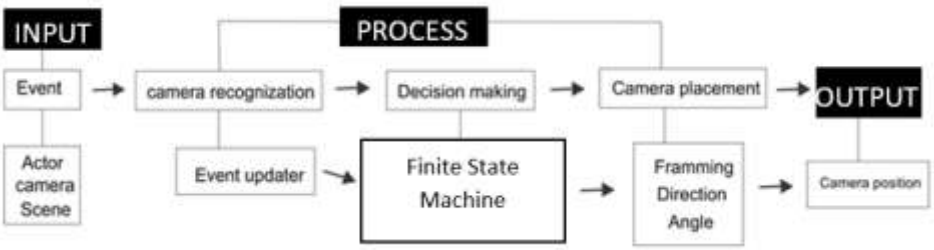


Figure 2. Automatic Cinematography System Workflow.

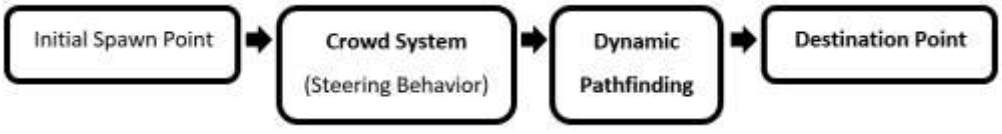


Figure 3. Crowd Behavior System Workflow.

Figure 2 shows the Automatic Cinematography System (ACS) workflow. To take a decision regarding the shot to be taken, the camera system must have an autonomous decision maker, in this case the system will adapt finite state machine for selecting proper shot according to the events occurred in the virtual world. Figure 3 shows Crowd Behavior System that will control how the crowds will take initial spawn point in the virtual world, and how the crowd behave during evacuation simulation to find exit route from the building to the destination point or safe zone when earthquake happened

2.1. Pre-Production

As shown in figure 1, in the pre-production section, there are two main task has to be done the first is to analyze evacuation plan, and the second is create evacuation route. In order to solve the pre-production step, at first, we must know the Egress System. The egress system is part of the circulation system in the building. Most of the codes use the term "Means of Egress" for the egress system. Means of egress is defined as a continuous path of travel from any point within a building or structure to an open space, which is safe and outside the building. This system is comprised of three distinct parts: the exit access, the exit and the exit discharge [16]. An egress system includes the exit access, the exit and the exit discharge. The exit access is the part of the means of egress that leads occupants from any part of the building to the entrance of an exit. Exits mean door leading directly outside or through a protected passageway to the outside at ground level. The exit discharge. It is the location that occupants leave from the exit. Ideally the discharge area is outside the building.

To evaluate egress routes in a building for evacuation needs to recognize static or dynamic situations. Static situations mean building evacuation with all egress paths available (e.g. fire drill) or building evacuation with selected egress paths blocked before egress begins (earthquake or terrorist attack).

For this system we have created simple five-story building in the virtual world and the layout plan for this building. Figure 4 is plan layout for five-story building used in this research. Table 2.1 is an adjacency matrix for this building. In table 2.1, number 1 indicates connectivity between room and number 0 represent no connectivity. When any space becomes blocked, any connection related to that space are impossible. In other word, number 1 of those connection will be changed to be number 0.

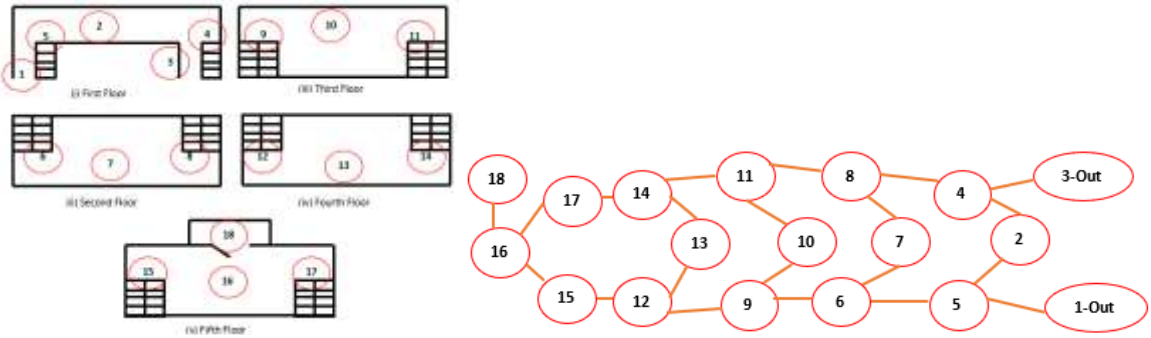


Figure 4. Floor Plan Layout for Five story building and Network of Figure 4 (Evacuation Route).

2.2. Production

In the stages of production, a lot of things to be done and this work is related to many parties, ranging from 3D artist, 3D modeler to create realistic virtual environment. In this work there are two important parts, the first is making a virtual environment and the second is create a navigation mesh, so that the virtual environment created can be explored by the crowd agent

2.2.1. 3D Environment Creation

After floor plan is analyzed and evacuation route is decided, the next process is to create the 3D environmental building according to the floor plan layout. This includes the 3D character modeling, 3D object modelling, material editing, texturing, pre-render process and 3D light source placement in order to make realistic 3D environment. Figure 5 shows final result of our five-story building.

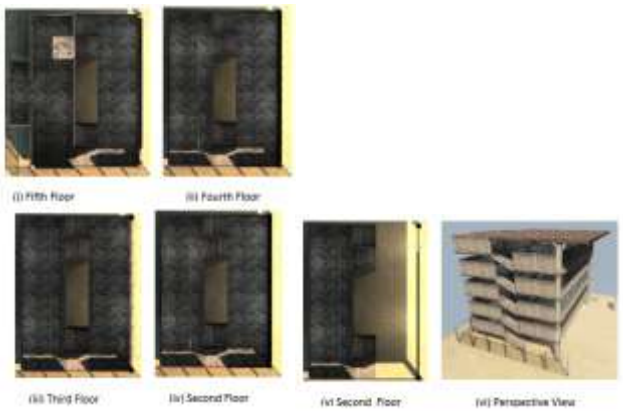


Figure 5. 3D Environment creation.

2.2.2. Navigation Mesh

To be able to guide the crowd toward the exit discharge using pass through the lane provided. We need navigation mesh. Navigation mesh represented series of polygon that the crowd need to walk through to reach their goal. The generation of navigation mesh can be complete in three steps, Exploration, starting at crowd spawn point, walkable space is sampled by "flood-filling" outwards from that spot, searching for adjacent walkable points, Mesh Simplification, this step can be done by square merge to reduce number of the polygon, merge all polygon into concave slabs separated only by difference in slope, and then decompose concave slabs into convex shapes. This done via convex decomposition process that uses A* approach to find optimal configuration shapes to represent the concave slabs, and Mesh Finalization, is building path-able edges between nodes and generating the obstacle mesh

2.3. Simulation

In the simulation process, as shown in figure 1, we performed 2 tasks simultaneously which is crowd behavior system and automatic cinematography system.

2.3.1. Crowd Behavior System

Crowd behaviors system used in this paper is using Reynold's [17] approach, the crowd agent is driven by steering force and their position is updated every frame.

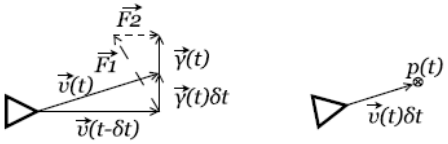


Figure 6. Computation of force applied to crowd agent. (i)The agent represented by triangle. The agent velocity is updated by integrating acceleration expressed as a sum of force, (ii) the crowd agent then oriented along the newly computed velocity.

2.3.2. Automatic Cinematography System

In this section our objective is to implement basic cinematography rule to properly captured scene from an emergency earthquake evacuation. The task assigned to camera proper capture emerged events during an earthquake in a crowd. The following desired visual properties for camera are the pathway captured should fully visible, not obstructed with obstacle (Figure 7), The scene should be framed as close as possible to the center of the screen (Figure 7), and the scene should be viewed from back with medium to high angle shot. Figure 8 (a) shows the shot direction angle from front view to back view, figure 8 (b) show shot angle direction from low angle shot to high angle shot.



Figure 7. Pathway should be fully visible, Rule of the third, framed to center of the screen

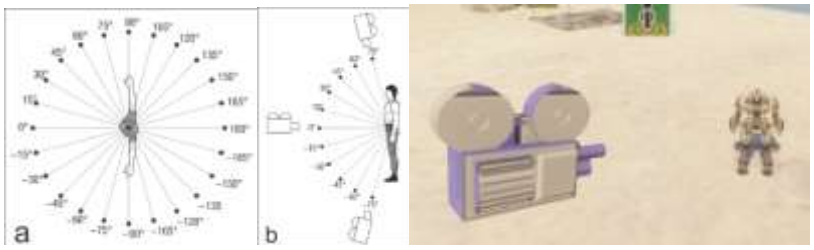


Figure 8. Shot Direction (a) and Shot Angle (b)

The camera system can recognize the changes of occurring event. Change events that occurred is marked by a change in position, actor's circumstances and information regarding the position of the camera. Event block shown in figure 1 consist of three parameter, actor which is the crowd, camera actor, and the scene (in this case is five-story building). From the parameter given the system parsing the parameter into camera recognition to make decision making according to finite system for which camera will take the shot, determine the framing, camera direction and camera angle. The final output is the camera position and orientation that take the shot for occurred event happened in the scene

3. Result

The system implemented in unreal engine and runs on Intel core i7 2.4 GHz machine. The evacuation simulation run-in real-time scenario. Using navigation mesh explained in section 2, here is the example navigation mesh for the fifth floor on the building used for this simulation.

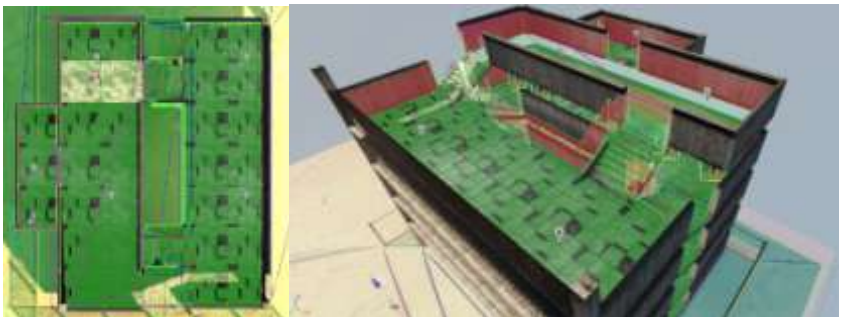


Figure 9. Navigation Mesh

Figure 9 shows the created navigation mesh, green color mean walkable path, and red color mean blocked path. We first computed the evacuation route captured by the camera agent without crowd agents, the second is we captured evacuation doing by the crowd agents captured by our camera. It is intended to see whether the results of the shoot which has been obtained by the cameras without involving a crowd agent has the same result as the camera shots involving crowd agent. Figure 9 show the captured evacuation scene without crowd agents. The dynamic pathfinding is successfully adapted for unpredictable event, such as collapse wall. The crowd agent should be able to find another path to reach their goal. The evaluation for this can be seen in figure 10.



Figure 9. Captured Scene for Evacuation Simulation

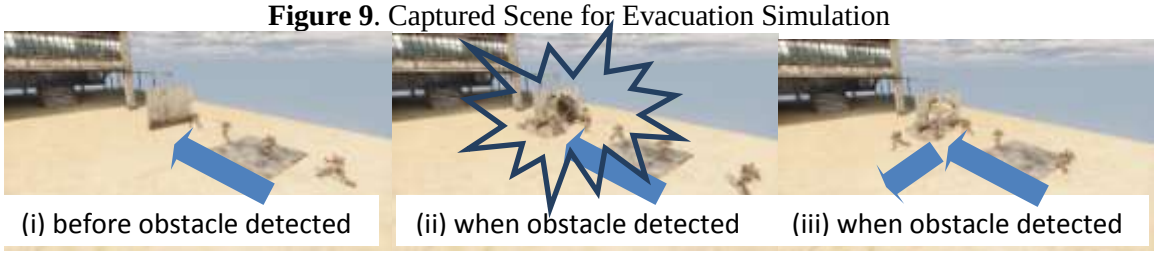


Figure 10. Dynamic pathfinding and Obstacle avoidance

The next experiment shows that our system, in a proper way can take the shot to show the exit and exit discharge area, in the evacuation plan it is necessary to show where is the exit and the exit discharge area. In our test, the exit discharge area is marked with Red flag, it is where the crowd must go during an evacuation when earthquake happened. The result is shown in figure 11.

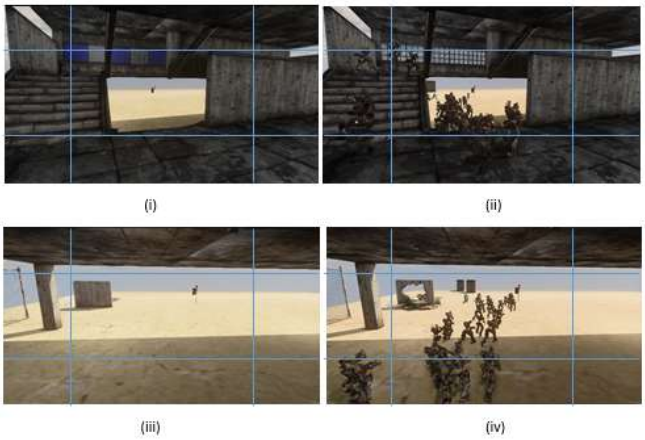


Figure 11. (i)(ii) Show the exit, and (iii)(iv) show the exit discharge area marked with Red Flag.

4. Conclusion

We have presented a prototype system for automatically generated evacuation simulation animation video and shot selection in machinima during an earthquake evacuation simulation. The system takes initial resource from event that occurred in virtual world and combined with cinematography technique to acquire shot or footage machinima generated animation. Our system extends virtual camera computation approach to extract events from given scenario, solve camera placement problems and determine the virtual camera placement and shot selection to make an animation and also shows how evacuation should be done if there is an earthquake happened.

The system exploits the ability of steering behavior for crowd agents, basic cinematography rule, an evacuation plan and convex decomposition process together with A* algorithm to determine walkable path for the building also FSM for camera placement. We used Unreal Development Kit for this research. We also plan to improve the camera control for placement and shot selection in the larger area for an example in outdoor evacuation simulation.

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Machine learning to predict rainfall at Deli Serdang Stasion in North Sumatra

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Abstract. The Flood in North Sumatra over the past year had caused loss in many sectors. The rain is one of the factors that is causing flood. One of the early way to prevent the flood is by predicting the rainfall in Deli Serdang Station. This prediction uses the method/ algorithm of Backpropagation Neural Network (BPNN), DBN (Deep Belief Network) and SVR (Support Vector Regression) which results will be compared to each other. The results of this comparison can be used to determine the best method for predicting the rainfall of Ular River every day. This research is using 3601 daily weather data from January 2008 until December 2017. Independent variables are minimum, maximum and average temperature, duration of sunshine, average humidity and wind speed. Those variable are used to predict rainfall in same day. The data is divided as training and testing such as 60:40, 70:30, 80:20 and 90:10. Five iteration by Root Mean Square Error (RMSE) criteria shows that BPNN in 90% training and 10% testing are the best.

1. Introduction

Rainfall is the height of rainwater collected in a flat place, does not evaporate, does not seep, and does not flow [1]. The unit used in measuring rainfall is millimetres (mm). Lack of rain result crop failure in agriculture, thereby reducing the income of an area. Too high rainfall also causes flooding that paralyze community activities such as agriculture, industrial and trade activities. One solution to help overcome these problems is to predict rainfall. Rainfall prediction can help people make better plans to anticipate the consequences of rain.

Machine learning is a part of artificial intelligent. Machine learning is a machine that learns from data [2]. At this time, machine learning has been developed in the field of data scientist where data can be processed to obtain knowledge or knowledge that can be used to benefit a person or a company. Backpropagation Neural Network (BPNN), DBN (Deep Belief Network) and SVR (Support Vector Regression) are machine learning method can use to predict rainfall.

Every year in North Sumatra Province, Deli Serdang is also to be topic in news because flood. Flooding also causes damage to infrastructure and harms economic activity. Deli Serdang Regency is an area that surrounds Medan City as the centre of North Sumatra Province. In 2016 there were three floods in Deli Serdang, at February, May and September. Flood events in this district became a news topic because it often claimed casualties. In this paper, rainfall is importance part of flood will predict with BPNN, DBN and SVR to choose the best method.

2. Theory

2.1. Back Propagation Neural Network (BPNN)

Neural Network (NN) is a machine learning method that has a network architecture such as nerve cells of the human brain. Magnitudes that show relationships between neurons in order to convey information are called weights. Broadly speaking, the weight of these other neurons will enter through the neuron into the function to then be compared to the threshold value (treshold) through the activation function with the requirement that input must pass through the threshold value to enable the neuron to be activated. The result will then be sent to output to all associated neurons. One method of supervised learning NN is the backpropagation learning algorithm that usually uses multiple layers. There are several activation functions (activation function) in NN including sigmoid function:

$$y = f(x) = \frac{1}{1+e^{-x}} \tag{1}$$

where, $f(\mathrm{x})$ whis activation function of variable x.

2.2. Deep Belief Network (DBN)

Deep belief is a type of deep neural network with many hidden layers and a large number of hidden units in each hidden layer [3]. Deep belief network is divided into two parts, restricted boltzman machine (RBM) and backpropagatian. RBM is a generative stochastic of neural networks that can be studied based on the probability model by using unsupervised learning techniques.

Deep belief network is combined from several layers of RBM, which is said to be restricted because the layer contained in DBN is only 2 types, visible layer with hidden layer. Each of the RBMs has a visible layer v and a hidden layer h that is connected by a random weight taken. The relationship between DBN and RBM is presented as shown at figure 1. Based on the picture of the relationship between RBM and DBN, it can be concluded that DBN is a combination of several RBM blocks. In backpropagation is said to be a backward phase that aims to correct the weight or weight that will be used to produce results that have a small error when compared to the target value or dependent variable.

