

# International Indonesian Student Conference Edition

Spatial Distribution and Carbon Sequestration Capacity  
of Indonesian Blue Carbon Ecosystems: Result of  
Preliminary Analysis towards SKN Implementation

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## PREFACE

Indonesian Scholar Journal (ISJ) is an independent academic journal **which started** as a result of a collaborative effort among **the** Indonesian students associations (Perhimpunan Pelajar Indonesia – PPI) around the world. The idea was first initiated **during** the Overseas Indonesian Students Association’s plenary meeting in Malaysia on February 2012. ISJ **is conceived** as a movement to strengthen Indonesian research through online publication of scientific journals.

This year, ISJ together with PPI Germany and PPI France published a special edition proceeding titled “International Indonesian Student Conference Edition”. The proceeding contains some of the best papers from two International student conferences that were held (PPI-France : OKTI and by PPI-Germany: ICONIC), aimed for Indonesian students and academicians around the world to share their ideas and contribute for the development of Indonesia. The papers cover issues from various fields of study such as: tourism, engineering, biochemistry, geomatics, and education.

On behalf of the editors, reviewers, PPI Germany, and PPI France I would like to thank all of the authors and we hope that this publication serves as a pivot for their future academic career.

Dr Bagus Nugroho  
Executive Board Indonesian Scholar Journal

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# Spatial Distribution and Carbon Sequestration Capacity of Indonesian Blue Carbon Ecosystems: Result of Preliminary Analysis towards SKN Implementation

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**Abstract.** Indonesian archipelago, as one of the world maritime axis, possesses a great distribution of blue carbon ecosystem. With this great potential contributes to the global carbon (C) budget issues, the Government of Indonesia (GOI) has developed a concept related to C trading named *Skema Karbon Nusantara* (SKN). Through SKN, C sequestration capacity of the Indonesian blue carbon ecosystem can be registered, verified, and certified for trade. Furthermore, compensation fund to be earned from this activity can be used as a major contribution towards the ASEAN Community 2015 implementation. To support this, spatial analysis of blue carbon ecosystems distribution and its C sequestration capacity potential become important steps to do. This paper reports results of a preliminary study based on data collection and analysis aimed at to map the Indonesian mangroves and seagrass beds spatial distribution and to calculate their total C sequestration capacity. The results revealed that Indonesian archipelago consists of 3,244,018 ha of mangrove ecosystem covering 23.54% of the world's mangrove region and 3,000,000 ha of seagrass beds, making both the mangrove ecosystem and the seagrass beds areas the largest in the world. The Indonesian mangrove ecosystem has C sequestration and storage capacity of 6.3 tCO<sub>2</sub>e/ha/year, giving rise to 20,437,313.4 tCO<sub>2</sub>e/year total absorbing potential while the figure for the seagrass beds is around 4.4 tCO<sub>2</sub>e/ha/year which contributes to an absorbing potential of 13,200,000 tCO<sub>2</sub>e/year. In total, Indonesia's blue carbon capacity potential is about 33,637,313.4 tCO<sub>2</sub>e/year. Based on the voluntary C trading market exchange rate currently at US\$ 6.5 for one ton of C, this preliminary calculation gives rise to a total revenue estimation for Indonesia from C trading up to US\$ 218,642,537 annually. This great opportunity is expected to encourage the GOI to develop and actuate blue carbon ecosystem conservation plan by determining carbon absorber area with the most dominant extent in the region.

**Keywords:** *blue carbon, carbon trade, carbon sequestration, coastal ecosystem, spatial distribution, SKN*

## A. INTRODUCTION

Indonesia is a house for the world's richest tropical marine ecosystems, including mangroves and seagrass meadows, with 3.6 million km<sup>2</sup> of territorial seas. These ecosystems form a large part of the Coral Triangle of the Indo-Pacific, termed 'the center of origin' for many of the world's tropical marine flora and fauna (Veron et al [1]). Coastal ecosystems

provide extensive benefits for supporting and enriching people's lives and national wellbeing for countries within the Coral Triangle. Globally, coastal ecosystems have been valued at US\$ 25,783 billion (Conservation International [2]). For many coastal communities of the Coral Triangle in ASEAN region, coastal ecosystems also play a significant role in their culture and identity.

Human activities have caused a substantial increase in the concentration of carbon dioxide (CO<sub>2</sub>) in the atmosphere. This increase in atmospheric CO<sub>2</sub> —from about 280 to more than 380 parts per million (ppm) over the last 250 years—is causing measurable global warming. Referring to this environmental issue, utilization of “blue carbon” has become one of the most appealing yet challenging concepts to reduce the global carbon emission.

The objective of this paper is to value the services associated with the capture and storage of oceanic carbon, known as Blue Carbon, as a basis to provide conservation recommendation for marine protected areas in Indonesia. The monetary value associated with these services was generated through simulation approach of a hypothetical market for oceanic carbon. To do so, a benefit function that considered the capacity of mangroves and seagrasses for capturing and storing blue carbon was constructed, and scenarios for the variation of key variables such as market carbon price was simulated.

## **B. LITERATURE APPROACH**

### **Blue Carbon**

Blue carbon is a term used to address the carbon captured by and stored in the marine and coastal ecosystems. The carbon captured by living organisms in coastal ecosystems is stored in the form of sediments from mangroves and seagrasses. It does not remain stored for decades or centuries (like for example in rainforests), but rather in millennia. The world’s oceans are the primary long-term sink for human-caused CO<sub>2</sub> emissions, currently accounting for a global net uptake of about 2 gigatons

of carbon annually according to Sundquist et al [3].

A carbon sink is a natural or artificial reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period. The process by which carbon sinks remove carbon dioxide (CO<sub>2</sub>) from the atmosphere is known as carbon sequestration. The term “carbon sequestration” is used to describe both natural and deliberate processes by which CO<sub>2</sub> is either removed from the atmosphere or diverted from emission sources and stored in the ocean, terrestrial environments (vegetation, soils, and sediments), and geologic formations (Sundquist et al [3]).

### **Coastal Ecosystem**

By far, the largest carbon pool is the one stored in the soils of the coastal ecosystems (Spalding et al [4]). Coastal ecosystems transfer and store carbon from the atmosphere and ocean at rates of up to 4 times higher than tropical forests. Duarte et al [5] stated that marine vegetation habitats (seagrasses, salt marshes, macro algae, and mangroves) occupy 0.2% of the ocean surface, but contribute 50% of carbon burial in marine sediments, which means that the oceans play a significant role in the global carbon cycle, not only because they represent the largest carbon reserves but also because they can store and redistribute it through the cycle. Nellemann et al [6] affirmed that approximately 93% of the earth’s carbon dioxide is stored and undergoes its cycle in the oceans. Similarly, the coastal ecosystems are recognized as the largest carbon sinks, given that they store large quantities of carbon both in their vegetation and the seabed (Sifleet et al [7]). About 95% to 99% of total carbon stocks of seagrass ecosystems are stored in the soils

beneath them, while in mangrove systems, 50% to 90% of the total carbon stock is in the soil; the rest is in living biomass.