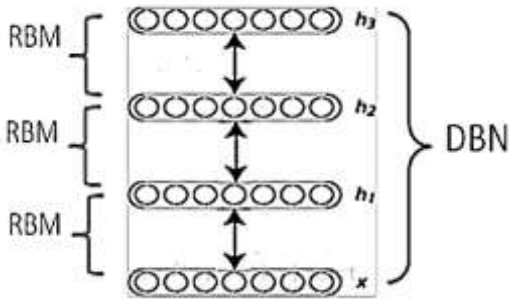


Figure 1. Relationship of RBM and DBN [4]

2.3. Support Vector Regression (SVR)

Support Vector Regression (SVR) is a development of Support Vector Machine which is used for regression cases [4]. SVR is a method that can overcome overfitting. The purpose of using SVR is to find a function as a hyperplane in the form of a function that matches all input data with an error and makes it as small as possible when equal to 0 the perfect regression is obtained, which is meant in this is error tolerance. The regression function as a hyperplane has a bias value of b to produce a better regression value. The linear regression function is the basic idea of the SVR method which is described in the following equation:

$$f(\mathrm{x}) = w \cdot x + b \tag{2}$$

Equation 2 is Linear regression function with
w = weighting vector
x = input vector in the form of data
b = value of bias

3. Methodology

3.1. Data

BMKG's online data is obtained from the government agency website (bmkg.go.id) as a provider of information about weather predictions and predictions of natural disasters that will occur. The weather data are from Deli Serdang climatology stations at Sampali. To retrieve the historical rainfall prediction data contained on the BMKG website from 2008 to 2017, an account is required to enter the BMKG online database. An account to access the BMKG online database is obtained from BMKG via e-mail and is only given to users who need the data in conducting research. Sample data from BMKG was used in this research such at Table 1.

Table 1. Sample of weather data from BMKG Deli Serdang Regency

Station Name	*WMO. ID*	Date	X1	X2	X3	X4	X5	X6	Y
Stasiun Klimatologi Tuntungan	96037	23/05/2009	32.8	26	28.5	4.6	2	85	0
Stasiun Klimatologi Sampali	96031	23/05/2009	33.3	25	28.5	4.3	4	80	0
Stasiun Klimatologi Kualanamu	96035	23/05/2009	33.2	23.3	27.7	9999	9999	88	0
Stasiun Klimatologi Tuntungan	96037	24/05/2009	34	25.6	28.8	5.1	3	82	0
Stasiun Klimatologi Sampali	96031	24/05/2009	35.2	25.1	28.8	5.2	5	77	0
Stasiun Klimatologi Kualanamu	96035	24/05/2009	34.6	22.8	26.3	9999	9999	84	0

Rainfall is the height of water that is accommodated in a certain area. In the BMKG unit the area of rainfall is 1×1 meter or is called 1 square meter. Rainfall is measured on a millimetres (mm). To predict rainfall (Y), several variables are found in the BMKG historical data such as:

1. Maximum Temperature (X1)
   Temperature is a measure of the average kinetic energy of the movement of molecules. The maximum temperature intended is the temperature measured in 24 hours where the highest calculated temperature is used as the maximum temperature.
2. Minimum Temperature (X2)
   The minimum temperature intended is the temperature measured in 24 hours where the lowest calculated temperature will be the minimum temperature.
3. Average Temperature (X3)
   The mean temperature meant is the temperature recorded 24 hours which is then divided by the number of measurements taken.
4. Duration of Sunshine (X4)
   The duration of irradiation is the duration or duration of the sun shining brightly on the surface of the earth which is calculated from the rising of the sun to the setting of the sun.
5. Average wind speed (X5)
   Wind speed is the wind mileage or wind movement per unit time that can be expressed in m/s.
7. Average humidity (X6)
   Moisture is the amount of water contained in the air. Humidity depends on the temperature at which the higher the temperature, the more the moisture content.

3.2. Methodology

Methodology of this research start with pre-processing data then split data into training and testing. Algorithm BPNN, DBN and SVR are run five times to get error (RMSE). Step of methodology can see at the Figure 2.

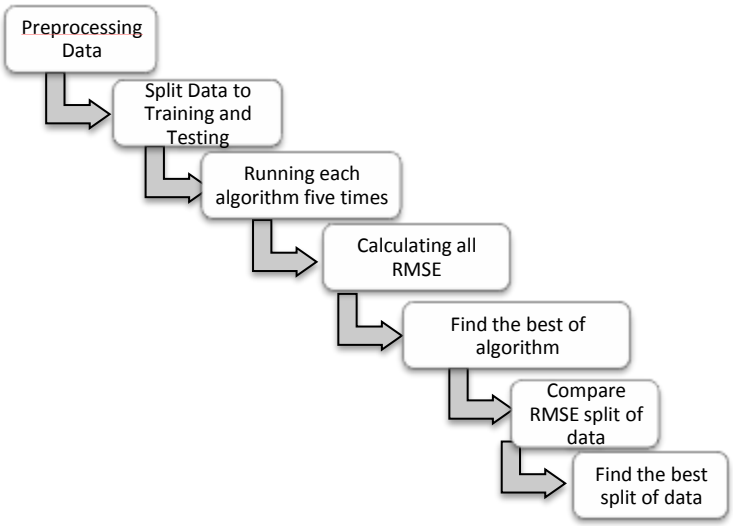


Figure 2. Research methodology

The pre-processing stage is the stage that will do some treatment, namely:

- Fill in the missing value: The algebra average method is a measurement carried out on several stations (Kualanamu and Tuntungan) at the same time summed up and then divided by the number of stations that are close together [5].
- Data normalization: Normalization of data that aims to obtain data of a smaller size and represent the original data without losing its own characteristics [6]. The method used in this normalization is min-max normalization.

After pre-processing, data split to training: testing become 60:40, 70:30, 80:20 and 90: 10. Then running BPNN, DBN and SVR to each split of data five times. Each model built then RMSE counted to all of testing data. Find the best algorithm and find the best dataset.

3.3. Tools

The tools which are needed to build the daily rainfall prediction simulator in Deli Serdang are as follows:
Hardware specifications used are: Processor Intel core i5 and Memory 4.00 GB RAM
Software specifications used is R software with library neuralnet, metric, caTools, MASS and e1071.

4. Result and Discussion

The first step is preprocessing dataset, which is to fill in the blank data with the average value of the predicted results of BMKG stations adjacent to other stations. The following is a data image that has not been done preprocessing data. Lines that have a value of 9999 are empty data but have been filled with new data using the average algebraic method from the BMKG station Climatology Sampali. The following are the results of the preprocessing that has been done. In the picture above, it can be seen that the data is empty but has been filled with new data marked with red data to be used in this study,

data from the Sampali climatology station. After preprocessing data is done, the data normalization is then carried out to obtain smaller data. The following is the result of normalizing data:

Table 2. Normalization data weather

Station Name	*WMO. ID*	Date	X1	X2	X3	X4	X5	X6	Y
Stasiun Klimatologi Sampali	96031	23/05/2009	0.740	0.723	0.618	0.048	0	0.823	0.331
Stasiun Klimatologi Sampali	96031	24/05/2009	0.822	0.651	0.658	0.095	0	0.774	0.366

After the normalization stage is done, the results of the normalization of the data will be used as a dataset in comparing the three methods. After this dataset is used, the final step is denormalizing data to return the output value to the actual value. Result of five experiments from each dataset and machine learning algorithm shown at Table 1. The higest error is produced at first iteration. RMSE of iteration 2 to 5 are stable. The lowest RMSE result by BPNN method in training 90% and testing 10%. In all combination of splitting data, BPMN is the best algorithm then DBN then SVR.

Table 3. Result of running of simulator

No.	Dataset	Algorithm	RMSE of Experiments				
			1	2	3	4	5
1	60:40	BP-NN	0.081*	0.082*	0.082*	0.082*	0.082*
		DBN	1.081	0.085	0.086	0.086	0.085
		SVR	2.081	0.088	0.088	0.088	0.088
2	70.30	BP-NN	4.081*	0.081*	0.081*	0.081*	0.081*
		DBN	5.081	0.084	0.085	0.085	0.085
		SVR	6.081	0.089	0.089	0.089	0.089
3	80:20	BP-NN	8.081*	0.073*	0.073*	0.072*	0.072*
		DBN	9.081	0.076	0.076	0.076	0.076
		SVR	10.081	0.080	0.080	0.080	0.080
4	90:10	BP-NN	12.081*	0.067*	0.063*	0.064*	0.064*
		DBN	13.081	0.067	0.068	0.068	0.068
		SVR	14.081	0.068	0.068	0.068	0.068

Figure 3 show the prediction comparison chart with the actual data above shows that the predicted rainfall pattern follows the actual data pattern but on certain dates such as 01/12/2017 and 31/12/2017.

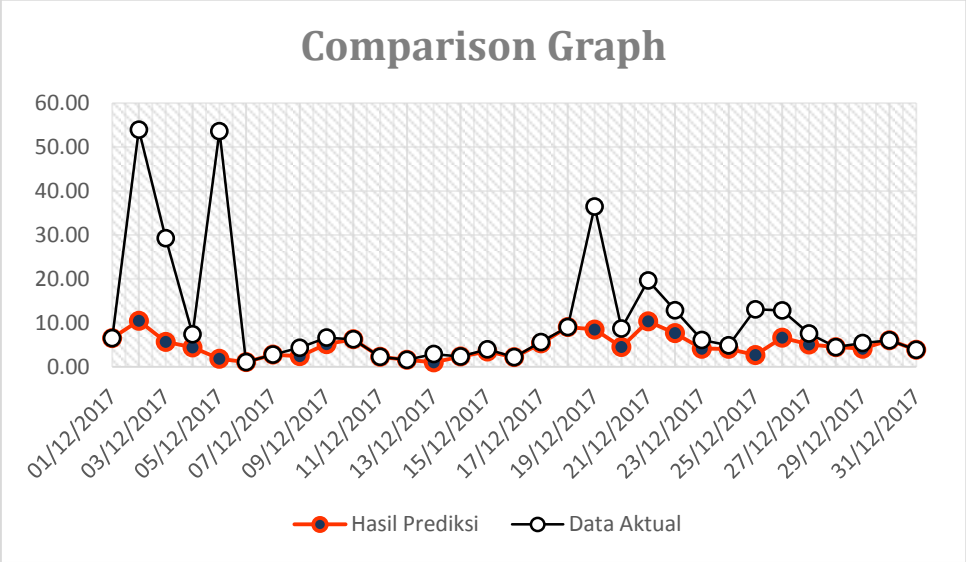


Figure 3. Comparison graph prediction with actual

The lowest rainfall at 6th and 12th December 2017. The highest rainfall at 2nd, 5th and 19th December 2017. The prediction results with the best method produce a pattern that follows the actual rainfall data but when there is extreme weather the method cannot predict optimally because it cannot capture rainfall patterns at the height of extreme rainfall.

5. Conclusions

The conclutions from the experiment result are:

1. The best dataset for predicting daily rainfall is 90% training data and 10% testing data because it has the smallest RMSE value of 0.066.
2. From the results of the experiment that has been done five times, the best method among the three methods (BPNN, SVR and DBN) is backpropagation neural network (BPNN) with the average value of RMSE is 0.066525633.
3. The prediction results with the best method produce a pattern that follows the actual rainfall data but when there is extreme weather the method cannot predict optimally because it cannot capture rainfall patterns at the height of extreme rainfall.

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Rethinking third place in the digital era

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Abstract. As time develops, cities need to pay attention to the changing of human needs as social beings. Creating such an inviting environment, including *third places,* is an interesting phenomenon because it is currently widely emergence in urban areas in order to enhance the quality of life. Mentioned by Oldenburg, third places are the anchor of the community and urban public life to grow. A third-place is a neutral place; no one acts as a host, informal, and filled with individuals beyond the realms of home and work. Oldenburg theories on the Third-Place arosed long before information and communication technology (ICTs) as well as the social media and the internet had not yet been created. In this modern era, ICTs has become "the fabric of everyday life" [11], it has an important role in increasing physical space [2] and taking action for its existence. Society's needs will change, and they demand extra requirements for the third place. Third place today needs reconsideration to fit in the current IT based community. As a method, this study used direct observation and qualitative analysis of *Sketsa Pulang Kerja* community that congregated in Platform 78 Café as the third place. The result showed that the presence of ICTs impacts the sociability in third place; people are often attached to technology and networking services. We suggested some design strategies that can enhance the quality of third places for empowering more the community in the digital era.

1. Introduction

During the hustle and bustle of human activity to live and make living, urban inhabitants need a medium to unwind and relief stress. *A third place* is a social place that has potentials to socialize and to be more socially inclusive. According to Ray Oldenburg, these places are neither home nor work, but a place of a social environment that is separate from two other environments, which are home as a first place and work as the second place. In his book entitled The Great Good Place (1989), Ray Oldenburg emphasizes the importance of social gathering places to accomplish the needs of social beings for enhancing the quality of life and balancing their needs. These places identified as "heavens of sociability" that provide opportunities for people to connect with others in communities and increase the quality of public life. Oldenburg mentions that coffee shops, bars, and barbershops are examples of third places. These are the places for the community to grow by gathering and directly socializing. According to Oldenburg, third places share several characteristics; 1) neutral ground—no one act as a host; 2) leveler—people come and interact freely, people from different socio-economic may attend; 3) conversation is the main activity—playful and informal atmosphere; 4) accessible—the place is easily accessed; 5) the regulars—regular people are there to make the place comes alive; 6) a low profile—whoever can come; 7) playful mood—no pressure among the interaction; 8) a home away from home—comfortable atmosphere just like at home.

In this modern era, lifestyle had shifted from the past when Oldenburg first stated third place characteristics. It shifted the characteristics previously explained by Oldenburg as well, but third place is still an important medium for social interaction—increasing the ability of cities to be more adaptable as times develop. Most societies demand more needs in third places. Technology is an important thing that happens in the digital era. Nevertheless, third place is still an important medium for social interaction. With the development of ICTs, third places need advancement and improvement to foster the sense of community to bring the active and informal interaction among people aside from home and work.

1.1. Third place as the center of a community

Third place fulfils the needs of a social being. It is useful for developing communities in society. In the community, there is a psychological condition of feeling close to groups of individuals who share membership, influence, common needs, and emotional connection [1]. The condition of the community would give impact the public health. The benefits of being part of a community are not only to have friends to interact, but also to develop a sense of belonging. People have the desire to encourage interaction with one another, as the way to reduce loneliness and reduce the level of stress. For the sake of a better community, public space is essential for their social sustainability. The community will suffer if there is no place for people to meet and interact. Third place can strengthen community cords through social interaction and the quality of life; and in a neighbourhood level, it affected by the availability of third places [7]. The community in a particular society have varied dimensions. The place they are going to, outside the home and workplace, are also vary. The presence of third place is as essential as the community itself; if there is no place to meet and do activities together, then the community will not survive. A place determined by the activities of individuals who occupy spaces [1]. Many public spaces with relaxed space settings have determined as the space used to rebuild an existing or newly formed community [12]. Oldenburg explained that public space which has a set of relaxing spaces such as coffee shops, pubs, and beer gardens, is a third place that supports the community.

1.2. Third place in the digital era

When Oldenburg introduced the concept of third place, ICT has not had any impact on the formation of society. Throughout the world, the fundamental character of Oldenburg, a home away from home, was found in places for the public, such as pubs in England, cafes in France, and beer gardens in Germany. Urban and suburban communities are inspired by the Oldenburg concept and use it to create third places in open landscapes [5] and even in places like photo-shops and prisons [1]. However, this implementation is still attached to the idea which assumes that ICT does not yet exist, so it is not compatible with the current need of the third place. The presence of third-place should provide more varied functions—such as the role of an internet-hub, or a place to work [9].

Third place, for years, was able to bring people together and socialize. In this digital era, technology helps availability of third place. There had been much research explaining how the internet has now given access to humans, by creating new ways of communicating, namely, communication in virtual social spaces [10]. In that case, the internet connects humans with other humans although detached by distance.

2. Method

The question is, how does the digital era multiply the role of ICTs to redefine and improve the third places? What design strategies that third places need for empowering more the community in the digital era? In order to answer the questions, we need literature studies about third place, community, and current communication technology. The goal is to find out how third place has developed to foster the sense of community in the digital era. We also have to make an observation of the place that represented the current third place through the case study. The question is: what people in the community do and feel about the space-related to their identity? We chose a community with the

members who have the similar interest on sketching called *Sketsa Pulang Kerja.* We merged into the community to enable conducting in-depth observation and qualitative analyses. The study took place in Platform 78 Café, Bandung, where the community of *Sketsa Pulang Kerja* gathered on Wednesday, April 24, 2019.

3. Discussion

3.1. Third Place-Sketsa Pulang Kerja Community

Sketsa Pulang Kerja is a drawing community that exists because they are looking for a way out to relief stress of the working pressure. This community has a very casual activity. They hold gatherings regularly once a week by promoting their activity through social media, the Instagram. Platform 78 Café, as the third place, is promoting that gathering on their Instagram. We noticed that both the community and the third-place tried to promote their existence in a virtual place. It contradicted to Oldenburg claim on the third-place characteristic; he said third place is a low profile; they are not advertised, have few expectations, and not elegant. In this case, we saw the most notable difference from Oldenburg's conceptualization; in the digital era, people have an online presence. In other words, contemporary third places have a digital complement in the virtual world. It alters the characteristics of the third-place from Oldenburg; the third place filled with the regulars. As a matter of fact, people who attend this community are always unpredictable since they came from the virtual place as well, so it is irregulars in character.

The Platform 78 Café located in a superblock surrounded by campuses, cafes, boutiques, hotels, and several offices. This café is one of the places most visited by various groups and therefore its location considered to be a hot spot. This place has an indoor and outdoor area and meeting rooms. *Sketsa Pulang Kerja* took place in an outdoor area [3]. One of the amenities of the café is the outdoor location. We noticed the domination of technology attributes in this café; there were facilities to support the activities of the community—such as power outlets, WiFi (internet connection), surveillance camera, and LCD with projector to show off the presence of the community. People were easily noticed this community.

The surveillance camera that recorded every action at this café contradicted to Oldenburg statement that third places were home away from home, although they still got the feeling of social belonging in the community. Indeed, being recorded and watched would not typically find at home. The café provided outdoor seating areas that was inviting people to sit down and enjoy the pleasant atmosphere. This café has a picturesque atmosphere, made everybody feels relax and comfortable. This in accordance to Oldenburg theory; comfortable setting in the third-place is inviting to a human being. Comfortable impression also obtained from the users' perception of the safety. The café located at a higher level than the nearby highway. Its positioned was projected in such a way that it provided privacy. There is a sharp boundary between the outdoor area and the street. It is possible for the visitors to watch the street, but the street cannot look inwards; in other words, this place's presence is not obvious. In this case, it contradicted with Oldenburg suggestion, that third place must be easily accessed and accommodated. This place can be traced easily by Google Maps and the *ojek online*. Therefore, this café is noticeable and accessible although its location is not apparent.

We noticed that this place was thematically decorated and offered entertainment that specific to visitors. The community chose this place to congregate because it has a tropical ambiance; well represented through the furniture and interior objects. The availability of facilities and the ambiance as the result of the arrangement in the outdoor area is indeed better than the indoor area. For the customers, the outdoor area was the most favourite place to sit.

Contrary to Oldenburg's explanation of third places, the presence of ICTs in third places are outstanding. There were two ways of utilizing the ICTs, either for the community and the cafe. First, this third place uses a variety of social networking services. The aim is to promote the café and its events, and to track its location. This phenomenon did not yet appear in Oldenburg's era; in that time, third places merely relayed on the physical place. Today, although the presence of the place is not

apparent physically, because of the ICTs, people may recognize the existence of the place. Another phenomenon was represented by how people often connected to virtual social media and focus more on their gadgets during enjoy the third places. In the case of *Sketsa Pulang Kerja*, most of the members tend to draw with modern techniques. They were using various types of technology to draw—laptop, iPad, pen-tablet, and mobile phones, as in Figure 2. For that reason, they demanded some electric and connection devises and facilities. The interesting fact is that the conversation is not entirely the main activity at the third place anymore, because people often use their electronic devices and focus on their gadget alongside face to face conversation.

One of the most-flashy property was the seating arrangement that almost had no sharp boundary one to one another. Some arrangements invited people to talk privately, but again; there was no such distinct boundary. The neutrality is shown by how they arranged the seating arrangement. There were types of seating arrangement that offer flexibility for different kind of interactions—active social interactions or private interactions. Visitors could move the chairs as they pleased and created their boundaries to create their own space, especially when they came in a group, like in the case of the community of *Sketsa Pulang Kerja*. This community highly concerned on the activity of interacting; it could easily carry out because chairs and tables could be shifted and merged with other tables. Platform 78 Café was made intentionally for community, they put community as their priorities and expect them to come to this place, or in other words, they did 'human-centered' as a design process; design that started with people [4]. The process helped them knew the needs for particular reasons and then created solutions in the form of appropriate space design [4].

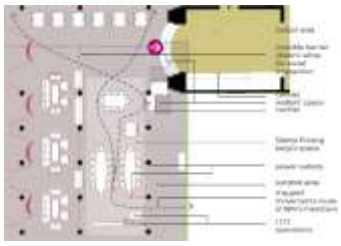


Figure 1. Outdoor area plan and management.



Figure 2. *Sketsa Pulang Kerja* activity and the presence of technology.

However, this place was not necessarily a neutral ground. Although everyone had no obligation and free to come; as Oldenburg said, instead, this place took roles as the center of information between the visitors. In this third-place, people discovered and had been discovered. We observed that in *Sketsa Pulang Kerja*, one visitor discovered by other visitors. The situation of the café created boundaries among the members; and highly possible the host of the café intervened the visitors because they were in a big group. However, on the other hand, in a circle of the community, these settings related to Oldenburg's construction. The configuration of seating supported the mission of the community; to invite as many people as possible, even stranger ones. They enjoy their social activity as if no one was watching them. When strangers came and tried to interact with them, it would be such intervention, but they would be happily welcomed and let them joined. It represented one of Oldenburg's characteristic of third places; neutrality.

3.2. Sociability

A place will be alive if the place has special activities [3]. *Sketsa Pulang Kerja* has unique activities that instantly make the café come into alive. Members of this community came from different backgrounds—not only those who have an art background. It is in accordance with Oldenburg statement; different people derived the connectivity in the community. It created playfulness by having an enormous conversation. It also affected the character of third-place mentioned by Oldenburg, what he called a leveler. He said that social distinctions were not a big issue in third places. However, in today's third place, people who have access to the internet, specifically Instagram, may recognize this community and the café quicker than those who are not Instagram users. This cafe provide space large

enough for visitors with large numbers and has high social value for each individual to interact. It was the right place for the community to gather because they offered good amenities with tropical ambiance. It could create another playful mood for them so they might linger as long as they wanted.

During our observations, we noticed another tendency, which was the formation of the visitors in *Sketsa Pulang Kerja*. One man just came and joined them. He was sitting alone until he was approached by two other members who seemed to have joined the community before. After they left their seat, within a minute, there came another girl tried to talk to him. In this digital era, behaviour like this is often happening in virtual places like *Instagram* and *Twitter*. People who stayed longer tend to bump and approach into different people in order to bond and make friends. This behaviour presents similar ways of how people tend to cope with other people. The distinction between the virtual and physical worlds is nothing but blurry.

Another thing we noticed during our observation was that the servants were standing by at a certain point, frequently at the entrance, as can be seen in Figure 1. They were forbidden to walk up and down, as it might interrupt the privacy and comfort for visitors. Management of a social place must also be supported by how staffs work [3]—friendly, does not intimidate visitors, and help encourage conversation [8]. The sociability, both among the visitors and staffs, was arranged well for the sake of comforts. Platform 78 Café, as the contemporary third place, shows alteration characteristics mentioned by Oldenburg. The presence of ICT is undeniable, and the facility to complete *Sketsa Pulang Kerja* is a must. It is also one of the reasons why *Sketsa Pulang Kerja* chose this place for gathering after work for hours, that is because this third place is well known as a communal space and belongs to communities.

4. Conclusion

This paper proposes a framework for the development of third place that foster a sense of community in the digital era. As mentioned by Oldenburg in 1989, a third-place mainly used for enhancing public life, especially for the community to congregate. As time goes by, the third places need development as well. Society and technology change since Oldenburg introduced the concept of third place. In this modern era, where internet and networking services are excessively spreading, people demand more requirements to complete their activities. There are ways of how people connected to a better quality of life. ICTs is making life easier to connect. Nowadays, ICTs can be used to establish the relationship between the third place and the people, as well as the relationship between the people and the community. However, technology is not 100% issue in this era. Urban inhabitants will seek for peace to unwind and relieve stress. They need hanging out informally in a relaxing and friendly environment. The sense of place depends on the spatial organization of the surroundings [6]. However, sufficient amenities and ICTs can support third places in empowering a community whose members dwell in a busy society. Oldenburg's conceptualization still applicable to achieve third place, but a better reconsideration is needed to balance the needs of today's society. Hence, in order to be a good and successful third place, contemporary third places need further development. Based on our findings, we suggested design strategies that can enhance the quality of third places for empowering more the community in the digital era as follow:

1. *The integration of ICTs to boost third places;* in Oldenburg's era, the third-place existed only in physical settings. As we observed in our case study, this nature has changed. Third places today tend to include digital properties to boost their existence and popularity. It is also important for the virtual third places to promote themselves in the physical third places. People might indicate the virtual third place far more leading and win the competition compare to physical third place. They rarely think that those two might lead towards complementary and diversity. It is apparent from our case study of *Sketsa Pulang Kerja* community, virtual and physical third place united by Instagram. It realized because there is another form of socialization, that is through virtual communication.
2. *Purpose-built third places;* people's beliefs and values reflect their preference of the third-place. *Sketsa Pulang Kerja* community gathered for talking about drawing and dinner. However, it is

not about the quality of the drawing they are going to make, or about the food they are going to eat. It is about the place they are drawing and eating at, and whom they are going with. The amenities are powerful elements— imaginative visuals, comfortable space, sufficient facilities; they also foster the potential interactions among the members. When the place is convenient, the interaction will be increasing. In Oldenburg's era, he stated that third place is as simple as an informal public place. As long as people have the company to spend their time aside home or work, third place perception will occur. Yet this is not what happens in today's era because people demand excessive needs.

3. *User-centered design;* to correlate with two previous points, in the case of opened community like *Sketsa Pulang Kerja*, the members like to expose their existence. They are comfortable to discover and be discovered. They like to catch attention from strangers in order to attract more members. It is different from other places whose visitors are seeking more privacy and not willing to be exposed. It shows that different cultures establish different characteristics of third places. The third-place we had observed could handle those two different situations. It provided the place that facilitated different spots for different goals or needs. Hence, determine the needs of different customers is essential to enhance the quality of third places.

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Image based indonesian fruit recognition using MPEG-7 color structure descriptor and k-nearest neighbor

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Abstract. Image based fruit recognition can be applied in several sectors including food industry, food retail, and medical. This paper proposes a method to recognize Indonesian fruit from image. The method uses MPEG-7 Color Structure Descriptor (CSD) as input features to k-nearest neighbor classifier. CSD describes the local color structure of image in HMMD (Hue, Max, Min, and Difference) color space. In this study, the numbers of features extracted from a fruit image were 32, 64, 128, and 256. A simple feature selection method based on variance has been applied to reduce the dimension of input features and to increase classification performance. A feature with variance less than predefined threshold was excluded from feature space. Three hundred and fifty images from seven types of Indonesian fruit have been used to validate the proposed method using 10-fold cross validation. The experimental result showed that the best classification accuracy of 90.86% was achieved using 256 features of CSD combined with feature selection.

1. Introduction

Fruit recognition from image is an alternative to traditional recognition method [1]. It can be found in various field, such as food industry, food retail, as well as medical [2]. Generally, the steps of fruit recognition from image consist of image acquisition, segmentation, feature extraction and classification. Although fruit image was captured with a same background, several study in fruit recognition from image still employed segmentation step to separate fruit object from its background such that the extracted feature only come from fruit object [2-5]. On the other hand, segmentation step can increase computational time.

Siswantoro, et al. [2], Garcia, et al. [3], Prabuwono, et al. [4], and Koslowski, et al. [6] have proposed a method to recognize natural produce, including fruit, from image. Although the proposed methods achieved a good accuracy, the methods only recognized fruit image containing single object. The other researchers have proposed natural produce recognition from image with multiple objects in one image using the combination of several features and complex classifiers fusion [5, 7, 8]. However, extracting several features and training complex classifiers fusion is a time-consuming process. Convolutional neural network (CNN) was also used in fruit recognition from image [1, 9]. However, the training process of CNN requires not only a computer with high specification but also time-consuming.

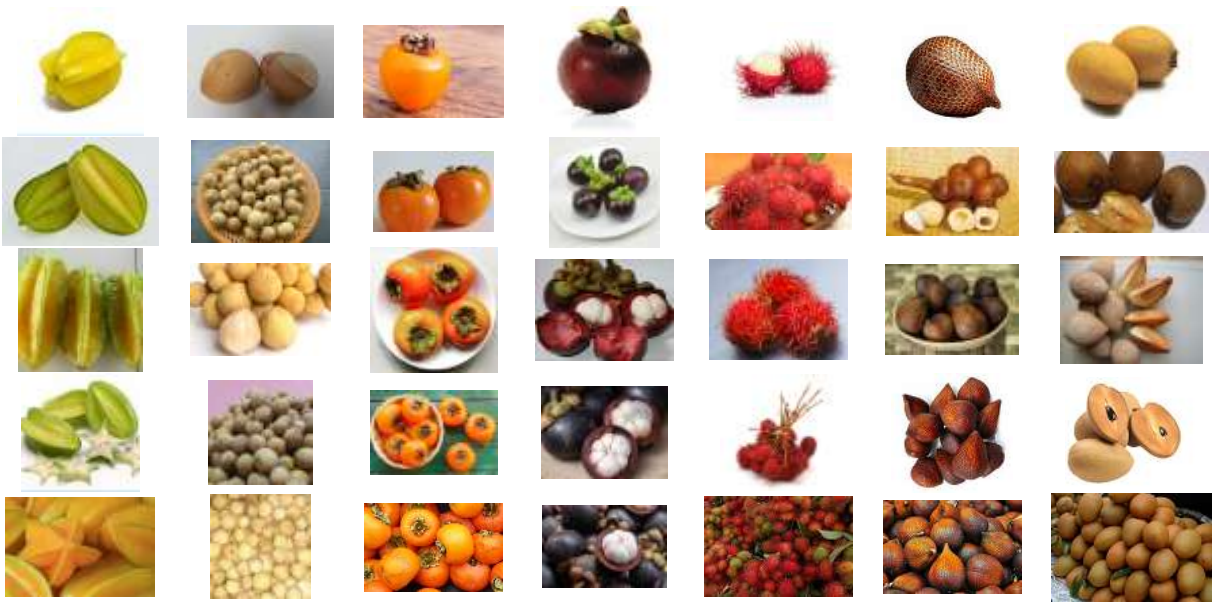
According to Uji [10], there are more than 200 edible fruits that grow in Indonesia. Furthermore, there are many types of Indonesian fruits currently sold at supermarket. Based on these facts, there is a chance to apply Indonesian fruits recognition from image for fruit pricing at supermarket cashier. In the previous studies, the fruit samples used in fruit recognition from image were not specific fruits

from Indonesia. In addition, there are several kinds of Indonesian fruits that have similar color, shape, and texture that were not found in fruit dataset used in previous studies. Therefore, there is a need to develop a method to recognize Indonesian fruits from image that can be applied for fruit sale. This paper proposes an image based Indonesian fruit recognition method using MPEG-7 Color Structure Descriptor (CSD) dan *k*-nearest neighbor classifier. CSD features represent the color structure and color distribution of image that can be directly extracted from image without segmentation process [11]. A variance based feature selection is used to reduce the dimension of CSD as well as to obtain higher recognition performance [12]. The rest of the paper is organized as follow. Section 2 describes the materials used in experiment and explains the steps in the proposed method. Experimental setup is explained in Section 3. Result and discussion are provided in Section 4 and conclusion is drawn in Section 5.

2. Materials and method

2.1. Materials

A fruit image dataset containing seven classes Indonesian fruits, including belimbing (start fruit, *Averrhoa carambola*), duku (*Lansium domesticum*), kesemek (persimmon, *Diospyros kaki*), manggis (mangosteen, *Garcinia mangostana*), rambutan (*Nephelium lappaceum*), salak (*Salacca zalacca*), and sawo (*Manilkara zapota*), was used to validate the proposed method. The dataset was collected from Google Images using keyword "belimbing", "duku", "kesemek", "manggis", "rambutan", "salak", and "sawo". Every fruit class contained 50 fruit images in RGB (Red, Green, Blue) and saved in PNG (Portable Graphics Format) file. Totally, there were totally 350 fruit images in the dataset. The images in the dataset varied in size, the number of fruits, background color, and brightness. The size of image varied ranging from 201,600 pixels until 1,920,000 pixels. The number of fruits in an image also varied from one fruit until all area in the image covered by fruits. In general, almost all fruit images were captured in white background. However, there were some images captured in different background color. Furthermore, some fruits ware placed on a plate during image acquisition. Figure 1 shows the examples of image fruit in the dataset.



(a) (b) (c) (d) (e) (f) (g)

Figure 1. The examples of image fruit in the dataset: (a) belimbing, (b) duku, (c) kesemek, (d) manggis, (e), rambutan, (f) salak, and (g) sawo.

The proposed method was implemented in an Intel® Core™ i7-8550U CPU @ 1.80GHz 2.00 GHz with Windows 10 Pro 64-bit Operating System, x64-based processor and 8 GB RAM. Python 3.7.3

programming language was used to implement the proposed method with an open source computer vision library OpenCV 2.3.1 [13] for image processing and a machine learning library scikit-learn 0.20.3 [12] for classification. In addition, the proposed method also employed MPEG-7 Low Level Feature Extraction Static/Dynamic Library [14] to extract MPEG-7 CSD features.

2.2. Proposed method

The proposed Indonesia fruit recognition method comprised a series of steps started with features extraction followed by feature selection, and classification. The detail of every step is explained in the following sub sections.

2.2.1. Features extraction. In this step MPEG-7 CSD features were extracted directly from a fruit image without pre-processing and segmentation steps. CSD features describe the local color structure and color distribution of an image extracted in HMMD (Hue, Max, Min, Diff) color space. The values of Max, Min, Diff, and Hue were obtained from R, G, B values in RGB color space using equations (Error! Bookmark not defined.), (Error! Bookmark not defined.), (Error! Bookmark not defined.), and (Error! Bookmark not defined.) respectively [11].

$$Max = \max(R, G, B) \#(\text{Error! Bookmark not defined.})$$

$$Min = \min(R, G, B) \#(\text{Error! Bookmark not defined.})$$

$$Diff = Max - Min \#(\text{Error! Bookmark not defined.})$$

$$Hue = \begin{cases} 0, Max = Min \\ \dfrac{60(G-B)}{Diff}, Max = R \,\&\, G \geq B \\ 360 + \dfrac{60(G-B)}{Diff}, Max = R \,\&\, G < B \\ \dfrac{60(2+B-R)}{Diff}, Max = G \\ \dfrac{60(4+R-G)}{Diff}, othewise \end{cases} \#(\text{Error! Bookmark not defined.})$$

Suppose M is the number of nonuniformly quantization of HMMD color space. CSD features were constructed by sliding an 8×8 structuring element to every position in the image to obtain an M-bin histogram by calculating the number of colors $c_i, i = 1,2, \dots, M$ covered by the structuring element. This procedure resulted CSD features of length M. The values of M used in the proposed method were 32, 64, 128, and 256.

2.2.2. Feature selection. Feature selection is a process to exclude unimportant feature(s) from feature space. The purposes of feature selection are to reduce the dimension of feature space as well as to increase classification performance [15, 16]. A simple statistical based feature selection method called low variance feature selection [12, 16] was used in the proposed method to find the most important features for fruit image classification. Features with variance less than a certain threshold value were omitted from feature space. The value of threshold was heuristically determined during experiment in the range of $[50,1050]$ with increasing of 50, such that higher classification accuracy is achieved.

2.2.3. Classification. The proposed method employed *k*-nearest neighbour (*k*-NN) to recognize a fruit image based on CSD feature. *k*-NN is a simple classifier that work by classifying an unknown input data to a class which has highest number of objects among the *k* training data in the neighbor of input data [15]. Suppose $\mathbf{f}$ is CSD feature extracted from unknown input image, and $\mathbf{f}_1, \mathbf{f}_2, \dots, \mathbf{f}_n$ are CSD features extracted from n training data. The following steps were used to classify an unknown input image using *k*-NN.