The exciting thing is that healthy mangrove and seagrass ecosystems continuously store carbon in their soils over long time scales, unlike terrestrial soils which tend to plateau over time (Schlesinger and Lichter [8]). In addition, the rate of carbon sequestered and the size of the carbon pool may continue to increase over time (Chmura et al [9]). This is because the sediments in which healthy mangroves and seagrass grow increase in volume in response to rising sea levels (McKee et al [10]).

Ecosystems such as mangroves and seagrass remove green house gases (GHG) from the atmosphere through the process of photosynthesis. These ecosystems sequester significant amounts of GHG, mainly CO<sub>2</sub>, and store it as biomass and in the seabeds that underlie them (Sifleet et al [11], Duarte et al [12], Kennedy et al [13], and Jenkins et al [14]).

### **Conservative Approach**

Even though the total land area of mangroves and seagrass is small as compared to land in agriculture or forests, the plentiful carbon beneath these habitats is substantial. If released to the atmosphere, the carbon stored in a typical hectare of mangroves could contribute as much as GHG emissions from three to five hectares of tropical forest. Sifleet et al [11] revealed that a hectare of seagrass meadow, with its small living biomass, may hold as much carbon as one to two hectares of typical temperate forest. The draining, conversion or destruction of coastal ecosystems for other uses can disrupt the carbon sequestration and may switch these

ecosystems from being net sinks to net producers of carbon (McCleod et al [15]). For example, converting mangrove forests to aquaculture ponds could result in the release of 150 tCO<sub>2</sub>e/ha/yr. from the removal of the mangroves and 750 tCO<sub>2</sub>e/ha/yr. from the exposure of mangrove sediments that have been accumulating carbon for millennia. In fact, loss by conversion from mangroves and seagrasses can imply a release of 0.15–1.02 billion tons of carbon dioxide, equivalent to 3–19% of emissions from deforestation globally (Lavery et al [16]).

The global efforts made to reduce GHG emissions have led to the creation of the emissions trading system, known as the Carbon Market, which generates economic incentives to encourage the landowners not to transform the forest ecosystems. However, the inclusion of marine ecosystems in the carbon market is still being negotiated because the scientific understanding and consensus about the blue carbon mitigation potential have not been sufficiently developed until now (McCleod et al [17]).

Despite these efforts, developing countries such as Indonesia are keep struggling against the lack of funding for increasing their protected areas and consolidating them as a network, in order to increase efficiency and efficacy of conservation and to fulfill the commitments of ratified conventions. The economic valuation of the services provided by the ecosystems has become a main topic to highlight the importance of key ecosystems for conservation and the need of funding for the establishment and expansion of marine protected areas (Tatiana and Maldonado [18]).

The valuation of the services provided by marine ecosystems such as carbon capture and storage seeks to associate an economic value to such services to generate economic incentives that support their conservation. The protection of new hectares of the marine ecosystems area including those that capture carbon will be directly visible in the total storage and in the annual capture rates which is currently considered stable. This implies that the protection scheme will guarantee that the ecosystems are free from human-imposed threats such as habitat transformation so that the dynamics associated with their health are appropriate and natural, also it makes possible to guarantee that their processes of capture and storage are kept.

### C. MATERIAL AND METHOD

The method used for this study is focused on spatial analysis within a generated thematic map of mangrove and seagrass distribution. Area analyzed lies between 6° NL – 11° SL and 95° EL - 141° EL. Standard calculation was conducted to obtained value of blue carbon sequestration in Indonesia.

#### Data Inputs

Inputs of areal data were derived from international monitoring databases of the United Nations Environment Programme-World Conservation Monitoring Centre (UNEP-WCMC), Indonesian Geospatial Information Agency (*Badan Informasi Geospasial*; BIG) and recently published literature. It should be noted that this study does not consider the types of mangrove and seagrass and all values are truly independent of each other. This study applied the recently corresponding

mangroves area estimate of 3.24 Mha (obtained from BIG spatial data [22], 2009). For seagrasses, this study applied an area estimate of 3 Mha (obtained from UNEP-WCMC spatial data [23], 2005).

### Work Flow

Maps of mangrove and seagrass distribution in Indonesia was constructed from the data obtained, and the calculation of mangrove and seagrass distribution extent was conducted from the mapping results and from previous studies referenced for the purpose of data validation (Fig. 1).

Total annual carbon uptake was obtained from the calculation of mangrove and seagrass extent in Indonesia while the estimated amount of carbon sequestration capacity per hectare was obtained from several literature sources. The annual Indonesian revenues from carbon trading were estimated by calculation of the total carbon sequestered per year multiplied by the determined carbon price that is based on the global carbon market rate.

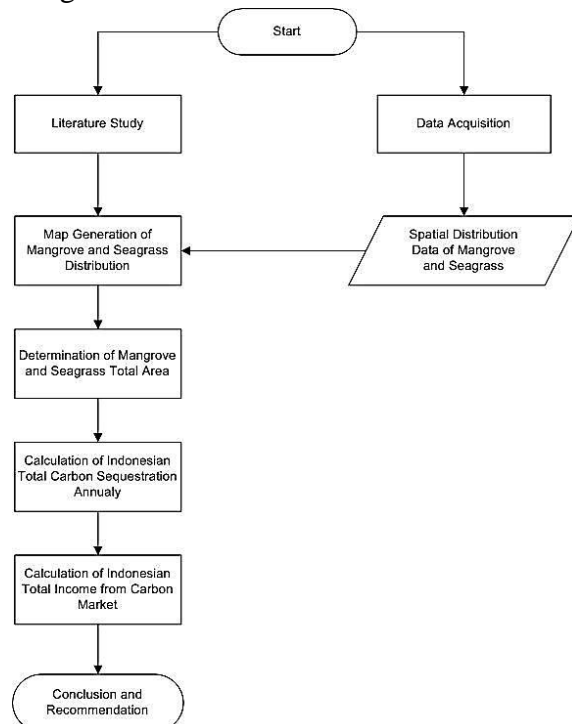


Fig.1. Study Work Flow



## D. RESULT AND DISCUSSION

### Spatial Distribution of Blue Carbon Ecosystem

Measurements of mangrove and seagrass capture and storage of C (in biomass and seabed) demonstrated a variation (Lavery et al [16], Pendleton et al [19], Emerton [20], Sifleet et al [7]), as shown in Table 2. For this study, the average values reported from these studies for capture, storage, and potentially releasable carbon was used.

Fig. 2 shows the comparison between mangrove and seagrass abundance in Indonesian archipelago. The chart was derived from the data obtained in Table 1.



Fig. 2. Blue Carbon Ecosystems in Indonesia

Table 1. Mangrove and Seagrass Extents

Ecosystem	Total Area in Indonesia (ha)	Total Area in the World (ha)	Percentage (%)
Mangrove	3,244,018	13,776,000	23.54
Seagrass	3,000,000	30,000,000	10

Fig. 3 shows the mapping results of mangrove and seagrass spatial distribution

in Indonesia. From the map, mangrove abundance is high in the coastal area of Sumatera, Kalimantan, and Papua. For seagrass, the high abundance is available to the eastern part of Indonesia which consists of Sulawesi, Bali, Lombok, Nusa Tenggara and Papua. It can be considered that the conservation area, based on spatial analysis, can be developed at mangrove and seagrass area with high population. The high population of seagrass and mangrove indicated that those areas were still far-out from the adverse effects of human activities that threaten these ecosystems. Therefore it can be said that those areas have a great potential to be preserved in order to continue their contribution of carbon sequestration.