- Calculate the distance between $\mathbf{f}$ and $\mathbf{f}_1, \mathbf{f}_2, \dots, \mathbf{f}_n$ namely $d(\mathbf{f}, \mathbf{f}_1), d(\mathbf{f}, \mathbf{f}_2), \dots, d(\mathbf{f}, \mathbf{f}_n)$, respectively. The proposed method used Euclidean distance to measure the distance between

two features. Euclidean distance between $\mathbf{f} = (f_1, f_2, \dots, f_M)$ and $\mathbf{f}_i = (f_{i1}, f_{i2}, \dots, f_{iM})$, for $i = 1,2, \dots, n$, is calculated using equation (5).

$$d(\boldsymbol{f}, \boldsymbol{f}_i) = \left(\sum_{j=1}^{M} (f_j - f_{ij})^2 \right)^{\frac{1}{2}} \#(5)$$

- Choose k smallest distances and arrange the distances from smallest to larger to obtain $\{\mathbf{f}_{i_1}, \mathbf{f}_{i_2}, \dots, \mathbf{f}_{i_k}\}$ with $d(\mathbf{f}, \mathbf{f}_{i_1}) \leq d(\mathbf{f}, \mathbf{f}_{i_2}) \leq \cdots \leq d(\mathbf{f}, \mathbf{f}_{i_k}) \leq d(\mathbf{f}, \mathbf{f}_{i_{k+1}}) \leq \cdots \leq d(\mathbf{f}, \mathbf{f}_{i_n})$.
- Assign the input image to a class *c* such that $\{\mathbf{f}_{i_1}, \mathbf{f}_{i_2}, \dots, \mathbf{f}_{i_k}\}$ majority containing the features of training images from class *c*.

In this study, the value of *k* was also heuristically determined during experiment in the range of [1,10], such that higher classification accuracy is achieved.

3. Experimental setup

An experiment has been performed to validate the proposed fruit image recognition method with two experiment scenarios. In the first scenario, *k*-NN classifier was trained and tested using full length CSD features extracted from fruit image, while in the second scenario the feature selection was performed to CSD features before used to train and test *k*-NN classifier. In both scenarios, stratified 10-fold cross validation [15] was employed to measure the performance of *k*-NN classifier. The fruit image dataset was partitioned into 10 mutually exclusive subsets having same cardinality using stratified random sampling without replacement, such that every subset has the number of fruit images from every class with same proportion. In training and testing *k*-NN classifier, nine subsets (315 images) were used as training dataset and the remaining (35 images) as testing dataset. The training and testing processes were repeated 10 times such that every subset is used as testing dataset once.

On i^{th} testing process, the accuracy of *k*-NN classifier was measured using equation (Error! Bookmark not defined.),

$$Accuracy_i = \frac{\#\ correcly\ classified\ fruit\ image\ in\ i^{th}\ testing\ dataset}{\#\ fruit\ image\ in\ i^{th}\ testing\ dataset} \times 100\% \#(\text{Error! Bookmark not define}$$

for $i = 1,2, \dots, 10$. The final accuracy of *k*-NN classifier was obtained by calculating the average of $Accuracy_i, i = 1,2, \dots, 10$. For further analysis, the confusion matrix [17] of *k*-NN classifier was also determined to analyze the performance of *k*-NN classifier in every class.

4. Result and discussion

The classification accuracy of *k*-NN classifier in the various value of *k* with the first experiment scenario is depicted in Figure 2. As can be seen in Figure 2 the highest classification accuracy was obtained at $k = 1$ for all CSD features. For $k = 1$, *k*-NN classifier achieved highest classification of 84.86% when trained using CSD256 compared to CSD128 (81.71%), CSD64 (80.57%) and CSD32 (73.71%). For $2 \leq k \leq 10$, the classification accuracy of *k*-NN classifier fluctuated between 67% and 81%, with highest accuracy was still achieved when trained using CSD256. This can happen since the more CSD features are extracted, the more detail the color structure used in classification.

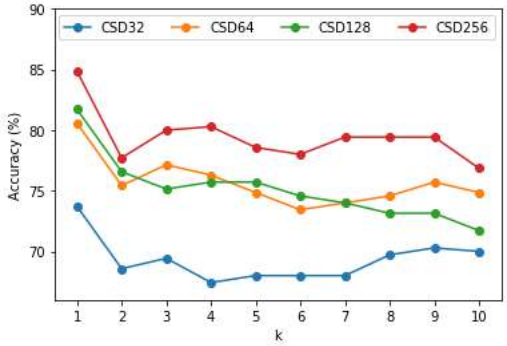


Figure 2. The classification accuracy result with the first experiment scenario.

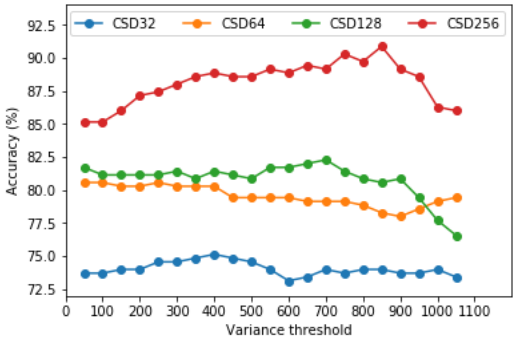


Figure 3. The classification accuracy result with the second experiment scenario

Figure 3 shows the classification accuracy with the second experiment scenario. In this scenario *k*-NN classifier used $k = 1$ and was trained using CSD combined with low variance feature selection. As can be seen in Figure 3, the highest classification accuracy of 90.86% was achieved when *k*-NN classifier trained using CSD256 and low variance feature selection with threshold value of 850. For CSD128, CSD64, and CSD 32, the highest classification accuracy of 82.29%, 80.57%, and 75.14% were obtained when combined with low variance feature selection with threshold value of 700, 50, and 400, respectively. This result shows that by employing low variance feature selection, the classification accuracy is increased except for CSD64. For CSD256, low variance feature selection could increase the classification accuracy of *k*-NN classifier by 6% and could reduce the dimension of CSD256 up to 89.45% (from 256 to 27). Furthermore, low variance feature selection could reduce average training time from 77.45ms to 50.11ms.

The normalized confusion matrix of *k*-NN classifier ($k = 1$) trained with CSD256 combined with low variance feature selection for every class is depicted in Figure 4. The diagonal elements of confusion matrix in Figure 4 represent the percentage of fruit images that can be correctly recognized (recognition rate) for every class. The highest recognition rate of 96% was achieved in 1st class (belimbing), followed by 4th class (manggis) 92%, 5th class (rambutan) 92%, 6th class (salak) 90%, 7th class (sawo) 90%, 2nd class (duku) 88%, and 3rd class (kesemek) 88%. The element in i^{th} row and j^{th} column, for $i \neq j$, represents the percentage of fruit images in i^{th} class recognized as j^{th} class (misrecognition rate). For 1st class there were 4% of fruit images recognized as 3rd class. For 2nd class there were 2% fruit image recognized as 3rd class and 10% as 7th class. For 3rd class there were 4% fruit images recognized as 1st class, 2% as 2nd class, and 6% as 7th class. For 4th class there were 2% fruit image recognized as 5th class and 6% as 6th class. For 5th class there were 2% fruit image recognized as 3rd class and 6% as 4th class. For 6th class there were 4% fruit images recognized as 4th class, 4% as 5th class, and 2% as 7th class. For 7th class there were 8% fruit image recognized as 2rd class and 2% as 3rd class. The misrecognition occurred since the color of some fruit from a class is similar to the color of fruit from other class. Therefore, the using of other MPEG-7 descriptors can be considered to reduce misrecognition rate in the next study.

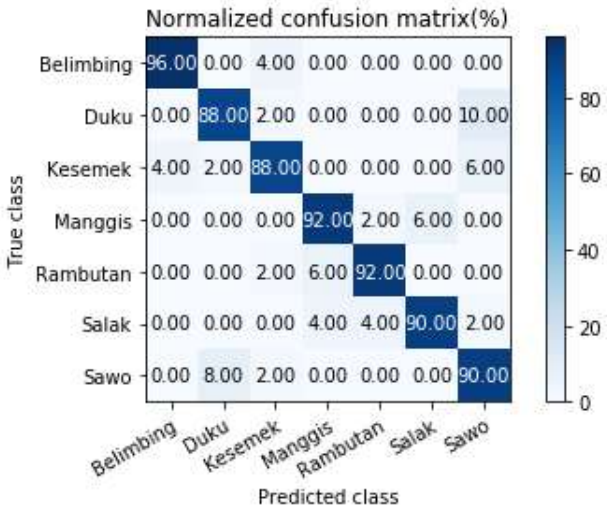


Figure 4. The Confusion matrix of *k*-NN classifier ($k = 1$) trained with CSD256 combined with low variance feature selection

For comparison, the proposed method was also employed to classify natural produce images dataset used by Siswantoro, et al. [2] . The dataset consists of 10 classes including red delicious apple, green apple, potato, orange, tomato, mango, egg, pear Ya, pear Peckham, and carrot. The proposed method achieved the classification accuracy of 95.20% in classifying natural produce images the dataset. In previous study, Siswantoro, et al. [2] extracted 16 features from each natural produce image. The features consisted of 12 statistical color features, including mean, standard deviation, skewness, and kurtosis in HSV color space; and four shape features from the derivative of radius function. The classification accuracy of 77.40% was obtained using *k*-NN classifier. This result indicates that the proposed method outperforms the classification result of previous study.

In term of computational time, the proposed method needed about 45ms to extract CSD features from a fruit image. For recognizing a fruit image based on extracted CSD features the proposed method needed 0.98ms. Therefore, the total time needed to recognize a fruit image was 45.98ms. This result shows that there is a possibility to apply the proposed method for identifying the type of fruit during pricing at supermarket cashier.

5. Conclusion

This study proposes a method to recognize Indonesian fruits from image. The proposed method employed MPEG-7 CSD features with the length of 32, 64, 128 and 256 as input for *k*-NN classifier to recognize the class of fruit image. Low variance feature selection was also applied to CSD features before used by *k*-NN classifier to reduce the dimension of features space and to increase the classification accuracy. The proposed method has been validated using 350 Indonesian fruit images from seven classes. The highest classification accuracy of 90.86% was obtained by using *k*-NN classifier with CSD256 combined with low variance feature selection. The using of feature selection could reduce the dimension of features space up to 89.45% and increase classification accuracy by 6%. Future study will be focused on the developing of Indonesian fruit images dataset and the investigation of other MPEG-7 descriptors and other simple classifiers to recognize fruit images in the developed dataset.

Acknowledgments

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The design of android-based application for museum guide information system using beacon technology

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Abstract. Surabaya is the second largest city in Indonesia after state capital of Indonesia DKI Jakarta. Surabaya as the capital city of east java province is also known as city of heroes to recalling many heroic events during national revolution of Indonesia. In order to memorize many monumental and historical event, Surabaya's government has built several museums. Museum Surabaya in one of museum in Surabaya that has historical objects collection of Surabaya's development. This museum is inaugurated by Tri Risma Harini, as Mayor of Surabaya, in May 2015. So far, Museum Surabaya has many visitors. But unfortunately, they just came to look around the object of the museum while taking pictures of themselves without being interested more to discover stories behind the objects. Management of the museum has only prepared some boards of information for every object being displayed that not interested enough for the visitors to read. Besides, the differences time arrival of the visitors caused the management difficulties in providing official museum guide to depict stories behind every historical object to the visitors. This has become a common problem for many museums. Regard to the manner of today's people, as they become familiar with the use of smartphone technology, the design of android based application using beacon technology can be developed as an information system that assists interactively museum visitors. Visitors have to install this application on their smartphone to get some features like pop-up information of the object being displayed when they approach those object's area at Museum Surabaya. To attract the attention of the visitor, this pop-up information displayed in the form of text, image and also video. For future opportunities to museum management, this application makes possible for the visitor to make a reservation of their individual or group visit regard to the level of occupancy that provided by the application, on the day they will plan to visit. This information may also describe as graphical report that will be useful to museum management in order to make some managerial decisions. This application also provides information about incoming museum's events for the visitor, so it may attract the visitor to come to the museum again.

1. Introduction

Surabaya is the second largest city in Indonesia after state capital of Indonesia DKI Jakarta. Surabaya as the capital city of east java province is also known as city of heroes to recalling many heroic events during national revolution of Indonesia. In order to memorize many monumental and historical event, Surabaya's government has built several museums. Government Regulation of Republic Indonesia No. 66/2015 states that the museum is an institution, a place of storage, maintenance, security and

utilization of material evidence as results of human culture and nature and its environment in order to support protection and preservation the wealth of national culture[1].

Museum Surabaya in one of museum in Surabaya that has historical objects collection of Surabaya's development. This museum is inaugurated by Tri Risma Harini, as Mayor of Surabaya, in May 2015.

So far, Museum Surabaya has many visitors. Literally, they came to discover Surabaya's historical objects. But since management of Museum Surabaya has only prepared some boards of information for every object being displayed, it seems that some visitors did not interest enough to read the information, especially the visitors which classified as millennial generations. The results of a study conducted by the Boston Consulting Group (BCG) with the University of Berkley in 2011 in the United States [2] about millennial generation USA state that the interest in conventional reading has now declined due to Millennial Generation prefers to read through their smartphone. This cause some visitors are just coming to look around the object of the museum while taking pictures of themselves without being interested more to discover stories behind the objects. The differences time arrival of the visitors also becomes a reason for the management difficulties in providing official museum guide to depict stories behind every historical object. Actually, this condition has become a common problem for many museums.

Based on data compiled by the Ministry of Communication and Information of the Republic of Indonesia [3], the level of internet users in Indonesia almost 50% in 2018. This condition is supported by the improvement of the internet infrastructure built by the Indonesian Government. According to the data presented in OkeZoneFinance [4], Indonesian has occupied the 4th level in terms of smartphone users. Meanwhile according to the Ministry of Women's Empowerment and Child Protection and Statistic Centre Department [5] as written in their book entitled Thematic Gender Statistics: Profile of Millennial Generations of Indonesia states that 91.62% of millennial generation both in urban and rural areas have used cellphones and 56.42% of them have familiar in accessing the Internet including mobile application as part of smartphone technology.

Regard to the manner of today's people especially the millennial generation as one of its target market, as they become familiar with the use of smartphone technology, the design of Android-based application using beacon technology can be developed as an information system that assists interactively museum visitors.

2. Research Method

This research is classified as Applied Research since it offers a practical solution for the research object. The institution that takes part as the research object is Management of Museum Surabaya. Besides, the museum visitors especially those from the millennial generation also get involved as the object research. The research is aimed to develop a design for Android-based application using beacon technology which implemented as an information system that assists interactively museum visitors. According to the software development life cycle, to produce a proper system design, this research must be preceded by the analysis step. Analysis step attempt to discover users requirements. Requirement discovery methods used in analysis step are observation and interview. Observation aimed to understand business process of museum surabaya and visitor behaviour. Problem recognition obtained from interview with the museum management and some visitors. From this analysis step, several user requirements are identified. System design is then developed regards to user requirement produced by the previous step. The system design consists of a database design modeled by ER Diagram, process design modeled by use case diagram, and user interface design.

3. Experimental Research

According to software development life cycle steps, analysis and design phase need to be done to yield a good software system. This following analysis and design result would be a basis for developing the system in the subsequent research.

3.1. System Anlysis

Museum Surabaya collects many historical objects that are generally owned by the city of Surabaya from the 1800s to the present. The Surabaya Museum is managed by the Surabaya City Government and was inaugurated in May 2015 ago. At this time, museum Surabaya runs its business processes conventionally like any other conventional museum. To get information the object that is being displayed, visitors have to read board of information near the object that has been prepared by Museum Surabaya management. On the entrance to the Museum Surabaya, there is a guest book and the visitors are expected to write any criticism, suggestions, and opinions about Museum Surabaya. In any certain times, Museum Surabaya may organize several kinds of events. Visitors can get these events information by reading promotional posters on the Museum Surabaya billboard. At this time, Museum Surabaya does not charge any entrance fee to the visitor. Thus, Museum Surabaya management cannot figure out the statistical visit data. This statistical data actually might be used to take various managerial decisions of Museum Surabaya.

Currently, numbers and distribution of millennials generation are quite dominating. Based on data compiled by the Ministry of Communication and Information of the Republic of Indonesia[3] , this millennials generation that is defined as citizens in the age range of 20 to 40 years old reaching around 88 million people or about 33,75% of Indonesian population. This proportion is even greater than Generation X and Baby Boomer as the previous generation or Post Millennial Generation as shown in figure 1.



Figure 1. Distribution of indonesian generation

Regard to this condition, Museum Surabaya should consider this millennial generation as their initial target market. So that the millennial generation needs must be well-provided during their visit. One of initial characteristics of this millennials is their trend to retrieve information using the smartphone compared to reading the information conventionally. This fact certainly not in line with current facilities in the Museum Surabaya, where information is displayed in text or asking the Surabaya Museum staff. At this moment, information text potentially become a problem because of the text size and position that is less convenience to access. Meanwhile, museum staff unable to guide every visitors during their visit because of the limited number of museum staff. So that an Android-based museum information system application is expected to facilitate the needs of visitors. This system can also be used as a guide when visiting the Museum Surabaya. Visitors have to install this application on their smartphone to get some features like pop-up information of the object being displayed when they approach those object's area at Museum Surabaya. To attract the attention of the visitor, this pop-up information displayed in the form of text, image and also video. For future opportunities to museum management, this application makes possible for the visitor to make a reservation of their individual or group visit regard to the level of occupancy that provided by the application, on the day they will plan to visit. This information may also describe as graphical reports that will be useful to museum management in order to make some managerial decisions. This

application also provides information about incoming museum's events for the visitor, so it may attract the visitor to come to the museum again.

4. System Design

System Design is described in several ways that are process design using Use Case Diagram, data design using Entity-Relationship (ER) Notation and user interface design.

Application is designed for two user roles: admin and visitor. Admin has several rights such as to create/update/delete Objects of Museum and Events, and to verify payment and to update ticket status. The visitor has the right to purchase tickets, to see data visit graph and events, to see historical object's information and to submit any testimonies like suggestions or critics. Use case diagram of this system's role describes in figure 2.

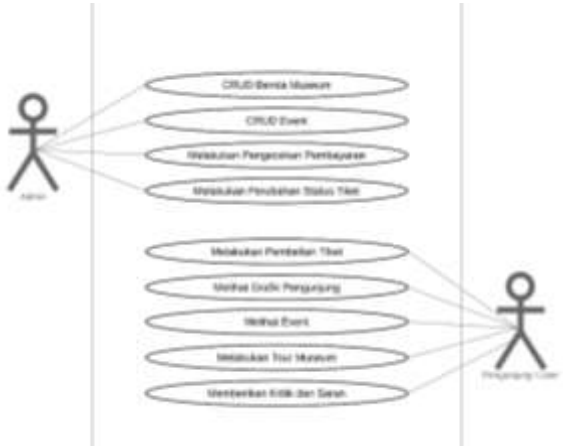


Figure 2. Use case diagram of the system

This application consists of 8 main entities, each of which has a primary key attribute named ID. These entities are barangs, cubeacons, events, category_barangs, critic_sarans, notas, visitorss, status_tiket, tikets, and users. figure 3 describes the Entity Relationship Diagram of the system.

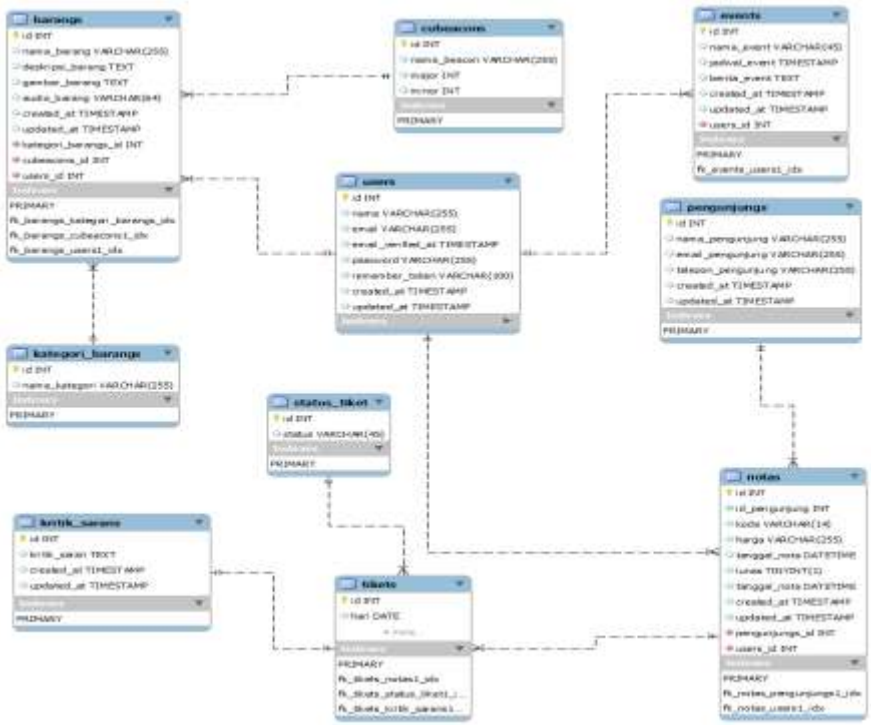


Figure 3. Entity relationship diagram of the system

Figure 4 and figure 5 illustrate the historical object information from the user perspective. First, visitors have to activate Bluetooth on their smartphone so that the smartphone will connect with the beacon. Once after the connection is established, visitors will accept pop-up notifications about various historical objects within about 3 m radius around him, according to the position of the visitor. Figure 5 is a display design when a visitor chooses one of the objects listed on the previous page as describes at figure 4. Here visitors are provided with objects description in text, several objects pictures, and video accompanied by the objects descriptions in sound that can be heard through the visitor's android device.



Figure 4. User interface design of object information captured by smartphone



Figure 5. User interface design of certain object Information

5. Conclusion

From the results of the analysis and design of this application, will be expected as the basis for application development. With this application, visitors are provided with some information about museum objects museum and also other information about museum activities and events interactively through their smartphones. This application is expected to facilitate visitor needs, especially the millennial generation. In terms of museum management, besides some critics and suggestions information from visitors, the visit data also can be recorded so that it can help managerial decision making.

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Virtual reality app on Milky Way solar system, case study: Kebraon II Public Elementary School, Surabaya, East Java, Indonesia

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Abstract. 6th grade students of Kebraon II Public Elementary School at Surabaya, Indonesia, learn the introduction to astronomy about the solar system. However, they don't understand some basic concepts, such as the differences of rotation and revolution, shape and size of planets and other celestial bodies. In addition, they are not interested in studying astronomy, because of the books consisting of large amount of text and black-and-white still images. To spark the students' interest on astronomy, we create an interactive application which features virtual reality (VR) to introduce astronomy. It features the solar system and other celestial bodies with their information (orbital time, rotation time, revolution time, etc.), as well as solar and lunar eclipse animation and information, in accordance with Indonesia's Ministry of Education 2006 curriculum, KTSP (Kurikulum Tingkat Satuan Pendidikan, School-Based Curriculum). The application is developed for Samsung Gear VR using Unity 5. Users will be able to see the whole solar system and navigate using a Bluetooth-enabled, Android-compatible gamepad, and interact with celestial bodies to see their information. The application is black-box tested to teacher and 10 students. All students are more interested in astronomy, concluding that this app can be used as an alternative medium to introduce astronomy.

1. Introduction

Astronomy is a very broad topic which consists of Solar System [1]. The components of our solar system are the eight planets, Sun, Moon, comets, meteoroids, asteroids, and other celestial bodies. There are also natural phenomena in our solar system, such as solar and lunar eclipse. These celestial bodies form a galaxy, such as our galaxy Milky Way.

The curriculum for 6th grade elementary school in Indonesia includes astronomy as one topic to study for natural science class. The selected topics for astronomy are Solar System, planets (along with their characteristics such as orbital time, rotation time, revolution time, mass, diameter, distance from Sun, temperature, number of natural satellites), asteroids, meteoroids, comets, and solar/lunar eclipse. However, the books [1] and [2] do not provide figures for individual planets and celestial bodies. There are only Solar System figures within the books. They are even presented in black/white, although the books are in full color, as seen on Figure 1. This results in confusion among students because they cannot figure out what the planets look like in real life.

Lack of appropriate figures and tools to represent planets and celestial bodies results in less interest from students to learn and understand astronomy. Therefore, in this research, we aim to spark their interest in astronomy by developing an interactive application by mean of virtual reality. This application will comply with Indonesia's Ministry of Education 2006 curriculum for 6th grade.

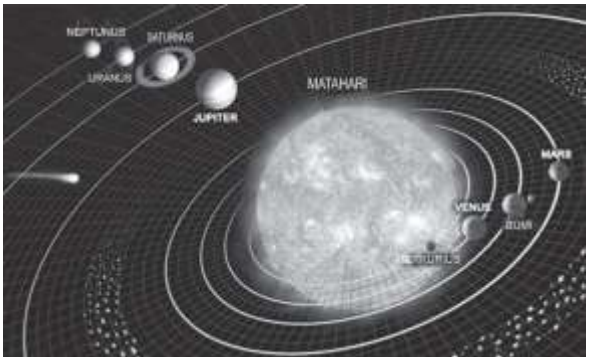


Figure 1. Example of figure showing the formation of Solar System

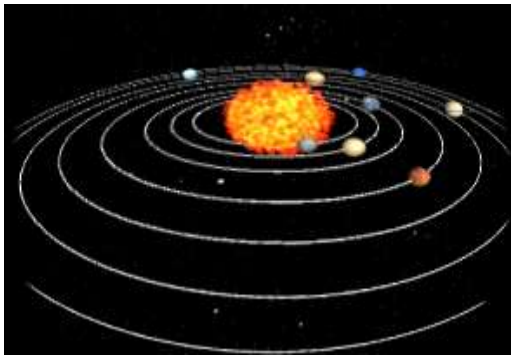


Figure 2. Screenshot of solar system app used for comparison

2. Methodology

We will use a case study of 6th grade students from Kebraon II Public Elementary School (Sekolah Dasar Negeri Kebraon II) at Surabaya, East Java, Indonesia. While developing the application, we conform with the software development life cycle, which are planning, analysis, design, implementation, and testing. Before development, we collect specific data related to the application we are developing, such as astronomy topics for the 6th grade students, VR, and similar or related works. During the analysis phase, we interview a 6th grade teacher as well as 6th grade students of Kebraon II Public Elementary School to discover issues we want to solve with the application. Because of the broad nature of astronomy, we carefully select celestial bodies which conforms with KTSP (Kurikulum Tingkat Satuan Pendidikan, or School-Based Curriculum, also known as 2006 curriculum) as required by Indonesia's Ministry of Education. We do this by selecting two books used by the teacher to teach astronomy to her students. These books will be used as basis of material. We also do research on VR and what medium to implement. After analysis, we design the application by designing the flow of material presented within our app, as well as the interface flow. We develop prototypes to quickly evaluate our design before implementing the app in the next step. Results from the final prototype are then implemented using the help of Unity3D, Samsung Gear VR SDK, and T2S (text-to-speech) for the voiceover. Finally, we perform a black-box testing with teacher and 6th grade students of Kebraon II Public Elementary School. We test our application by randomly sample 10 students, use our app, and fill in a questionnaire about aspects of the app. We end the research by summarizing the results and writing documentation for future use and research for those interested in this topic.

3. Literature Review

Although there are many forms of educational apps, we decided to use VR for this topic, as VR can be used to enhance core curriculum subjects [3]. VR enables students to be engaged with the topic using their multiple senses, as VR provides immersiveness to the virtual world. Students can interact with various aspects of the virtual world, enabling them to retain the material.

When we began this research, there were some completed researches on the same subject. One research [4] was conducted on a different sample domain and yielded fair result. The VR app was developed for Android smartphones with help of Google Cardboard. Figure 2 shows the Solar System from a top-down camera. The app was deemed quite difficult to use since users had to target the UI button with their head and moved the magnet on the side of Google Cardboard to click the button. This mean of navigation was not comfortable, especially when answering the quiz provided in-app. The planet models were too small from the user's point of view; however, users must interact with them to be able to see information about specific planet. Another similar VR app in solar system was developed with good result [5], however there were too many bodies of text, as if they were copied from the textbooks. We argue that a very long body of text is not appropriate for a VR application, as

it will reduce the immersiveness and is not different than reading books. A research developed VR of mathematics for elementary school [6], which had 80.84% satisfactory rate, claimed that VR development, especially in education, was not abundant in Indonesia and still dominated by VR games.

4. Result and Discussion

Based on literature review, we decided to perform a similar research on VR app on Solar system but with different approach. Aside of the different sample domain, we use a different platform, Samsung Gear VR (SM-R323), as shown in Figure 3. Although this severely limits the range of our market by only allowing Samsung Galaxy S6 (and above) and Galaxy Note 5 (and above) [7], we believe the smartphone capability of performing VR with more power will compensate our limited market. To make the interaction easier, we opted to use a Bluetooth-enabled, Android-compatible gamepad for UI navigation as well as some of user navigation in-app. The joystick we use is Steelseries Stratus XL as can be seen on Figure 5. Users will still be able to look around with the headgear, but they only need to press a button in the gamepad to click a button.



Figure 3. Samsung Galaxy VR (SM-R323)



Figure 4. Steelseries Stratus XL Bluetooth joystick

After we decided on the platform, we started our own research by searching for current issues with the students. We interviewed a teacher of Kebraon II Public Elementary School. She uses book as the main medium of education in the school. The main disadvantage of book is the blurry or unclear figures (as discussed previously). Therefore, she has hard times to attract students when studying astronomy. Students easily get bored by just sitting and listening to the teacher, reading, and looking at still figures from the book. From the interview, it is revealed that students struggle to grasp the idea of rotation, revolution, shape and size of eight planets and other celestial bodies. She did not use any tools to represent rotation and revolution, thus the students' confusion. Furthermore, this resulted in students disinterest of astronomy. Interviews to 10 students revealed similar results. Therefore, we want to help students better understand and get interested in astronomy by developing an interactive educational app, with help of VR.

In design phase, we select the materials to be included in our app. By using two textbooks as sources, we decided to select all eight planets, meteoroids, asteroids, comets, Sun, and Moon as celestial bodies to be modeled and explained in our app. For historical reason, we also include Pluto as the "ninth planet", although in the information later it will be classified as a dwarf planet, to adhere to IAU definition of a planet [8] and NASA's classification of Pluto as a dwarf planet [9]. To help students understand the shapes of each planet, we use high definition maps from James Hastings-Trew which are derived from NASA and other reliable sources. The planets will also be modeled in proportional scale according to their real size. Information about each planet includes orbital time, rotation time, revolution time, mass, diameter, atmosphere condition, distance from Sun, temperature, and number of natural satellites. We also include common-but-rare natural phenomena, which are solar and lunar eclipse. Sun, Moon, and Earth will be positioned accordingly and move until eclipse happens. When it does, users will be notified to press a button to view more information, such as why and how eclipse happens. As VR app is still scarce in Indonesia, we feel the urge to have a dedicated tutorial section within our app, so users will have minimal difficulty of using our app. Ambient sounds will be added in all scenes to help users relax while exploring the Solar System. In this stage, an interface flow diagram helps us determine how many screens we need and how to transition between screens, as illustrated in Figure 5. Each celestial body has its own information screen, but their screens

are compacted in Figure 5 to simplify the diagram, as we have numerous celestial bodies and they in fact follow the same flow.

When all design is complete, the app is then implemented in Unity 5 with help of Oculus Gear VR SDK. All planet textures are imported to Unity, then materials are created for each texture. Planets are formed by simply using Unity's primitive sphere and applying their respective materials. A rotation script is then attached to each planet with respect to its rotational speed. Revolution script is also attached to each planet so that they will revolve around the Sun. To help students easily find all planets when they start the simulation, all planets are aligned within a straight line from the Sun. All other celestial bodies are created in a similar manner but without the rotation script. For comets, we add a trail renderer component to simulate its tail. Solar and lunar eclipse screen are created in a similar manner, but the system will detect when the Sun, Moon, and Earth are within one straight line to yield an eclipse. Instruction screen is simply a collection of a gamepad image to show button layouts (as someone may never use a gamepad before), Gear VR layout, and some text explaining how to navigate and use our app. Samsung Gear VR has a Back button to exit application, nevertheless we decide not to use it and implement an Exit menu, so users never need to take their hands off the gamepad. This is to create consistency on how to interact with our app, which is solely using a gamepad. Figure 6 shows the Solar System in-app.

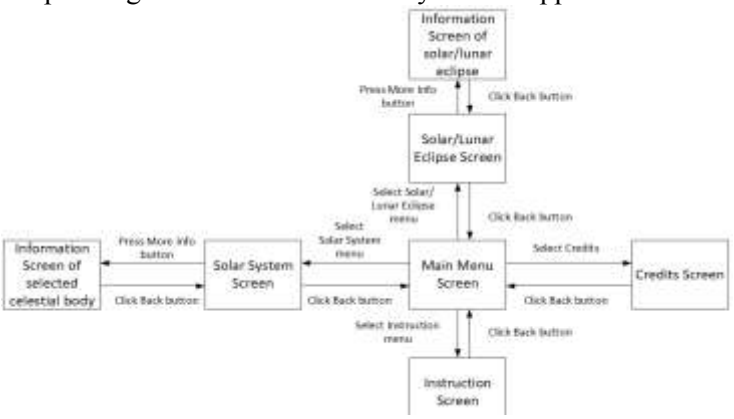


Figure 5. Simplified interface flow diagram

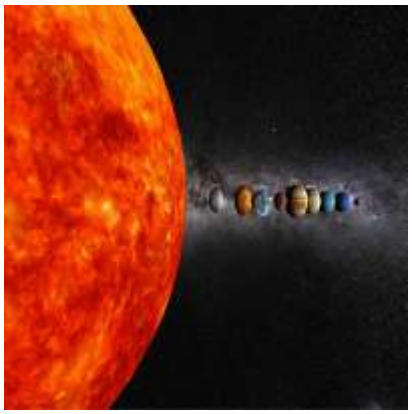


Figure 6. The Solar System screen

When the implementation is complete, it's time to evaluate the app. As the application is intended for Indonesian student, the following figures will be presented in Bahasa Indonesia, with explanations and translation for English readers. Both the teacher and randomly-selected 10 students try our app. They begin by navigating through the main menu as presented in Figure 7. When they choose Solar System formation, they will be presented with the Solar System screen. They may move the camera by using their head to rotate the camera and directional pad or left analog stick to pan the camera. To move forward, they press A button; to move backward, they press X button. This scheme is chosen as directional pad and left analog stick is already used to pan the camera. However, this schema has a drawback. As A button is already used, we cannot use A button as a confirm button, which most game uses. We finally resolve to use Y button as confirm button, with B button still acts as cancel button. When they are within range with a celestial body, they can press Y to enter information screen about the selected celestial body, as shown in Figure 8. The information is also read with the appropriate pre-recorded voiceover, which is just a result from a text-to-speech app.

When they choose Lunar Eclipse, they will be taken to the lunar eclipse screen as can be seen on Figure 9. The camera is above Sun, Earth, and Moon and looks down toward them. When Moon is between Sun and Earth, a text will occur and the animation will stop for a determined time, prompting user to press LT button for more information (Figure 10). After being satisfied with the information, user can press Y button when Back button is highlighted to go back to the previous screen.

There is a substantial problem we are unable to solve. Initially, the custom shader enables us to simulate the real lighting of Sun. All planet faces facing away from the Sun is rendered dark. However, when exported to Android, all planet faces are lit bright, even if they are facing away from

the Sun. We suspect that the custom shader is created with DirectX (Windows), therefore it is not compatible with Android (which uses OpenGL ES [10]) and disabled when our app is exported to Android.



Figure 7. Main menu. From top to bottom: (title) *Solar System*, (menu) *Solar System formation, solar eclipse, lunar eclipse, instruction, credits, exit*.



Figure 8. Planet information screen. In this screen, Mercury is displayed.



Figure 9. Lunar eclipse screen. *Matahari* is the Indonesian word for the Sun.



Figure 10. On-screen prompt when lunar eclipse occurs. The prompt reads: (top) *A lunar eclipse occurs.* (bottom) *Press [LT] button to see more information about lunar eclipse.*

After trying the app, we conduct an interview with the teacher. According to the teacher, the app is easy to understand with the help of instruction screen, although she never uses a gamepad and VR app beforehand. The topics presented already conform with KTSP. She thinks that this app can be used as an alternative medium aside from books when explaining about astronomy, to gain students' interest on the subject. However, she has concern about the cost of additional tools required for this app. As per May 10, 2019 (prices are taken from various Indonesian online shops, such as Lazada and Tokopedia), a Samsung Galaxy S6 costs approximately 2.6 million Indonesian rupiahs (USD 180, using the currency rate of IDR 1 = USD 6.9×10^{-5}), a Samsung Gear VR costs approximately 1.5 million rupiahs (USD 104), and a Bluetooth-enabled, Android-compatible gamepad costs around 750 thousand rupiahs (USD 52). She hopes the Indonesian government is willing to provide the cost for our VR app. She also suggests creating another VR app for various topic; however, it is beyond the scope of our research.