Coastal ecosystems remove carbon dioxide from the atmosphere via photosynthesis, however, they return some to the atmosphere through respiration and oxidation then store the remaining carbon in two pools: living biomass and soil organic carbon. The carbon sequestration rate quantifies how much carbon is added to the biomass and soil carbon pools annually. This sequestration rate is assumed to be constant over time for the purposes of this paper.

Average rates of carbon sequestration for mangrove are between 6 and 8 tonnes of carbon dioxide equivalents (CO<sub>2</sub>e) per hectare per year, whereas seagrasses tend to sequester carbon at a somewhat lower rate of approximately 4 tCO<sub>2</sub>e/ha/yr. These rates are about two to four times greater than global rates observed in mature tropical forests (1.8–2.7 tCO<sub>2</sub>e/ha/yr.) (Lewis [21]).

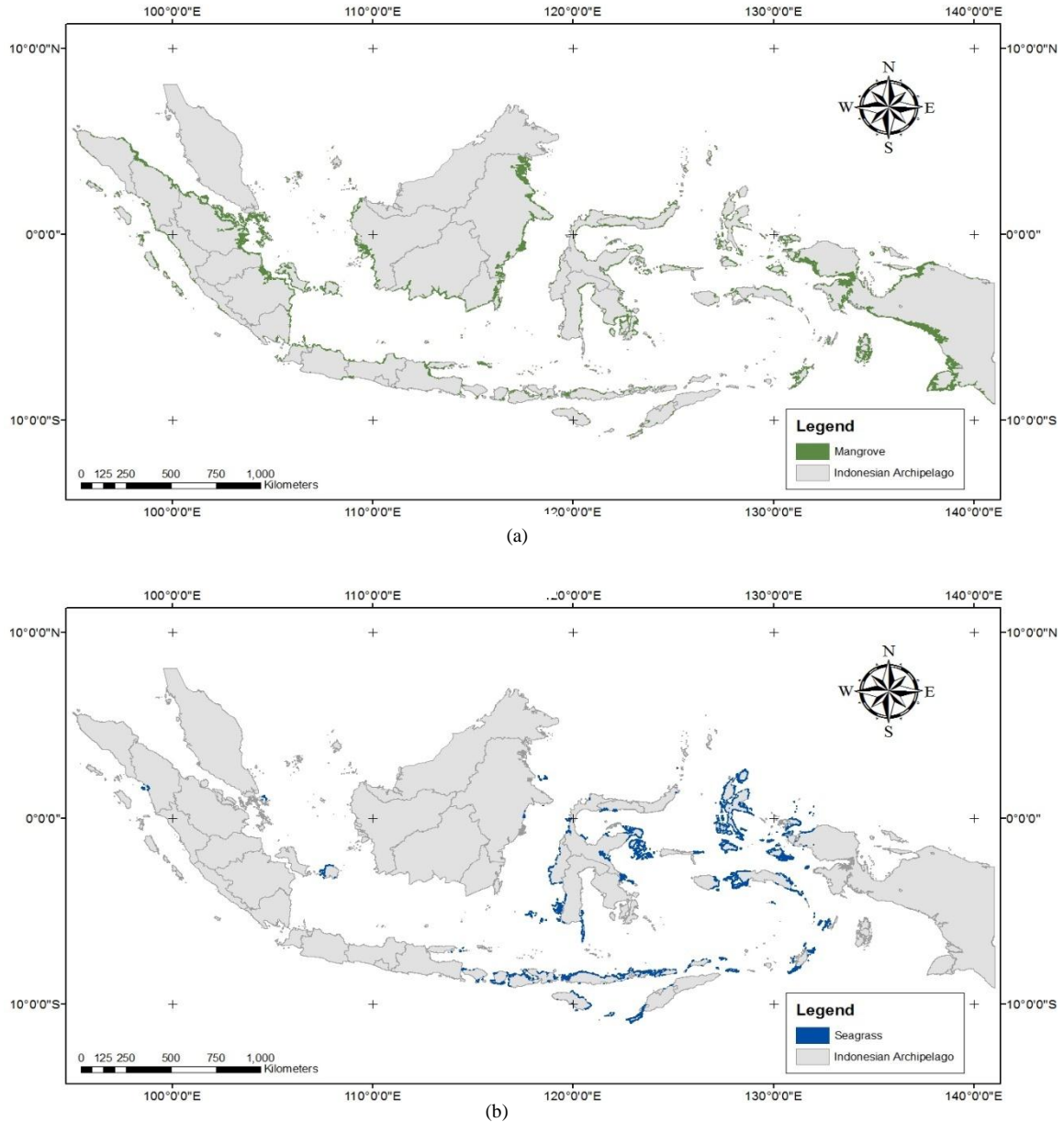


Fig. 3. (a) Indonesian Mangrove Distribution; (b) Indonesian Seagrass Distribution

The amount of carbon held in living biomass varies among the habitat types; seagrasses contain 0.4–18.3 tCO<sub>2</sub>e per hectare, and mangrove forests, which can grow up to 40 meters tall according to Spalding et al [22], clearly leading in this area for maintaining 237–563 tCO<sub>2</sub>e/ha in living biomass.

Soil organic carbon is the biggest carbon pool for the focal coastal habitats. In the first meter of sediments, the average content of soil organic carbon is 500 tCO<sub>2</sub>e/ha for seagrasses, 1,060 tCO<sub>2</sub>e/ha for estuarine mangroves, and nearly 1,800 tCO<sub>2</sub>e/ha for oceanic mangrove.

Table 2. Mangrove and Seagrass Carbon Stock

Ecosystem	Annual carbon sequestration (t CO <sub>2</sub> e/ha/y)	Storage Capacity (t CO <sub>2</sub> e/ha)	
		Living Biomass	Soil organic carbon
Mangrove	6.3 ± 4.8	237 – 563	1,060 – 2,020
Seagrass	4.4 ± 0.95	0.4 – 18.3	66 – 1,467

Table 2 provides means and ranges of the estimate of carbon stocks and sequestration rates across the different pools and regions of the world for each of the focal habitats.

### SKN Implementation

In the global carbon market system, Indonesia is a country involved in Clean Development Mechanism (CDM) system, in which the developed countries can purchase the reduction in GHG from Indonesia. In this system, the trading commodity is the certified emissions uptake under the terms and conditions prevailing in the market. CDM output is a carbon credit called CER (Certified Emission Reduction) where each CER represents a reduction of GHG emission equals to one ton of carbon dioxide that has been verified. The credit can be sold and used by buyers to reach GHG reduction targets or even to have the carbon neutral or zero emission activity. This carbon market is commonly referred as carbon offsets or credit market.

Generally, the carbon credit market mechanism has the following process:

1. Proposal phase, which is establishment of project proposal documents compiled in accordance with applied regulations.
2. Validation phase, where the proposal documents conformity with the terms and conditions is examined.

3. Registration phase, where the project is declared eligible and recorded as crediting scheme participants.
4. Verification phase, where the results of emission reduction in a given time period are examined for correctness and suitability.
5. Publication of carbon credits, where the number of carbon credits are published based on the verification.