The validation is also conducted to students. We randomly select 10 students to use our app and let them fill in a simple questionnaire to find out whether they find our app useful. The questionnaire consists of five statements. For each statement, student must choose if they strongly disagree, disagree, agree, strongly agree, or have neutral thought about. Table 1 summarizes the findings. Overall, we conclude that students like our app. To our surprise, one student dislikes VR and rather chooses books. The reason is simply because she feels that using a VR headset is not practical at all, compared to

directly reading a book, which needs no additional tool. Two students stand in a neutral position over VR because they have motion sickness when using the app. In subject of information clarity, two students feel that the information presented in-app is less rich than the book counterpart, so they still don't understand about the subject.

Table 1. Student questionnaire result. Ten students participate in this questionnaire.

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This app is easy to understand and use	0%	0%	0%	30%	70%
It's easier to recognize celestial bodies using this app than other printed media (book)	0%	0%	0%	10%	90%
You are more interested in astronomy after using this app	0%	0%	0%	60%	40%
With VR, you don't get bored using this app	0%	10%	20%	50%	20%
Information about celestial bodies is clear enough	0%	0%	20%	20%	60%

5. Conclusion

As the research ends, we conclude that our VR app is useful and may be used as alternative medium of teaching astronomy. The information presented in our app conforms with KTSP so 6th grade students may use it alongside the textbook. Although the cost of acquiring the required tools is expensive, the teacher of Kebraon II Public Elementary School feels that this app can spark students' interest on astronomy, broadening their knowledge.

For future improvements, we suggest implementing the correct shader that is compatible with Android to fully simulate Sun's lighting. The instruction screen may be reworked to use less text and more image explaining the navigation. If necessary, the instruction screen may be replaced with an interactive tutorial that may be disabled for advanced users. A more conventional gamepad button mapping may be adjusted to better accommodate more users. The voiceover may also be replaced with real human actors to avoid discomfort of hearing robotic voiceover. Lastly, information may be represented in a more interesting way, rather than in a wall of text.

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Computer vision system in measurement of the volume and mass of egg using the disc method

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Abstract. One important process in egg production is the sorting process to determine the grade of the egg. The volume and mass of egg are the factors needed in this sorting process. But the conventional way to measure egg volume and mass can damage egg and takes a long time. This paper proposes a Computer Vision System (CVS) to measure egg volume and mass quickly, accurately, precisely without damaging the egg. The disc method is a method used to calculate the volume of an object with circular cross section such as an egg. CVS was designed to calculate the volume using the disc method and calculate the egg mass using density and regression models, based on images captured in real time or images that have been captured previously. The validation process is carried out using 50 egg samples by comparing results from proposed method with manual measurements. To compare the time needed by CVS and manual measurement, an average test was used. To test the output accuracy of the volume and mass of egg, relative absolute error, ANOVA test, and correlation test were used. Whereas to test the output precision, the coefficient of variation was used. Based on the results of the testing conducted, CVS in the proposed method successfully measuring the volume and mass of egg quickly, accurately, precisely, without damaging the egg.

1. Introduction

Egg volume and mass are important factors in the egg production process. One process that uses volume and mass of the eggs as its criteria is the sorting process. Because of the importance of knowing the volume and mass of eggs, the calculation method used must be precise and efficient. One method commonly used to measure egg volume is water displacement method, where the volume of spilled water is the same as the volume of eggs put into it. But this method is considered to be less accurate, can damage the eggs, and takes a long time[1]. The using of computer vision system (CVS) is better alternative to existing manual method. Computer Vision System (CVS) can measure accurate, precise, quickly, and non-destructive egg volume [2]. To measure the volume of eggs, the method proposed used is a two-dimensional CVS, where the camera will capture the cross-sectional image of the egg. Assuming that eggs are an axisymmetric object, the egg volume can be calculated by rotating the cross section of an egg around its long axis [3]. We can then use various methods of calculating the volume of solids of revolution, namely the cone method [4], methods based on the Pappus theorem [5], Simpson's rules [6], and the disc method [7][8]. The disc method assumes that the volume of a solid of revolution is the sum of the volume of all the thin cylinders that made up the object. The disc

method used by Bridge et al. [7] to calculate the volume of Florida Scrub-Jay bird eggs. Koc [8] also uses the disc method to calculate the volume of watermelons. The result from study by Bridge [7] shows that the volume calculation is accurate. However, the CSV system used cannot automatically align image obtained parallel to the main axis. This will cost extra time for the user to align the egg manually. The system proposed by Koc [8] was less accurate, because as the size of the watermelon increased, the image processing method overestimated the volume. This was because of the change in distance between the camera and the watermelon surface. Although the distance between the camera and the surface where the object lays was constant, the distance between the watermelon surface and the camera reduced with increasing watermelon size.

Mass has a very close relationship with volume. The information about egg's mass was not only used in the grading process but was also used to determine egg-yolk to egg ratio, eggshell thickness, and egg hatchability [9]. For egg mass calculations, if the egg volume is known, the egg mass can be obtained from multiplying the volume and density of eggs [5]. In addition, estimation of egg mass can also be done using a linear regression model [9]. This system uses diameter data obtained from digital image processing to estimate the mass of "White Leghorn Line" chicken eggs.

The similar system that has been developed, there is no system that can calculate the volume and mass of objects simultaneously. This study aims to propose a 2D CVS for predicting the volume and mass of egg using disc method from the image of egg. The proposed CSV system can automatically align image obtained parallel to the main axis. The rest of the paper is organized as follow, section 2 explains proposed computer vision system. The experimental results and discussion are provided in Section 3. Conclusion is explained in Section 4.

2. Proposed computer vision system

Computer Vision System proposed consists of hardware part and software apart. Hardware in the system is mainly used to take a picture of the egg. Software in the system is used to process the image captured, and perform mathematical calculations to find the volume and mass of the eggs.

2.1. Hardware part

The hardware consists of a camera, LED lighting, black background, and a computer to operate the software, can be seen in Figure 1. The camera used in this system, is a portable webcam "Logitech C170" with a resolution of 5 MP and connected to a computer via a USB cable. This webcam is also equipped with a clamp, making it easier to place. The webcam is placed 30 cm above the egg, with lighting coming from a 5 watts LED lights placed 40 cm above the webcam. The system uses dark colored cotton fabric. This cover cloth serves to block light from outside the system during the image capture process.

2.2. Software part

The processing phase consists of image capture, initial processing, segmentation, opening-closing, rotation, extracting the size of the egg object, volume calculation using the disc method, and mass calculation.

1. Image Capture. The image capture process is carried out using a portable webcam placed right above the image. The captured image has an RGB color space and is then stored on the hard drive in jpg format with a size of 640 × 480 pixels.
2. Initial processing. Initial processing begins with color transformation of the image from the RGB color space to the gray scale. The filtering process is done using a Gaussian filter with a 7x7 kernel size, aims to clear the image of existing noise.
3. Segmentation. The segmentation process separates object from the background. This process begins with the search for the Threshold (T) value automatically. Pixels in gray scale images that have an intensity greater than T will be recognized as objects (white) with binary value 1, otherwise it will be recognized as a background (black) with binary value 0.

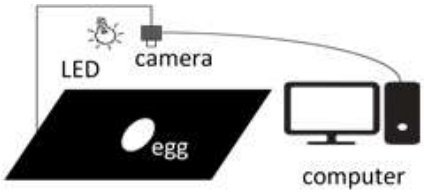


Figure 1. Hardware used in CVS

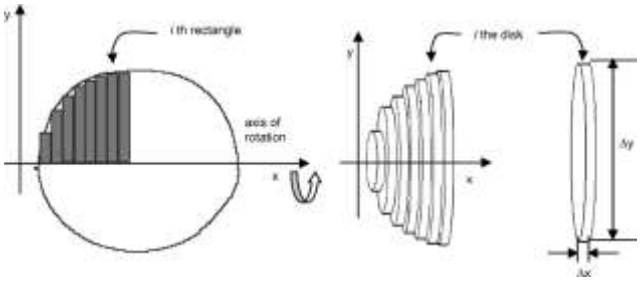


Figure 2a. Cross section of the object divided into n rectangles; b: cylindrical rotation results on the x axis

4. Opening-closing. An opening-closing process is performed to remove white spots on the background and black dots on the foreground.
5. Rotation. An image that was not aligned properly will be rotated until it's axis parallel to the x or y axis.
6. Feature extraction. This process aims to find the major axis and the minor axis of the egg. First, we need to locate the leftmost pixel, the rightmost pixel, the topmost pixel, and lowest pixel of the egg object in the image. The location of the leftmost pixel can be found by scanning the image from the leftmost column (x=0) to the right until the first white pixel found. This will be x_l. The position of the rightmost pixel (x_r), the topmost pixel (y_t), and the lowest pixel (y_l) can be found by similar fashion. The length of the x axis (Δx) is the difference between x_r and x_l. The length of the y axis (Δy) is the difference between y_t and y_l. The major axis is the longest between Δx and Δy.
7. Volume measurement. After the length of the major axis and the minor axis of the egg are known, the calculation of volume using the disc method. Volume measurement can be obtained by dividing the cross section of the object above the major axis into n rectangles with width Δx of 1 pixel and length ½ Δyi with i = 1, 2, 3, ..., n as shown in Figure 2a. Then the rectangles are rotated around the x axis to produce a cylinder with a height of Δx and a cylinder radius of ½ Δyi as shown in Figure 2b.
The volume of egg (V) can be calculated using Eq. 1, with a k scale factor that can be calculated from the ratio of the object length in cm to the object length in pixels (from the image captured by the camera). In this experiment, the scale factor value k obtained from the average scale factor of five randomly selected samples.

$$V = \frac{\pi}{4} k^3 \sum_{i=1}^{n} (\Delta y_i)^2 \quad (1)$$

8. Mass measurement. Mass measurement is done using two methods, namely, using density and linear regression models. Density is a measurement of mass per unit volume of matter. The mass of eggs(m) was determined using volume (V) and density (ρ) by Eq. 2,

$$m = V * \rho \quad (2)$$

Linear regression is a statistical model that serves to predict the value of non-dependent variables (y) based on independent variables (x) (Franklin and Haribaran, 1994). Eq. 3 represents the common equation of linear regression.

$$y = a + bx \quad (3)$$

From 20 randomly selected egg samples, the density are found to be 1.07 gr/ml, and the regression model is

$$y = 7.3148 + 0.448\,x \quad (4)$$

3. Result and discussion

The validation process of proposed method is carried out using 50 egg samples from 9 different angles (0°, 30°, 45°, 60°, 90°, 120°, 135°, 150°, 180°). The result of proposed method will be compared by manual measurement using water displacement for volume and using digital scales for mass.

3.1. Average Test

The average measurement from 9 different angles, the average of measurement from the experiment, and time needed by the proposed method will be compared with manual measurements, as shown in Table 1.

Table 1. The average measurement result

Angle	Volume(ml)	Mass (gr)-density	Mass (gr)-regression	Time (ms)
0°	57.79	61.85	61.91	311.59
30°	57.44	61.48	61.58	315.03
45°	57.11	61.13	61.27	312.52
60°	56.75	60.74	60.93	312.09
90°	56.49	60.46	60.69	316.14
120°	56.50	60.48	60.70	318.5
135°	56.54	60.52	60.74	312.22
150°	56.79	60.79	60.97	313.68
180°	56.99	61.00	61.16	319.52
Average measurement of CVS	56.93	60.94	61.11	314.59
Manual measurement	57.87	61.62	61.62	47962.8

As can be seen in Table 1, the results obtained from the proposed method are very close to the results obtained from manual measurement, with differences less than 1.62% in volume and less than 1.1% in mass on average. The average time to measure the volume and mass of the egg using CVS takes 314.59 ms. This is much faster than the time needed manual measurement of 47962.8 ms. This proves that using CVS to measure egg volume and mass can be done more quickly without damaging the egg.

3.2. Accuration Test

To test the accuracy of the result of the volume and mass of egg measurement using CVS, the relative absolute error, ANNOVA test, and correlation test were used.

3.2.1. Relative absolute error test. The absolute error used in this experiment is the magnitude of the difference between the manual measurement value and the measurement value by CVS. The percent error is the relative error expressed in term of per 100, by following equation:

$$Relative\ absolute\ error = \frac{|manual\ measurement - measurement\ by\ CVS|}{manual\ measurement} * 100\% \quad (5)$$

The relative absolute error test results for this experiment are shown in Figure 3. An experimental result is said to be accurate if it yields a relatively small absolute error value. Based on the experimental results obtained the absolute relative error value is <5%. This proves that the proposed method is accurate.

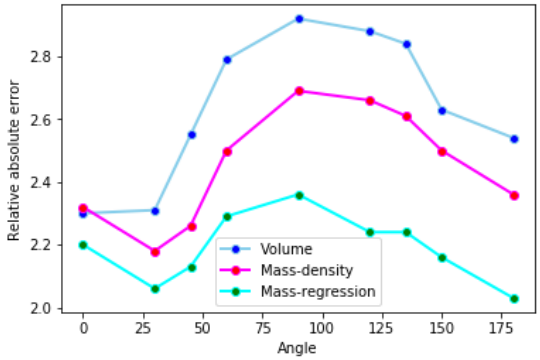


Figure 3. The relative absolute error result

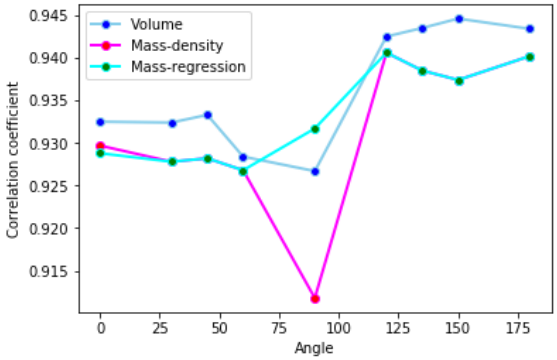


Figure 4. The correlation coefficient result

3.2.2. Correlation test. Correlation is a method of statistical analysis used to measure relationships between variables using a value called the correlation coefficient (R). Two data are said to have a relationship if they have R^2 values that are close to 1. The result of correlation test in this experiment shown as in Figure 4. All the result from this experiment are close to 1. Thus, this proves that data from proposed method calculations have a relationship with manual data measurement.

3.2.3. Anova test. Anova is a statistical methods used to compare the mean of several populations (usually more than 2 populations)[10]. The hypothesis used in ANOVA in this study is:
H0: $\mu_1 = \mu_2 = ... = \mu_{10}$
H1: at least two of the means are not equal
where μ_1 to μ_9 are average measurements from 9 different angles and μ_{10} is manual measurement as shown in Table 1. To test the hypothesis, use the calculation of the f value using Eq. 6, where MK_k is mean square between populations and MK_d is mean square values within population:

$$f = \frac{M_K}{MK_d} \tag{6}$$

H0 is rejected significantly α if the value f> fα, the value of fα can be seen in the distribution table F. The results of Anova test in this experiment are shown in Table 2.

Table 2. The Anova test result

	Volume	Mass-density	Mass-regresion
f	0.357	0.294	0.272
Significant	0.955	0.976	0.982

Significant value of the Anova test for volume is 0.955, for mass data density method is 0.976 and for linear regression method is 0.982, so it can be concluded that H0 failed to be rejected. It proves that mean square values of measurement and calculated results are equal or not different. Thus the proposed method is accurate.

3.3. Precision Test
Coefficient of variation is useful to see the distribution of data from the calculated average, if the percentage of data distribution is small (<1%) it can be stated that the data is precise. The coefficient of variation (CV) is the comparison between standard deviation (s) and the average value $\bar{x}$ expressed in percentage. The coefficient of variation is expressed by the formula,

$$CV = \frac{s}{\bar{x}} * 100\% \quad (6)$$

The overall value of CV of proposed method can be seen in Figure 5. Based on the above equation, the CV value for all data measurement is <1%, so it can be stated that the volume and mass data resulted from this method are precise.

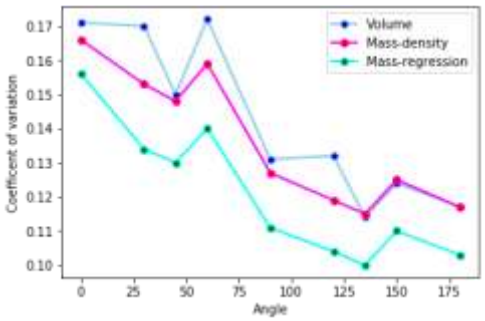


Figure 5. The coefficient of variation result

4. Conclusion

This study proposes a 2D CVS for predicting the volume and mass of an egg using disc method from the image of an egg. The proposed method has been tested using 50 egg samples from 9 different angles (0°, 30°, 45°, 60°, 90°, 120°, 135°, 150°, 180°). The difference in the orientation of the angle of the egg used turned out to yield similar results. Based on the results of the experiments, CVS in the proposed method successfully measuring the volume and mass of eggs quickly, accurately, precisely, and without damaging the egg. The next study will be to develop CVS to calculate the volume and mass of several eggs simultaneously.

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Fraud detection using process mining and analytical hierarchy process with verification rules on erp business process

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Abstract. Today many corporate run their business process by applying Enterprise Resource Planning (ERP). A corporate which has a well-defined business process will run its business process effectively and efficiently. In practice, the executed business process is not always complied with Standard Operational Procedure (SOP). The deviations of the business process can be identified by analyzing event logs from the business process activities using process mining method. The various kinds of deviation are skip activity, wrong throughput time, wrong actor, wrong duty, and wrong decision. But not all deviations are frauds. Hence, Analytical Hierarchy Process and verification rules are employed to analyze the deviations to determine the fraud status. The proposed method successfully detected frauds conducted in the business processes of the bank credit application and procurement process. The proposed method achieved up to 95% accuracy.

1. Introduction

Fraud is viewed as a threatening issue in the world. There have been 2690 fraud cases that have made a loss of US$7 billion from 125 countries in 23 industry categories [1]. On average, organization has lost a gross profit of 7% in a year. In fraud cases, 20% of people in company never do any fraud, 60% highly relies on the opportunity to do a fraud and 20% of the rest really does [2]. This is a fact which forced company to have policies in term to detect fraud. Fraud has a definition of a misuse of the system organization without breaking the law [3]. According to [4] fraud is a criminal act in using false information to gain an unfair advantage.

This research focuses on process-based fraud that is a fraud which occurs in business processes [5]. Deviation is defined as the occurrence of fraud criterions. Process mining is designed to identify, monitor, and improve the actual process of event logs data resulted by system. It uses event logs data to extract information and knowledge. Process mining has three main excellences which are discovery, conformance, and enhancement [6]. Discovery refers to an actual model shaping on how a business process occurs by using event logs data. Conformance refers to comparing event logs with SOP. It is also referred to one of capabilities of process mining to detect any deviated process in accordance with the event logs data. Analytical Hierarchy Process and verification rules are employed to analyse the deviations for determine the fraud status.

2. Basic Concepts

2.1. Event Logs

Event logs contain a record of an event executed when a business process is being run. Event Logs also frequently called as history, audit trail, or transaction log [6]. Event logs are used as a data to gain information from a business process that has been run. Event logs contain information about the actor who execute the event, length of event execution time, and another data which is needed to execute event. For example, in a case study of bank credit application in which a make decision activity has been done by a manager in certain time and the manager who making decision must considers the

credit submission requirements. Such requirements are in the form of attribute data as recorded in event logs. Event logs must comprise case id, events, start time, complete time, and actor who execute. Case id shows the ID of one instant process from the beginning to the end. Events refers to what activity is executed in a one process. Furthermore, start time is to show the beginning of an activity execution. Complete time refers to the end time of an executed events and actor refers to the actors who execute events. Table 1 shows the example of event logs.

2.2. ProM

ProM is a tool to run the process mining method. ProM was developed by lecturers and professors from the University of Mon Netherland [6]. ProM has more than 200 plugins and has the advantage of a very extensive approach to the analysis, such as the Discovery Process, Social Network, Conformance Checking. Other Prom excellence which can convert a variety of models such as Petri Net, EPC, BPMN, BPEL, YAWL. Prom is also able to read the event logs in XES or MXML format.

2.3. Process-based Fraud

Process-based Fraud (PBF) is a fraud which occurs in business processes [5]. Therefore, internal controls can be performed as a counter measure against fraud [7]. One of internal control is defining a Standard Operational Procedure (SOP). Fraud occurs due to a mismatch between the SOP against real events recorded in the event logs. Based on the research that has been done [8], there are six kind of deviations which we will use them as attributes to determine the fraud status which are skipped event [4], wrong throughput time, wrong actor, wrong duty, wrong pattern, wrong duty, wrong pattern, wrong decision.

2.4. Process Mining for Fraud Detection

Process mining is used to recognize the sequence of processes that exist in the event logs. According to [6] the goal of process mining is to extract knowledge from event logs recorded by the system. Process mining has three main objectives, namely process discovery, conformance check, and enhancement. Process, case, activity, and event logs is a common term in the process mining. A process consists of several case, activity, and events. A case is a collection of activity sequentially from beginning to end by the time of execution. An event is a representation of the activity that aims to differentiate based on execution time and case. Process mining can be used for fraud detection by performing four types of analysis, namely control flow analysis, resource analysis, throughput time analysis, and decision point analysis [4].

2.5. Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) is a structured technique for organizing and analysing complex decisions based on mathematical calculations [12]. The primary method of AHP is to compare the importance weights of criteria that influence for decision-making. Value will be stored in the table comparison matrix with n x n criteria dimensions. Every criterion, it is possible to have sub-criteria and will also do a comparison between the other weight of the sub-criteria in one level. The results of the comparison of each element are between 1 to 9, which shows a comparison of the importance rate criteria. If criteria in the matrix compared with itself the result of the comparison value is 1. Criteria assessment in comparing one with the other criteria are independent of each other, and this can lead to

inconsistencies. Saaty [12] has shown that the *Consistency Index (CI)* of *n x n* criteria matrix can be obtained by the formula:

$$CI = (\lambda maks-n) / (n-1) \quad (1)$$

λmaks means the Largest eigen value of *n x n* matrix. Largest eigen value is obtained by adding up the results of multiplying the value of each columns with the eigen vector (final weight criterions at a certain level). Inconsistencies limit in measurement is calculated by using *Consistency Ratio (CR)*, i.e ratio of *Consistency Index (CI)* with *Random Index (RI)*. This value depends on the order of matrix n. When the value of *CR* is smaller than 10%, criteria assessment is still acceptable. Consistency ratio can be formulated:

$$CR = CI / RI \quad (2)$$

The reason of using AHP is fraud detection needs subjective assessment from the expert for predicting the severity of each fraud criterions.

3. Proposed Method

In this research we proposed deviation analysis in event logs. The kind of deviations analysis are skip activity analysis, wrong throughput time analysis, wrong resource analysis, wrong duty analysis, wrong pattern analysis, and wrong decision analysis. Process Mining method is employed to analyze the deviation and calculate the occurrences of that deviation. We call each deviation as a fraud attribute to determine the fraud status of a process. The method is presented in the grey box of Figure 1, which shows the steps to identify the deviations from event logs and analyze the deviations using AHP to determine the fraud status. This method was implemented as a ProM Plugin in order to make easier for the users to use.

3.1. Skipped Event Analysis

This part is to analyse event logs to find out the presence of skipped event which unfit with SOP. This analysis was conducted using ProM Plugin which name is conformance checking in order to present the number of skipped events. The input of this analysis are SOP and Event logs.

3.2. Wrong Pattern Analysis

nalyse patterns in event logs by comparing the sequence of events in event logs with SOP. If there was a case in which the activity inside runs with the sequence not in line with event logs, it would be detected as a wrong pattern. The inputs of this analysis are SOP and event logs.

3.3. Wrong Actor Analysis

This part is to analyze on each actor who execute each activity recorded in event logs. If there was an event which is executed by an actor who was not authorized execute it based on SOP model, it would be detected as Wrong Actor.

3.4. Wrong Duty Analysis

In this part, an analysis would be done to find out whether there was an actor execute two events in a process simultaneously. This could be suspected as a fraud in a business process.

3.5. Wrong Throughput Time Analysis

An analysis on time execution from all event logs was done in this part by comparing the time standard existing in the SOP. If time execution was not in line with SOP model in term of it was too fast or slow, it would be suspected as a fraud.

3.6. Wrong Decision Analysis

An analysis in this part concerned with the decision events or branching events. The decision events had an attribute that was influential on the event that must be executed next. To do Wrong Decision Analysis, event logs were firstly transformed into Ontology-based event logs to facilitate ontology

query using SPARQL [11]. Figure 2 illustrates the decision event which is "check plafond" that had a plafond attribute that would have an effect on the activity that will be executed next. The essence of wrong decision analysis using query SPARQL was to identify the event that had plafond amount of 500.000.000 but the event that was done next was not director authorization.

3.7. Fraud Weighting using AHP

Analytical Hierarchy Process (AHP) is a technique to support the decision-making process aimed to determine the best choice from several alternatives taken. The excellence of AHP is its capability to provide an alternative weight in a decision-making. In this case, AHP can be used to give a weight in the case suspected as a fraud based on fraud criterions. The fraud weighting of each fraud criterions was performed by experts after the process mining analysis was done. The final weight of each criterions has been obtained in Table 2. For sub-criteria, the final weight would be multiplied with its weight of main criteria. For example, skip sequence as a sub-criteria of skip had a weight of 0.33 x 0.27 = 0.09. In weighting a case suspected as a fraud, the number of deviation in each criterion would be multiplied with the final weight and divided with the maximum number of deviation that might occur in each criterion.

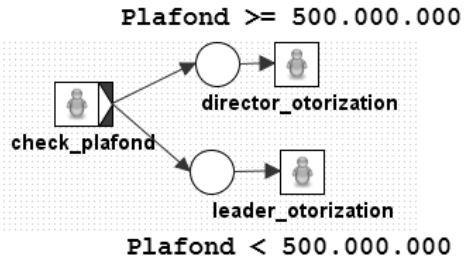


Figure 2. Sample of decision event

3.8. Training and Determining Verification Rules

There are X^{10} deviation combinations in a business process. The integer X indicates the number of events in business process and 10 indicates the number of deviations. The training dataset is developed based on the fraud weights which represent all combinations of frauds. In this phase, the system

determine the threshold or the weight limit used to differentiate whether a case is fraud or normal. The threshold limit must have the most maximal accuracy value. The accuracy value would be measured using Receiver Operating Characteristic (ROC) method. However, the weight of the threshold was often not able to differentiate whether a case was a fraud or not. Thus, a rule is necessary to cope with it. By determining the threshold limit, it was possible to identify if a case truly was as a fraud detected by system (True Positive), a case as truly normal not detected by the system (True Negative), a case truly as a fraud but not detected by system (False Negative) which can occur when there is a fraud but has a low weight of fraud deviation, or a case truly normal but detected as a fraud by system (False Positive) which can occur when there is a normal case but has a high weight of fraud deviation.

Verification is an effort to accommodate the rules aimed to minimize the False-Negative and False-Positive values. The resulted rules were used in doing a dataset test consisting of fraud and normal case. By so doing, if there was a case with the weight of fraud under the threshold limit but in fact, it was a fraud, the system would determine that the case was a fraud in accordance with the verification rules that has been resulted in training. It was also similar with the case that was truly normal but had a fraud weight above the threshold. To illustrate, from a fraud case with one infraction of wrong decision from the maximum eight infractions, the case would have a weight of 0.26 x 1 / 8 = 0.035. Meanwhile, the threshold limit with the best accuracy was 0.014. Based on the threshold limit, the case is considered as fraud by system. That deviation here can be considered as Wdecision Low as the number of deviations in divided by the maximal number of deviation is 1 / 8 <= 0.3. Thus, a verification rules was used in which any deviation of Wdecision Low, it would not be considered as a fraud although the weight of the fraud was above the threshold limit. Similarly, it was also valid in any other deviation.

4. Results

4.1. Case Study of Credit Bank Application

For the case study of credit application, 130 cases of training data comprising 100 fraud cases and 30 normal cases were used. From the result of the training, threshold was generated from 0.001 up to 1 and resulting the maximal threshold of 0.033. The threshold limit was then used as the base of the threshold limit for the next data testing. But if we depend only on threshold limits there are 6 false negative cases. Furthermore the verification rules are utilized to analyse fraud in the case of this false negative cases. Table 3 shows verification rules of this Credit Bank Application and Procurement case study. After the training was complete, the threshold limit and verification rules were used to perform a test. There were 100 cases of testing data comprise 70 fraud cases and 30 normal cases. Table 4 shows the result of testing.

Table 2. Final weight of each fraud criterions

Final Weights									
Skip Seq	0.1	**TT Min**	0.07	**Wrong Resource**	0.1	**Wrong Duty Dec**	0.07	**Wrong Pattern**	0.07
Skip Dec	0.2	**TT Max**	0.07	**Wrong Duty Seq**	0.02	**Wrong Duty Com**	0.04	**Wrong Decision**	0.25

4.2. Case Study of Procurement

For the case study of procurement, 100 cases of training data comprising 70 fraud cases and 30 normal cases were used. From the result of the training, threshold was generated from 0.001 up to 1 and resulting the maximal threshold of 0.014. The threshold limit was then used as the base of the threshold limit for the next data testing. But if we depend only on threshold limits there are 14 false positive cases. Furthermore, the verification rules are utilized to analyse fraud in the case of this false positive cases. There were 100 cases of testing data comprise 40 fraud cases and 60 normal cases were used. Table 5 shows the result of testing.

5. Conclusion

The fraud detections in the business processes of bank credit application and procurement have been studied. It can be concluded that the deviations in business processes can be identified using the process mining method. Then, the AHP method was successfully utilized to determine the fraud status. The AHP achieved the accuracy of 90%. Furthermore, the AHP method could be improved by adding verification rules to detect fraud cases with low weight of deviations and to detect normal cases with high weight of deviations. The computational studies show that the AHP with the verification rules increase the accuracy to 93.5%. Thus, it can be concluded that the AHP with the additional rules achieved high accuracy in detecting frauds in business processes.

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Customer intention to use airbnb application: a case study

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Abstract. Sharing economy is a form of economic activity that is present in today's modern world whose activities are carried out collectively. One example is the Airbnb platform as a meeting point for transactions between property owners and service users. This preliminary study seeks to contribute to the digital world by looking for influential circumstances that can affect the intention to buy. The variables tested were word of mouth, website usability, facility, experiential value, trust and intention to use. Six hypotheses will be tested to determine whether this model is suitable for this study. The results obtained show that this model pass validity and reliability test and the six proposed hypotheses can be supported based on the results of various kinds of indicators. This study gives a view of practical matters from a consumer's point of view that is useful in the application of room rental services.

1. Introduction

The study of sharing economy marketing is viral in the last decade as seen from the work of scientists which discusses the meaning, role, process in various fields and various efforts made to produce or improve the sharing economy performance [1-3]. Various factors such as financial benefits, reputation, enjoyment are the determinants of why someone decides to collaborate actively in providing or using the sharing economy platform service and using it for business purposes or enjoying the tour period [3].

Therefore a critical question arises, namely what must be in order for a motivational tour to be able to move tourists to enjoy all the tourist attributes presented in a destination. This study adopted the theory of consumption value [4-7] and experiential value [8, 9] in formulating a process to enhance a tourist's experiential value, namely questioning what values a tourist needs so he would be happy to surf on a virtual world platform, choosing a room according to his tastes and needs, taking the decision to transact in the application . This study aims to develop an initial theoretical model to predict the process of how the motivation of a potential tourist is managed so that he can increase the level of his experiential value. We developed this model by incorporating various process variables such as word of mouth as a potential leverage for trust, website usability and facility as input for experiential value which was synthesized from the concepts of experiential value [10, 11] and consumption value theory [12], and predicted to have the ability to improve customer trust and intention to buy.

2. Literature review

The ease of customers in surfing the internet is an important thing that needs to be considered by the company. Currently, the website is a mandatory feature that must be owned and operated so that customers feel satisfied. It is proven to note that visual attractiveness plays an essential role in influencing trust in a company.[13]

By observing in the website, everyone can make price and facility comparison among Airbnb hosts. Airbnb accommodation also provides various economic benefits to consumers who rent

accommodation. Airbnb guests will get access to household appliances, such as kitchens, washing machines and drying machines [14]. Therefore, the interior of the room and the completeness of its facilities are factors that are remembered by consumers [15]. Furthermore, not only is the condition of the leading facilities related to water but also supporting features such as Wi-Fi access and internet speed are things that cause someone to become dissatisfied [16].

After someone has lived somewhere rented through Airbnb, this person will get the opportunity to evaluate the host (host) and the condition of the property itself. Word of Mouth (WOM) is informal communication between individuals and others in terms of products, brands, organizations, or services. WOM usually involves exchanging information [17]. In research on WOM, researchers discussed the condition of a person's tendency to make purchasing decisions by relying on other people's opinions. WOM has been recognised as an effective medium for disseminating information. People like to share their experiences and feelings with others, such as friends and family. People interact and communicate with each other and ultimately influence each other.

Consumer behaviour is the end of a process that if traced back is obtained from two types of inputs, namely environmental and consumer inputs that affect cognitive aspects which then affect one's emotions to use products or service [18]. Some reflective indicators are aesthetics, playfulness, service excellence and return on investment from consumers [10]. Further research in the world of hospitality management shows that emotional value, practical value, experiential quality, and corporate reputation are antecedents of experiential satisfaction [8]. Research on experiential value usually examines whether this experience-based value influences consumption intention, especially in the field of excellent services that make transactions online or offline [9]. In other studies, namely about experience economy, some variables overlap with experiential value such as aesthetics and entertainment, but the end is financial matters, either revisit or repurchase [19]. Trust is a psychological state that consists of the intention to accept vulnerabilities based on positive expectations of other people's intentions or behaviour [20], plays a vital role in cyberspace, especially during business transactions [21]. That means trust must be formed if buyers and sellers want to do business with each other online.

3. Research model and hypothesis

The development of the proposed model and variables is built based on hypotheses from previous research and related theories. Variables used are experiential value (EV), word of mouth (WOM), facility (FAS), website usability (WU), trust and intention to use (ITU). Figure 1 is a model proposed to be used in this study.

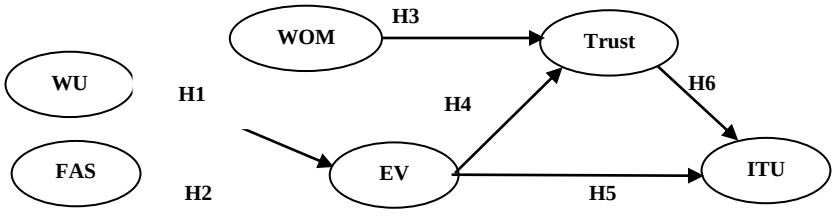


Figure 1. Straight path of the proposed structural model.

They are referring to the purpose of the research, six hypotheses that will be tested and are expected to provide answers to the proposed model.

Table 1. The hypothesis to be tested

	There is a significant positive effect between
H1	website usability and experiential value.
H2	facility and experiential value.
H3	WOM and consumer's trust
H4	experiential value and consumer's trust
H5	experiential value and intention to use
H6	trust and intention to use

4. Research Methodology

This research was conducted on young people under the age of thirty years. The total number of respondents who filled out the questionnaire was 165 people, but only 48 respondents were valid (30 women, 18 men). The reason for the majority of answers was rejected because respondents did not pass the consistency question test. All respondents were those who had used Airbnb services for the past year and rented rooms in tourist destinations such as Bali, Yogyakarta and Bandung. As for overseas, Japan ranks second 16.6%.