Indonesia will continue its carbon trading involvement through CDM, especially for projects that are already registered in the UNFCCC, participating in the development of new schemes and also try to develop the domestic carbon market as an alternative way to develop GHG reduction by market financing. The significance of this carbon market must be realized that with low-carbon development plans, given benefits are the increased efficiency, investment, the technology transfer level and for the assisted parties in enhancing sustainable development and maintaining the environment quality. Indonesia is also using the CDM scheme, especially as the benchmark for the domestic carbon market that will be developed called *Skema Karbon Nusantara* (SKN).

Indonesia does not have domestic carbon market like some other countries do. Nevertheless, the development of certification system of GHG reduction based on market mechanisms will give benefit to Indonesia as the basis for further development of domestic carbon market. SKN is the certification and registration mechanism of the GHG emissions reduction results which are voluntary, so actually there will be no obligation for anyone to be involved. SKN is very similar

to the CDM, the difference will be in its output.

SKN certified output is carbon credits that will be called *Unit Karbon Nusantara* (UKN). One UKN is equal to one ton reduction in carbon dioxide (CO<sub>2</sub>). Each UKN issued will be recorded in the SKN registry database and can be used to replace the GHG emissions that are released by the UKN owner (GHG offset).

SKN is expected to attract the private sector who are interested in reducing its GHG emissions since each UKN issued will be the evidence of the activities succeeded in reducing GHG emissions permanently, it is measurable and contributes to sustainable development. SKN can be enabled to reach the national commitment in GHG reduction up to 26% in 2020. As long as the buyer and the seller of UKN is an Indonesian entity, the resulting GHG reductions will be valued as domestic efforts of Indonesia.

Carbon markets with domestic, bilateral, regional, and international transactions are expected to complement each other as part of the financing mechanisms to mitigate climate change, which in turn will help to achieve low-carbon development, where high economic growth can still be maintained and concurrently sustains the environment for future generations. It is important to explore the implementation of carbon markets to support low-carbon development in Indonesia. One step that can be done is to estimate the potential value obtained from carbon credit based in Indonesian carbon market, as studied in this paper. Results from this paper can be used as a basis for an initial stage of a proposition in the carbon credit market mechanism.

The application of SKN with carbon credit base can give multiple advantages, not only it will reduce carbon emissions but also make a revenue from the incentives that will be provided by the UKN owner. If UKN price is adopted from CDM carbon price which is US\$ 18.64/tCO<sub>2</sub>e and the voluntary market which is US\$ 6.5/tCO<sub>2</sub>e (according to World Bank [28]), then the value of revenues obtained from carbon credit trading can be estimated. From the data in Table 2, the total blue carbon capacity in Indonesia is estimated by calculation applying Equation 1 and Equation 2. Result of the calculation of total carbon stock and blue carbon value in Indonesia is shown in Table 3.

*Total Carbon Stock<sub>i</sub>* =

$$\sum_{t=0}^n C Stock_{it} \quad (1)$$

*Blue Carbon Value<sub>i</sub>* =

$$\sum_{t=0}^n C Stock_{it} * Price (\$/t CO_2e)_t \quad (2)$$

where: *i*=habitat; *t*= time scale

Table 3. Indonesian Blue Carbon Value

Ecosystem	Annual Carbon Stock (t CO <sub>2</sub> e /yr)	Annual Blue Carbon Value (\$/yr)	
		CDM	Voluntary
Mangrove	20,437,313.4	380,951,521.8	132,842,537
Seagrass	13,200,000	264,048,000	85,800,000
Total	33,637,313.4	626,999,521.8	218,642,537

The resulted value is impressively high and has great potential to be used in conservation, maintenance, and replanting habitat of blue carbon sinks ecosystem. The more extent of conserved areas, the more carbon that can be captured so that Indonesia could become the world axis of

carbon crediting in efforts to reduce global GHG emissions. Furthermore, carbon market implementation is also expected to support the clean technology investment and stimulate the private sector to use market mechanisms in reducing emissions.

#### **Further Development: ASEAN Carbon Market**

If the development and implementation of SKN can be done appropriately, it is possible for Indonesia to develop more than a domestic carbon market. Development of a bilateral carbon markets through Indonesia and ASEAN countries cooperation will be a great way to speed up the implementation of low-carbon development in Indonesia. It will also accelerate cooperation in the implementation of the Asean Community in 2015 which now is on its ongoing progress.

This kind of implementation will acquire the benefits for both sides. This mechanism will become an incentive for ASEAN community to invest more in low-carbon activities in Indonesia. ASEAN countries will gain benefit because part of the GHG emission reduction from their investment projects in Indonesia will be claimed as a zero emission project. Indonesia also gets both economic and environmental benefits from such cooperation.

In addition, the bilateral carbon market which is addressed to be an International Offsetting Mechanism put up by Indonesia and ASEAN countries will have an equal position in international diplomacy on climate change. Eventually, the bilateral carbon trading mechanisms could become an international trading mechanism that would be approved by UNFCCC, and ASEAN will be able to

perform confidently in the global economic and development platform, with Indonesia as the leading country.

#### **CONCLUSION**

The calculations carried out in this paper give a result of the total value of carbon that can be captured by mangrove and seagrass per year in Indonesia is about 33,637,313.4 tCO<sub>2</sub>e. It is of a significantly high value and by the estimated revenue of Indonesia derived from carbon trading, Indonesia will receive US\$ 218,642,537 annually in the voluntary carbon market mechanism, whereas if Indonesia using CDM as the carbon credit market mechanism, the amount of revenue to be gained annually is estimated about US\$ 626,999,521.8. These numbers project strong stimuli for the conservation of blue carbon ecosystem, and Indonesia could implement the “zero emission development country” status in the near future, thus becoming the world axis for carbon credit market.

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# Backpacking Indonesia

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**Abstract.** This paper aims to investigate international backpackers' psychographic characteristics and the way they are an attractive target market of Indonesia tourism. Their travel behaviour, motivation of traveling, and travel experiences are being empirically explored and discussed. International visitors, considering their far-reaching role in boosting the economy, are chosen to provide the primary data for this qualitative study through semi-structured in-depth interviews with purposive sampling technique. The findings are interrogated under Grounded Theory approach. Through the analysis, it is found that backpackers are travellers who, in accordance with previous studies, prefer using local accommodation and transportation, emphasize interaction with local people and travelers, have a long duration of stay, embrace changes in the travel schedule, and do recreational activities. Yet, there are two other elements that strongly emerged and have never been comprehensively discussed in the previous literature; it is that they move from one place to another and exclude themselves from other type of tourists. Backpackers claim homogenous motivation that is to see different natural environments, to experience different cultures, and to meet new people. However in contrast, the study reveals that they exhibit heterogeneous experiences. Consequently, the author proposes a brand new categorization, the *Backpackers' Experience Spectrum*. A number of ways backpackers could enhance Indonesia development is also elaborated. It is hoped that this study gives contribution to the academic literature in tourism field as well as to the advancement of Indonesia destination marketing strategy in the future.