5. Results and discussion

The first thing that must be tested is the evaluation of the outer loading model, where the results have been shown in the recapitulation of table 2. According to the rule of thumb that used to assess convergent validity, the value of outer loadings must be between or more than 0.6-0.7 for exploratory research. Based on result in table 2, it can be seen that all indicators have outer loadings above 0.7. Along with Outer Loading, Average Variance Extracted (AVE) is also used to test convergent validity. AVE values must be greater than 0.5. Table 2 illustrates the output of the software that each construct has AVE greater than 0.5. Therefore, it can be concluded that this model has good convergent validity

Table 2. Outer model evaluation for the proposed model

Latent variable	Indicator	Outer Loading	Average Variance Extracted	Composite Reliability	Cronbach's Alpha
WOM	WOM1	0.913	0.747	0.922	0.887
	WOM2	0.843			
	WOM3	0.864			
	WOM4	0.836			
WU	WU1	0.890	0.755	0.902	0.835
	WU2	0.916			
	WU3	0.795			
FAS	FAS1	0.897	0.772	0.871	0.706
	FAS2	0.860			
EV	VAL1	0.888	0.734	0.892	0.821
	VAL2	0.856			
	VAL3	0.825			

Trust	TRUST1	0.838	0.734	0.943	0.927
	TRUST2	0.872			
	TRUST3	0.901			
	TRUST4	0.814			
	TRUST5	0.828			
	TRUST6	0.883			
ITU	INT1	0.842	0.770	0.931	0.900
	INT2	0.901			
	INT3	0.903			
	INT4	0.863			

Cronbach's alpha and composite reliability values are two indicators used to measure the reliability of the model. The minimum number required for a reliable exploratory study for Cronbach's alpha is 0.6, and composite reliability is in the range of 0.6- 0.7. Based on Table 2, the Cronbach's alpha value of all constructs is more than 0.6, and the composite reliability of all constructs is more than 0.7. It can be inferred that the model is reliable.

Whereas to measure discriminant validity, there are two methods, by calculating cross-loadings and comparing the square root of AVE. The first method states that the outer loadings of an indicator must be higher than the loadings of other constructs. According to the calculation that has been done, all outer loadings values of an indicator is higher than the value of the loadings of these indicators with other constructs. The second method states that the square root of AVE must be higher than the correlation value with other constructs in the model. According to the calculation that has been done, it also shows that all square root values of AVE of a construct are more significant than the construct correlations with other constructs. By considering these two methods, it can be concluded that this model has good discriminant validity

5.1 Evaluation of inner model

Table 3 is the recapitulation of the inner model evaluation results by looking at the R-square value. Meanwhile, Table 3 is the recapitulation of the results of the significance test from the model.

Table 3. Evaluation of inner model

	R-square	R-square adjusted	Characteristic
Experiential value	0.746	0.734	Moderate
Intention to use	0.753	0.742	Moderate
Trust	0.710	0.697	Moderate

The R-Squares value for each endogenous latent variable can be used to see the predictive power of the structural model. Based on the results of calculations in Table 3, the relationship between advantage and the variables that influence it has an R-Squares value of 0.746, and the relationship between intention to use and the variables that influence it has an R-Squares value of 0.742. Whereas, the relationship between trust and the variables that influence it has an R-Squares value of 0.697, so the model is moderate.

5.2 Significant of test

Significance test to determine the effect between variables is done through resampling with bootstrapping methods. The T-value value from the bootstrapping results will be used to determine the significance of the PLS path model. If the T-value is higher than 1.96, it can be assumed that the path coefficient is significant at the 2.5% (one-tailed) level. Based on the bootstrapping result with the

number of bootstrap samples of 1000, six hypotheses have a T-value of more than 1.96, and it can be said that all hypotheses are acceptable.

Table 2. Outer model evaluation for the proposed model

Hypothesis	T statistics	P value *(α = 0.05)*	P value *(α = 0.01)*	Support
H1	2.049	0.041	0.027*	Yes*
H2	6.909	0.000	0.000	Yes
H3	2.699	0.007	0.007	Yes
H4	8.071	0.000	0.000	Yes
H5	3.489	0.001	0.001	Yes
H6	3.587	0.000	0.000	Yes

* not accepted at α = 0.01

5.3 Managerial Implications

Those who provide rooms for rent need to pay close attention to various aspects that are often highlighted and become important considerations for consumers to choose accommodation. They need to learn from well-established hotels in the facilities and methods of good customer service so that after they return, they will have memories of good memories while in that place will give value to a consumer's experiential value. If this can be achieved, not only one day he will return to that place, but the strong message of word of mouth is just a matter of time to spread to their families and families.

5.4 Limitation and future research direction

Things that can be done for further research is to look for other variables that might give more space and influence so that the reliability value can increase significantly. Apart from that, it can also be explored about the possible differences between women and men as well as their older views on the use of this application. It is very likely that the older generation prefers the old ways of using hotels, given the certainty and stability of quality services.

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Evaluation of academic website using eye tracker and ueq: a case study in a website of xyz

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Abstract. The current study evaluated academic website using eye tracking and User Experience Questionnaire (UEQ). A total of 46 participants have been recruited for this study but then the data was reduced to 33 participants due to random response errors of an item in UEQ followed by reducing in eye tracker's data. Eye tracker had a gaze plot (scan path) data and task completion time as time to first view area of interest (AOI) where these data were used to evaluate important gaze plot and whether the provision of information in website has been clearly done. Gaze plot gave insight where important link, information and picture should be put in the website. Furthermore, Kruskal Wallis and Mann Whitney U test were also applied to see the difference between each task which were used to improve sub menu's name. At the same time, UEQ data showed that only novelty should be improved to be more creative, inventive, leading edge and innovative. Thus, this recommendation provides more input in designing website for academic use.

1. Introduction

Web is playing a significant role in diverse application domains such as business, education, industry and entertainment. As a result, there are increasing concerns about the ways in which websites are developed and the quality of information delivered [1]. The growth of the web is profoundly changing the way people interact with information and with people. This has led to an expansion of opportunities for the web on different vectors, including the massive production of contents [2]. This must be taking into account in new website development of academic website. As a case study in a website of XYZ has been evaluated. This evaluation involved the students of IE who use the website and access the important information such as lecturer data (email and area of interest), learning outcomes, downloaded forms, requirement for final project etc. Therefore, user experience measurement will be required.

The first requirement for an exemplary user experience is to meet the exact needs of the customer, without fuss or bother. Next comes simplicity and elegance that produce products that are a joy to own, a joy to use [3]. Without the user experience aspect of the user, the user will leave the website that is actually important [4]. User experience measurement can be done by eye tracker data which have been collected that demonstrate that eye movements are intimately related to the moment-to-moment cognitive processing activities of readers [5]. when users reach a Web page, they can scan the page and obtain a comprehension of it in a few seconds. Cognition refers to the ability of the human mind to acquire and manage information [6] and comprises different mental processes such as attention,
memory, perception, problem solving and learning [7]. By understanding sighted users' visual understanding of Web page complexity in relation with the time of task completion, important information should reveal with refer to the cognitive effort required for interaction with that page. To use eye tracking, participants' visual attention was measured and analyzed based on the gaze plot

(scan path) and heat maps eye gaze analysis [8]. Other than using UEQ, user experience can be measured using user experience questionnaire (UEQ). UEQ has 6 scale which are Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, Novelty [9]. Eye tracking's method is called objective measurement while UEQ is subjective measurement [10]

The current study focused on evaluating XYZ new website as an example of academic website by analyzing eye tracking and UEQ. Gaze plot (scan path) of eye tracker's data will be used to analyze navigational behavior and mean different in time to completion task as time to first view can be utilized to develop sub menu's name. At the same time, mean value of each scale in UEQ will be used to develop interface of the website. In this study, conformity of cognitive aspect between eye tracking and UEQ will also be analyzed.

2. Materials and Methods

This research used two methods that were eye tracking as an objective measurement and user experience questionnaire as a subjective measurement. Experimental procedure for eye tracker, explained below:

Eye movements were recorded by using Gaze point eye tracker. This eye tracker generates raw gaze-point location data at the camera field rate of 60 Hz. Position GP3 below the screen, centered and as close to the bottom edge of the screen as possible. This is approximately arm's length (65 cm) from the user. The device was approximately 40 cm below eye level and pointing a tan upwards angle towards the eyes [11]. Obtained data will be analyzed using the Gaze point Analysis system. It provides powerful method for collecting and analyzing eye-gaze data. Visualization can be performed through gaze replay, gaze plots, heat maps, and area of interest (AOI). Gaze replays enable to watch the test session video again with the user's eye motion overlaid over a recording of the changing computer screen image. In these a blue dot can be seen or user's eye, moving around a page. Gaze plots are another very valuable analysis tool in eye tracking technology. These compile the eye gaze of one user on one page. These do not combine more than one page or user in the representation. Light blue dots on the page show a number of important data items, including: 1) where the user's fixations were, 2) numbers in the dots depicting the order in which the user looked at the items, and 3) the size of the dot denoting how long the user looked at the item. Larger dots mean longer looks. There is another analysis tool in eye tracking technology that deserves a mention here, called Areas of Interest, AOIs, or Look Zones. This feature is meant to help with doing quantitative analysis [12].

This study recruited 46 participants that based on Nielsen theory, that said the minimum participant of eye tracking usability study is 6 Qualitative eye tracking (watching gaze replays) and 20 for Quantitative user testing [12].

This study used XYZ website as a research object. Participants were asked to fulfil 5 tasks. Task 1: participants were asked to explore the website for 30 seconds. This task aimed to enable participants to assess the appearance of the website and to find out the elements on the website that attract the attention of participants through gaze plot (scan path). Task 2 to find lecturer data, task 3 to find learning outcome, task 4 to find courses assignment's form, and task 5 to find Final Project requirement. Another 4 tasks will give a prior knowledge which area can be found faster. The matrix used was time to first view or fixation which measured the length of time taking for the respondent to reach AOI for the first time. Hence, we can evaluate whether the important information can be seen faster. Vertegaal explained [13], fixation information can be used to measure the attention that individuals have paid to stimuli.

The UEQ contains 6 scales with 26 items [9] that is explained below. The questionnaire and the analysis can be download online [14]. Attractiveness means overall impression of the product, perspicuity means how easy to get familiar or learn the product, efficiency means solving the tasks without unnecessary effort, dependability means feeling in control of the interaction, stimulation means how exciting and motivating to use the product, novelty means how innovative and creative the product.

Mean values between -0,8 and 0,8 represent a more or less neutral evaluation of the corresponding scale. Values > 0,8 represent a positive evaluation and values < -0,8 represent a negative evaluation. The range of the scales is between -3 (horribly bad) and +3 (extremely good) [9].

To detect such more or less random or not serious answers, a simple heuristic is used. The idea to detect random or not serious answers is to check how much the best and worst evaluation of an item in a scale differs. If there is a big difference (>3) this is seen as an indicator for a problematic data pattern. Such situations can also result from random response errors or a misunderstanding of an item. Thus, it makes no sense to consider a response as problematic if this occurs just for a single scale. Answer will be removed from the data set that shows a value of 3 or higher in the Critical [9] which then followed by eliminating the data from eye tracker.

To compare cognitive aspects between eye tracker and UEQ, we analyzed average first time to view of 4 tasks then it was compared with mean value of each cognitive scale in UEQ (we suggested perspicuity, efficiency, dependability as a cognitive scale). Nielsen [15] explained, If the web page survives 10 second judgment, users will look around a bit. However, they are still highly likely to leave during the subsequent 20 seconds of their visit. Only after people have stayed on a page for about 30 seconds does the curve become relatively flat. People continue to leave every second, but at a much slower rate than during the first 30 seconds. Therefore, we used 30 second as a standard time. When average time to first view was more than 30 seconds, but the UEQ result had high mean value, we called it discrepancy for cognitive aspect.

We also analyzed differences completion time for tasks 2,3,4,5 (H1). Due to data was not normally distributed, we used Kruskal Wallis test which is a nonparametric alternative to a one-way ANOVA [16]. Further analysis using Mann Whitney U Test will be used to see the difference between each task [17]. Statistical significance was analyzed through the use of SPSS 18.

3. Result

As was stated in the methods, a total of 46 participants were recruited for this study but the data was reduced to 33 participants due to random response errors or a misunderstanding of an item in UEQ [9] which then followed by eliminating the data from eye tracker.

The first set of analyses examined the gaze plot from eye tracker's gaze replay in response to task 1. We presented gaze plot as a navigational behavior started from path 1 as the most first viewed area in website, then continued to path 2, path 3, path 4, and path 5, respectively. As shown in Fig. 1, The most first viewed area in website sequentially were 1) home page which then the participants scrolled down through the picture which containing the news link, 2) profile as main menu, 3) each of main menu which was explored by participants.



Figure 1. Gaze plot analysis of eye tracker (navigational behavior)

While scrolling on the homepage, the gaze moved to the quick link. This was mostly done not only on path 2 but also on the next path (3,4, and 5) since this quick link is located on all pages. While participants explored the quick link, they would click on the assignment and practical courses I form, the final project form, and practical work 2 from. It can be seen that quick links have an important role here. Gaze plot to profile menu could be seen in path 1, 2 and 3. In this menu, sub menu facility and lecture and staff were the most clicked and viewed. The Academic and Student Affairs were the next main menu frequently seen. After looking the academic main menu, participants would click sub main menu which were courses and competency whilst in student affairs main menu, participants clicked final project, guidelines practical work, practical work I. They also explored the menu one by one in the first path. The picture containing the news link in the home page were also clicked by some participants.

In response to UEQ as shown in table 1, perspicuity, efficiency dependability got high mean value since it was above the neutral value 0,8. At the same time, stimulation had a high value while novelty had a value that was close to a neutral value where improvement will be needed.

Table 1. UEQ result

UEQ Scales	Mean	Variance	UEQ Scales	Mean	Variance

Obtained completion time of 4 tasks from 33 participants can be seen in table 2. Completion time was obtained by putting area of interest (AOI) in the destination website page for every task that called time to first view. It can be seen that tasks 2 and 5 consumed less time than tasks 3 and 4 since task 2 and 5 have familiar sub menu's name according to participants. Sub menu for task 3 was considered unfamiliar since participants were unaware that learning outcome was a part of the competency as well as practical work 1 form was also part of the document.

Table 2. Eye tracker result in response to task 2 to 4

Task	Time to 1st View (s)	Task	Time to 1st View (s)
	16,826		**31,051**
	42,897		**17,372**

To see the differences between each task, Kruskal Wallis were applied. These tests revealed that there were significant differences between time for completing each task since asymp. Sig 0,00004 (asymp. Sig <0,05). To understand which time of the task was different, Mann Whitney U test was applied. The result of the test can be seen in table 3. It highlighted that time in completing task 2 and 5 had no significant difference as well as task 3 and 4.

Table 3. Mann whitney U test Result for each task

Task	Mean Rank	Asymp. Sig. (2-tailed)	Conclusion
2 vs 3	24.27 vs 42,73	0,00009	Significant difference
2 vs 4	27.35 vs 39.65	**0,009**	Significant difference
2 vs 5	33,73 vs 33,27	**0,923**	No significant difference
3 vs 4	36,79 vs 30,21	**0,164**	No significant difference
3 vs 5	42,21 vs 24,79	**0,0002**	Significant difference
4 vs 5	39,97 vs 27,03	**0,006**	Significant difference

Moreover, verification of cognitive aspects in eye tracker and UEQ has been done. As was stated in the methods, 30 seconds was determined as standard time. It was interesting to note that the lowest discrepancy was 30,30% between eye tracker's result and scale of perspicuity in UEQ. The detail results were presented in table 4. Our experiments were in line with the meaning of perspicuity itself

which showed how easy the participants get familiar or learn the website. The findings above gave recommendations of website evaluation that can be seen in table 5.

Table 4. Discrepancy between eye tracker and Cognitive aspects of UEQ results

Cognitive scale in UEQ	Respondent Discrepancy	Percentage (%)
Perspicuity	10	30,30
Efficiency	18	**54,54**
Dependability	18	**54,54**

Table 5. Recommendation

Element	Recommendation
Gaze plot	● As was discussed above, some participants experienced difficulty to find learning outcomes (LO) and forms needed. Therefore, since LO is also important for the users, we suggest to put LO link in home page as a picture. As was analyzed in path above, participants frequently scrolled down the home page through the picture. Therefore, link as a picture such as important news, accreditation, student's life, and upcoming events should be added to attract more user see this page. ● Downloaded form should be put in sub menu according to the needs. Final project form should be put in the sub menu final project while practical work form should be put in sub menu practical work. We also suggest to add more sub menu in practical work which are Practical work 1, 2, and courses assignment form. ● Quick link placement is very useful. We suggest to add more important link such as competency, curriculum, courses and eliminate less important link such as archives and categories. Practical work 1, 2, and courses assignment form will remain here.
Novelty	● Website need to be designed more creative, inventive, leading edge and innovative. ● Each page of the website should be designed more colorful and not monotonous and more pictures should be added. ● Font should be changed from robot to more pleasant and web safe font such as arial, AvenirNextLTPro-Regular, verdana, etc. ● Paragraph arrangement should be improved. At this time, paragraph was looked too monotonous hence it was difficult to read.

4. Discussion

The aim of this study is to evaluate academic website using eye tracking and UEQ. As was analyzed in the result, the data can support this evaluation. Eye tracker as an objective measurement was used to analyze gaze plot that showed navigational behavior of the participants. This is important to see how they explored the website. A subjective measurement using UEQ showed that appropriate recommendations were needed to for near neutral value of scale.

Our study was unsuccessful to prove that there is a 100% conformity of cognitive aspect between eye tracking and UEQ. This can be related to standard time setting and the type of assignment given. related to standard time, explained by Nielsen [15], users often leave web pages in 10–20 seconds and continue to leave every second, but at a much slower rate than during the first 30 seconds. If we determined standard time which was 10 - 20 seconds, level of discrepancy will be higher, more than 30,30%. Therefore, further experimental investigations are needed to estimate this standard time. In addition, further studies are also needed to explore what kind of task used for eye tracking studies which has conformity with UEQ cognitive. To avoid elimination of participants data, analysis need to be done immediately after participants completed the UEQ.

5. Conclusion

The website is currently very important for various fields, especially education. A lot of information can be obtained by students especially from the website so that an appropriate website evaluation and development is needed. This study successfully evaluated websites using two methods, namely eye tracking as an objective measurement and UEQ as a subjective measurement. This paper has

highlighted eye tracker data which were gaze plot and time to first view. Gaze plot could give insight where to put important information, picture or link in the website. Kruskal Wallis and Mann Whitney U test were applied to understand significant difference of time in completion each task which were used to give recommendation of changing and adding sub menu. At the same time, UEQ data showed that only novelty which had a value near neutral, hence website needs improvement to be more creative, inventive, leading edge and innovative.

In this study, cognitive level of discrepancy between eye tracker's task and perspicuity in UEQ was 30,30% due to 30 seconds time standard. This has not been able to prove 100% of the conformity of the cognitive aspect between eye tracker and UEQ. Despite the fact that there are limitations of measurement of cognitive aspects, the further studies will need to develop standard time and type of task for eye tracking studies to measure cognitive aspects.

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