**Keywords:** *backpackers, Indonesia, experience, psychographic, segmentation, tourism*

## A. INTRODUCTION

The tourism sector has become one of the most significant parts of Indonesia's development. The Ministry of Tourism [1] reports that this sector raised Indonesia's GDP by \$86.2 billion in 2015 and it has shown a steady growth every year.

Table 1. Tourism performance summary  
2013-2015

	2013	2014	2015
Contribution to national GDP	9.20%	9.30%	10%
Foreign reserve (in trillion Rp)	110.5	133.9	144
Manpower (in million people)	9.6	10.3	11.3
Competitiveness Index (WEF)	#70	n.a	#50
Intl tourist (in million visit)	8.8	9.4	10

In contributing to the foreign reserve in Indonesia, tourism is ranked the fourth largest sector. This means international visitors play a far-reaching role in boosting the economy, albeit Indonesia's international openness index reported by the World Economic Forum [2] is still low and for 5 years, the country has not been able to catch up with its rivals in attracting international visitors [1].

Indonesia's tourism industry has enormous potential with the country ranking #19 in natural and #25 in cultural resources out of 141 countries in the world [2]. To maximize this potential, strategic destination marketing is needed. It requires market intelligence to bring out a clear



segmentation, targeting, and positioning strategy, but studies on this matter including the shifting market trend are still lacking.

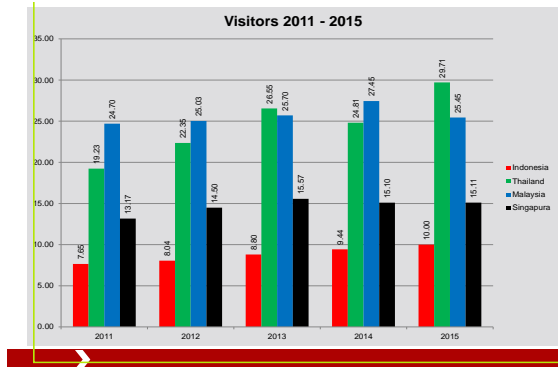


Fig 1. International visitation comparison with rivals

At the same time, recent studies in the tourism field have recognized the importance of a vast growing market: backpackers. Backpacker tourism has been argued to have a great economic significance and has been a major economic driver for a number of tourist destinations throughout the world, as explained by the Victorian Government [3]. This particular segment benefits the state of Victoria, Australia with around \$500 million in 2007, while accounting for 18% of all its international visitors [3]. The value is clearly projected by its high contribution through substantial total spending during visitation and above average duration of stay [3]. “Backpackers are also less vulnerable to fluctuating economic conditions and are more likely to be resilient travelers in the wake of challenges such as the global financial crisis” (p.5).

Yet, knowledge about the people constituting this market is still in short supply and much of the available literature merely discusses their demographic characteristics, while the psychographic

ones are considered very valuable in developing an effective destination marketing strategy.

Therefore, this paper aims to address those gaps by providing much-needed psychographic insight on behavior, motivation and experience of Indonesia’s international visitors as a vital market, in particular the backpackers.

### *Are backpackers a target market of Indonesia tourism?*

The Ministry of Tourism of Indonesia mainly segments its target market by geographical characteristic [4]. Nonetheless, additionally they also used a psychometric segmentation model based on the model of "Ark Leisure", which is an application of the universal value model by Schwartz [5]. This model is considered relevant for segmentation of leisure and tourism markets because it could show how values and beliefs shape travelers’ travel needs, which in turn affect their travel behaviour. Based on the definitional elements of each segment in this model, backpackers hypothetically fit with the characteristics of the “discoverers”.

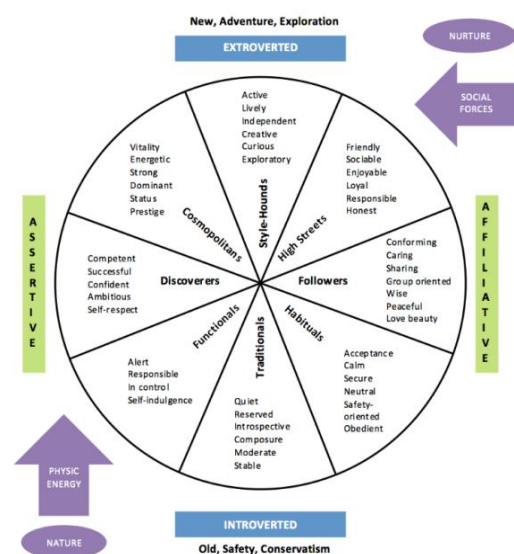


Fig 2. Ark Leisure Model

With this dense market segmentation strategy, prioritizing the best one to target is necessary due to constraints in budget and manpower. Among the various segmentation types, several researches such as Heath, Riche, and Townsend have argued that segmentation based on psychographic characteristic: consumer's activities, interests, and opinions (AIOs), are more useful and effective to construct communication within marketing strategies, than the one based on demographic characteristics [6, 7, 8].

Notwithstanding the difficulty in collecting detailed data, this piece of information is very valuable as a base for any destination marketing efforts such as designing, creating copy ideas, and selecting communication channels that resonate with the target travelers and better yet with their values.

Thus, this paper attempts to bring a comprehensive view of one specific psychographic segment that the author projects to be 'the future of Indonesia's tourism target'. It is what the Ark Leisure Model calls 'the discoverers', or in the more up-to-date term, the backpackers.

### ***Who are the backpackers?***

Often overlooked by practitioners and policy makers, backpackers began to be discussed and studied in the early 1990s, bringing recognition of their economic impact on the tourism industry. Later on, more and more studies about backpackers have generated by a number of researchers [9, 10, 11, 12, 13, 14, 15]. There are definitional elements, which were proposed by Loker-Murphy and Pearce [11], supported by the Australian International Visitor Survey data. Based on that, backpackers are travelers who:

- Have a preference for using budget accommodation
- Show an emphasis on meeting other people, locals/travelers
- Have longer rather than brief holidays
- Have flexible schedules and itineraries, which are independently organized
- Show an emphasis on informal and participatory recreation activities

In a similar yet more extreme line Uriely et al [15] mentioned three characteristics of self-defined backpackers. Backpackers are those who spend a period of months, or sometimes even years, rather than weeks; they are conscious on budget and live a low maintenance kind of living while traveling by choosing relatively cheap forms of subsistence and transport; and they are flexible and very open to any change in their travel schedule. In other words, they welcome serendipity with open arms.

In terms of demographic character, Sørensen stated that the big majority of backpackers are in the age range between 18-33, which indirectly supports the impression that most backpackers have finished their studies and started their career for a few years before their first trip [14]. Yet, studies reveal that it becomes more and more common for travelers to start their distant journey at earlier ages. Nevertheless in general, backpackers are well-educated people that mostly have an academic degree; and those who start their first trip at an earlier age mostly have an intention to continue their studies after the journey.

### ***How do tourists consume tourist experiences?***

To understand backpackers, it is fundamental to first figure out the ways in which tourists in general, consume, or in this case experience, the places they visit. The notion of tourist experience, such as perspectives on the demand factors, motivation, image, perception, and tourists' typologies, has long caught the attention of researchers in the tourism field. On one side, a number of studies explained tourist experiences as something merely superficial, with tourists traveling only for pleasure. Boorstin [16] said it is a "*trivial, superficial, frivolous pursuit of vicarious, contrived experiences, a 'pseudo-event'*" (77-117), a notion which was later reaffirmed by Turner and Ash [17] who see tourism as an escape from ordinary daily routines.

On the other side, MacCannell [18] criticized Boorstin's approach with empirical evidence, although with a selective sample of post-modern young tourists, expressing that tourists actually seek authenticity and 'real' experiences, rather than only trivial pleasure.

Clearing up the arguments, Erik Cohen created one of the leading scholarly works in the field [19] by stating that the experience tourists consume is not as simple and monolithic as argued in the earlier studies. He proposes a phenomenological typology of the experiences that portrays a chasing of superficial pleasure on one pole and the quest for meaningful authentic experience built from the relationship of one's spiritual 'center' on the other. Based on Cohen, as cited by Woodside and Martin, the concept of 'center' can be seen as "*the zone of sacred moral values that exists in every*

*society*" [19 as cited in 20]. Therefrom, Cohen proposed five modes of tourist experience, classified and distinguished by how tourists or travelers specify meanings to the center of their own culture or society in their normal life, and their search for other centers in other cultures or societies through their voyage.

		Tourism Motivations	
		Mere Pleasure	Profound Experiences
Attitudes Toward Daily Life	Alienated	Diversiory	Experiential Experimental Existential
	Meaningful	Recreational	(Humanists) (Dualists/Pluralists)

Fig 3. Cohen's modes of tourist experience [15]

The tourists in recreational mode take a break from their normal life and step outside to seek for entertainment. The experience on the trip is not personally significant, but rather seen as a recharge and refreshment before going back to the normal 'serious' living. These people seek mere pleasure and do not desire authenticity. The voyage does not have deep meaning or any kind of spiritual content.

Whereas, the tourists in diversionary mode are those who are alienated or do not even engage with the center of their own society, and do not seek for another center in another society either. They do the trip merely to heal their boredom of their 'meaningless' life. "*It is the meaningless pleasure of a center-less person*" [19,

p.186]. Glasser [21] called this kind of tourism a 'Therapy School' that helps the majority of modern urban people face their meaningless daily routine.

Tourists in the next mode, the experiential mode, feel that the center of their ordinary life is meaningless and far from the ideal. This awareness has become a common thought for many young well-educated people in their earlier stage of membership in middle class society. They strive for an experience in a meaningful center, as they want to begin to truly 'live' and they use traveling as a means to that end.

Finally, there are people in an experimental mode. They do not follow the center of their own society anymore and are in search of the best alternative. While the experiential traveler is content with knowing and observing the center of another society, the experimental goes along with it but does not want to entirely commit to it. They feel the need to see different alternatives and compare them; expecting one day to find the one that suits them best. The search itself can transform into a way of life, as it happens to the 'drifters'. They eventually become '*an eternal seeker*' [19, p.189].

The last mode in the spectrum is the existential. They once searched for spiritual center alternatives, and then entirely accepted and committed to the elected one. Berger and Luckmann [22] stated that they are spiritually 'switching worlds'. Although they have a desire to live where the elected center is, there are various reasons they cannot really move out. They then tend to live in dual worlds.

However, some people have more than one spiritual center. They are called humanists and dualist or pluralist.

Humanists have a very broad perception of their culture and live according to Goethe's saying, '*Nothing human is alien to me*'. Humanists do not follow a singular center, and rather believe that all cultures are equally valid. While the 'dualists' and 'pluralists' feel at home in one center of culture as well as in the other(s). They experience the existential mode without being estranged from the center in their own society.

Meanwhile, on backpackers in particular, Moscardo [23] collected and studied four different prior studies and found that the backpackers' major motivations of traveling are the desire for genuine and authentic experience, action and novelty, connection/ social reasons, and the accomplishment of learning. This popular argument also supports Cohen's [24] perspective, which points out that backpackers have a purpose in building a new temporary character of self that is more independent, relaxed, and courageous. This transformation or creation of the self, which is assumed to be best performed by traveling to destinations like the Third World, assembles cultural capital for the youth, which could affirm their position in the middle-class status, Desforges argued [25].

Based on the above review, the author proposes that (1) backpackers have a relatively homogenous travel style: they have a preference in using budget accommodation, show an emphasis on meeting other people, have longer rather than brief holidays, have independently organized a flexible schedule and itineraries, and show an emphasis on informal and participatory recreation activities. (2) Although only very few studies have explored backpacker

motivation and experience specifically, it is presumed that backpackers have a homogenous travel motivation: seeking for meaningful experiences in their journey, and (3) they are an attractive market for Indonesia and potentially give contribution to its development. These propositions are investigated empirically through an in-depth field research.

## **B. METHODOLOGY**

To provide a framework in conducting the study, the interpretivist paradigm is chosen for its suitability to seek out insight, meaning, and profound understanding. Interpretivists believe that different participants experience the organisational reality differently. This study is an exploratory research that shows unique views and studies change rather than stable issues and uses an inductive or bottom-up approach, unlike the majority of management, tourism and hospitality studies.

As opposed to the deductive approach, in the inductive approach the researcher puts less emphasis on the previous literature and hence has less predetermined ideas. Accordingly, the researcher has an open mind to see anything beyond the research situation. It allows her to understand what actually matters for and concerns the participants.

The Grounded Theory method, an inductive research design is selected, as it possesses all fundamental characteristics of a qualitative study but takes it to another level with its potential to develop new theoretical concepts. However, it is known that one of the difficulties of using this approach is the process of generating the final result from a descriptive narrative and notes. This is a process that requires

sustainable mental energy of the researcher, as mentioned by Collis [26]. Therefore it is necessary to choose the most optimal method in collecting and analysing the data.

Semi-structured interviews, which put more focus and interest in the participant's point of view, were conducted to collect the data. Applying the purposive sampling technique, ten international backpackers who have been to Indonesia were chosen due to their possession of experience, information, and perception of their journey. The question guidelines were established beforehand, but participants were encouraged to elaborate, explain deeper, and improvise.

Lastly, to analyse the data, the researcher creates a textual database matrix, and then discovers labels to variables that can be seen or constructed. Those variables are then clustered into themes. Subsequently, the researcher investigates the occurrence of any pattern and correlation, makes a comparison between participants' narratives, as well as analyses the way in which each of two or more concepts or themes is related.

## **C. RESULT**

On the backpackers' demographic profile, the finding is almost fully conforming to Sørensen's [14] assessment described previously. The majority of them are 19-27 years old, more than half have Master's degree and the rest have a Bachelor's degree, all in various fields of study. The occupations are either higher education student, or worker in the early stage of the career.

On the psychographic profile, the analyses are clustered into three main themes: behaviour, motivation, and experience.

## **Backpackers' Behaviour**

### **“We Choose Budget Transportation and Accommodation.”**

Various kinds of transportation are used by the backpackers while traveling within the destination country: scooters to move from one town to another, boats from one island to another, mini-buses, and less often than the others, taxi. There is no exact pattern on how they use the means of transportation, but almost always, they put the focus on its functionality and its value for money.

In terms of places to stay, all the participants exhibit the same preference, which is local budget accommodation instead of fancy big chain hotels. This includes hostels, small apartments, and small family guesthouses owned and managed by the local people. The reason is mainly “Because we did not want to spend that much money” as Participant 6 stated.

However, a few participants put uniqueness and ambience as the main concern. Among others Participant 3 mentioned, “The showers are mostly in open area, and I mean from Germany you don't know that, because you never really have a shower outside!”

Another reason of choice is strongly related with interaction. Participant 4 explained, “The guesthouses are the perfect mix... You have the place where the family sleeps, the temple, and then three rooms for three guests. So it's one campus where the family and you live together, close [*claps his hands*]. You have your own room with a western standard, but right next door to the Balinese local families.”

### **“We Interact with Other People.”**

The participants showed varying degrees of interaction with locals and other

travelers, but all of them do it to some extent. Interactions with locals are usually very memorable for the backpackers; it portrays how different the local culture is from the culture they come from. Participant 1 elaborated one of his most memorable experiences in Indonesia, “When kids turn 7 months, there was a huge celebration with dances going on and singing and drumming and eating as well, very interesting. Very, very interesting. We were given the traditional costume that we wear, it was great, and then we sat next to the people who were telling us 'now this happens, now that happens' really interesting. It was a family thing”.

In terms of the interactions with other travelers, it is most often portrayed in the form of exchanging information about destination, accommodation, and places of interest. It is possible that the common ‘status’ they shared as a traveler and the same place of origin makes the information seen as a highly influential recommendation. The strength of this recommendation comes to a point where a backpacker could even change her initially sound plan solely because of what other travelers said. It is also possible that this matter correlates with the fourth element of backpackers’ behavior: the ‘embracing serendipity’ mindset they have during the journey.

An interesting point is found in the case of Participant 2, which shows that the interaction between travelers is found to be a lot more intense in the journey of solo-travelers. When he travels by himself, he interacts with a lot of people and it is really interesting that he actually has never been truly alone. “When you met someone in the morning and said ‘oh you want to go there and yeah I want to go there as well’, you would spend the whole day together and it’s

like if you travel with a friend, but it's just... everyday, another friend. That's the thing", he explained.

### **“We Stay Much Longer.”**

All the participants stayed in Indonesia for two weeks minimum, with almost half of them staying for a month and longer. Backpackers' duration of stay is considered longer than the brief holidays common in other segments. It is certainly much longer than the average days of stay of Indonesia's international visitors, which is 7.8 days [4].

### **“We Wing Our Travel Schedule.”**

All the participants claim that they organized their travel schedule independently and they have a rather flexible than a fix and well-planned travel schedule and itinerary of the journey. They usually just booked the flight to the destination and the flight back home, “and everything in between we explored... If I wake up early I could go on to another city, if I sleep a little bit long I stay for another day. I don't know, there wasn't any plan”, Participant 2 stated. It also can be concluded from the findings that the more experienced a traveler is, the more flexibility he or she tends to have.

### **“We Fancy Nature and Culture Related Things.”**

The participants portray a high range of variety in terms of activities they engage with during their travel in Indonesia. These activities can be categorized in two big themes: environmental or nature experiences and culture experiences.

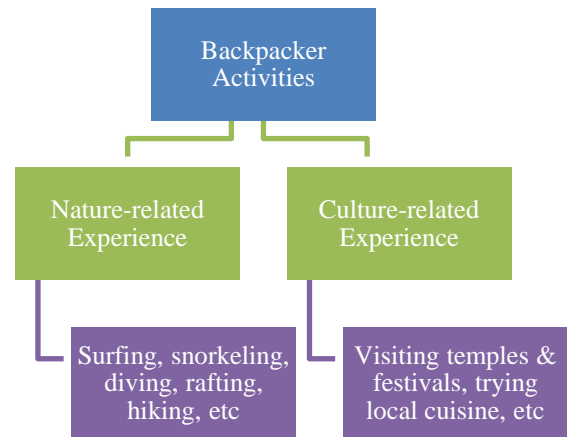


Fig 4. Backpackers' activities diagram

Besides the five aspects of backpackers' behaviour discussed that are conforming to the literature review, the following points are two elements that strongly emerged in this empirical study and kept occurring during the interviews. These two elements have never been comprehensively discussed in the previous backpackers literature.

### **“We Move from One Place to Another.”**

First, during the journey, none of the participants only stayed in one place, but rather frequently moved from one town or from one island, to another. Participant 6 stated, “We started out in Yogyakarta and stayed there for 5 days, then took a bus to Mount Bromo and then Ijen... And then took a ferry from Banyuwangi to Gilimanuk, we took a driver to Ubud and stayed there for 4 days, and then took a boat to Gili Air, where we spent 5 days, and then 3 more days in Lombok”.

It is possible that this frequent movement is one of the main reasons why they travel with backpacks or other kind of simple carrier. The reason behind their frequent movement is connected to their motivation of travel, which will be elaborated later in this chapter.

### **“We Are Not (Ordinary) Tourists.”**

Second, they put a strong emphasis on their resistance to visit any kind of destination where there are too many tourists, and relate those destinations with lacking of authenticity. “I think it's really important if you go somewhere to not be at really touristic area, but where you can experience the actual culture of the country”, Participant 3 stated.

The resistance is found all over the interviews. Participant 1 expressed his disappointment by stating, “I felt like Bali is too touristy and it wasn't enough Indonesia because there was time where you could walk down the street for 5-10 minutes and you only see Australians and Germans and Europeans and I felt like 'come on man...' and there's a lot of places in Bali that have restaurants with English descriptions so I thought like 'this is too English'. I'm looking for something more authentic, more local, where I have to engage, where I have to make efforts to understand the country, I don't like when it's too easy, you know.”

He also shared his aspiration about the next trip to Indonesia, “... [I will go to] some places that is even more remote and even less explored by tourist, Borneo would be a challenge; it would be something else.” Along a similar line, Participant 2 mentioned his preference by saying, “What I like about Java and Sumatra is the fact that there are not that many tourist as there are in Thailand and Cambodia... The people you meet are not really used to tourists so sometimes it was really difficult to communicate because they can't speak English... It's exciting, it's an adventure, and it's nice to explore the things and alone not with many tourists around”.

From the testimonials, they strongly

define themselves as something more than just ordinary tourists, and do not want to be seen as such.

### **Backpackers' Motivation**

When being asked about the reason to travel, all the participants in this study answered in a very similar way, as if they had the same script in their mind about the idea of backpackers' motivation of travel. Participant 6 said, “I just love to experience new countries and cultures and meet new people... There are so incredibly many interesting places to go and see, and I get so inspired by visiting them, I just love it!” while Participant 2 stated “One thing is for sure that is to see different natures, and different countries, and different places, historical places, and of course to get to know other cultures”.

The rest of the participants mentioned the same idea, each expressing it only in a slightly different way. It can be concluded that all the participants in this study claimed homogenous motivation, which is essentially to see and experience different countries, natures, and culture.

### **Backpackers' Experience**

The following figure draws experiences of ten different participants in this empirical study in Experience Mode matrix drawn by Uriely et al [15].



		Tourism Motivations			
		Mere Pleasure		Profound Experience	
Attitude Toward Daily Life	Alienated	Diversionsary	Experiential		
			P1	P3	P6
			Experimental		
			P9		
	Meaningful	Recreational	Existential		
			P4		
			Humanist		
			P2	P5	P10
Dualist/Pluralist					
P7		P8			

Fig 5. Backpackers' experience drawn in Cohen's phenomenology of tourist experience (P in P1-P10 stands for Participant)

Considering the heterogeneity and the difficulty in finding distinct patterns of backpackers' experience with Cohen's framework of experiences of more general tourists, the author analyses and proposes a brand new categorization, the *Backpackers' Experience Spectrum*, which is shown and elaborated below.

To enjoy	To understand	To compare	To commit	To integrate
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Fig 6. Backpackers' experience spectrum

### To Enjoy

In contrast with the popular assumption of backpackers' authentic experience, it is found that backpackers may also perform what Boorstin [16] calls a "... *frivolous pursuit of vicarious, contrived experiences, a 'pseudo-event'*" (p.77-117). Some of the participants in this study engage in activities that are neither reflected in nor relate to any deep meaning of the center of the culture and society of the destination. Participant 1 explained, "So what we did was surfing, snorkeling, swimming, cliff jumping, rafting... The guy who introduced us to Bali is a surfing fan

and we thought it might be a very interesting activity, which it is. Snorkeling because the underwater scenery is beautiful, rafting because it is a fun activity that you cannot do in Europe."

The journey itself is somewhat interesting, however, it creates no substantial change to the backpacker's personality, as he expressed, "I think it was unusual because we had so many activities, there was always something going on everyday, *bam-bam*, that was interesting. But I wouldn't say it has a great impact on my personality, I wouldn't say that".

This category of experience is in accordance with the Recreational tourism in Cohen's five modes of tourist experience. These participants do not hope to and therefore do not make meaningful connections with the 'center' in the culture they visit.

### To Understand

The next experience category the participants portray is seeing the center, being aware of the way it differs from their center back home, and understanding it. Participant 3 elaborated, "To understand the meaning behind it for Indonesian people is just what was so interesting about it. To see 'OK it's not just a place where they pray, it's something they turn for everything and that they have it within their living', that they have like little temple in every house. And that was something, which for us is so different. I thought it was really really pretty".

Substantially conforming to Cohen's experiential mode, the participants are generally satisfied only to know that another way of living exists somewhere outside their culture, without making any change to their personality. As Participant 1

explained, “I’m going to see a new place I haven’t seen before and understand more about the people, and the culture, and the tradition in that area, but I didn’t expect that to change my character. It changed my perspective, I have a great awareness but I was quite open to new stuff anyway”.

An interesting point was shared by Participant 6 who explained that it is rather an occasional matter, she said “Because this is not the first trip of that kind that I took, it really wasn’t about changing my life or my character, but it was really just about getting to know places and cultures that were unfamiliar and new”.

### **To Compare**

The next category that can be drawn is the experience of understanding the center of the culture visited, and comparing it with other centers in other cultures. Participant 9 strongly exhibits this tendency throughout the interview. As claimed by himself, he is a heavy traveler who spends more time on the road than staying in one place, who has a big interest in religion, culture, and the mentality of people. During his journey, he likes to compare cultures, for instance the way a religion is practiced in several different countries. “Islam in Arabic countries like Iran, central Asia, South East Asia, is very different”, he stated.

In accordance with Cohen’s experimental mode, Participant 9 expressed the transformation of his traveling purpose, which leads him to a final conclusion that the search itself is his way of life. He said, “In the beginning maybe... I look for something different and runaway from reality. But after a while, I just started looking for something, and after a while, I think... Ah, it doesn’t matter if I find it; it’s

not the point”. However, unlike Cohen’s ‘*eternal seeker*’, Participant 9 shows his awareness about the transformation and that in the future, there would be a point where he would eventually settle down.

### **To Commit**

The next category of backpackers’ experience is committing to the other center in the society that is visited. Participant 4 shows a strong inclination toward this category, as he said, “I call it the second home, because of the people, the Indonesian people. They are helping and friendly and once I learned a little Indonesian language, it’s like I got to know the people better... their thoughts, how they act, why they act like that... how to talk with them”.

He believes that the center and the value system where he was born and raised in is not the ideal center for him, and that the new center he found in Indonesia counts as a center that better resonates with himself. In this regard, he expressed his personal judgments toward the center in his society back home, and tends to be hypercritical about it. “Another thing that I really, really, really like [about Indonesia], it’s about respect, the culture. [In Indonesia,] the elder people are more respected and here, in western countries... not many people do it”. He also added, “They [Indonesian people] are happy about what they’re doing because they do what they like... There’s a big pressure here in western culture for your career. The whole system forces you into one thing, like if you want to have a good job you need to do good A-levels in school, get a good study, *blah blah blah*... And over there they just try and do what they like and become happy first and then make money... For me

the happiness is really, really, really important”.

His commitment to the center in the Indonesian or, in particular, Balinese culture can also be noticed by how many times he visited. He claimed that he has been there ten times, and the duration of his stay has always been four weeks or longer. “It’s like really cool how it connects and how it becomes a part of my life”.

### **To Integrate**

The last category includes understanding that there are a lot of centers out there, and integrating them, taking the best of both or all worlds. At this stage, the experience has changed some part of the self and the person’s values. Participant 2 explained his transformation, “[You would become] more open-minded than you were before in the end. And then you are much more flexible, because even when you have a plan for a few days, it never works like this, because the bus is broken, or... there are so many things, you can’t imagine... Just more relaxed when there is no bus today then you would say 'ok let's go another day'”.

He mentioned the comparison of his old and new self. He said, “... It's typical German, I would like to have people to be on time and in the beginning of traveling, it made me crazy. It made me crazy. The bus is coming two hours late, and you staying there, you don't even know if the bus is really coming *hahaha*... It was a few situations that would've been driven me crazy at the beginning of the trip but in the end I get used to it.”

He sees the transformation as an improvement. “It's still a bit better than (I was) before. I notice it, when I see other tourist sitting there alone, looking for

something, I automatically get in contact with them and ask 'what are you looking for, can I help you'... I do it more often, much more often then I did before I traveled”.

Participant 10’s journey is also personally significant. Her motivation to travel is “to get new visions of the world, new ideas about how to manage life”, and she believes that what one will get depends on what one is looking for.

She is aware that every center has its pretty and bad sides, and looking for the ‘pretty sides’ and then integrating it to her overall value leads her to become a much more open-minded and respectful person, especially towards different lifestyles and cultures. She is aware of how traveling changed her character and how much she embraced it. This positive attitude allows her to make the best out of it. This enlightened backpackers stated, “Yes, just accepting a different lifestyle and knowing that every life is worth, on earth, not depending on whatever you do, wherever you come from, and that there is always a kind of purpose for everyone”.

### **Backpackers’ Significance**

Drawing from the empirical study, it is highly possible that backpackers is an attractive market that potentially provide meaningful contributions to the development of tourism in Indonesia. This argument is built upon the following points.

In accordance with Stivala [27], their preference for using budget option of transport and subsistence is likely more than compensated by the fact that they have a much longer length of stay than any other type of tourists. Moreover, they also prefer to consume local products and accommodation, which means their

spending goes directly to local economies. This behaviour stimulates local participation, which leads to a more sustainable development.

Their spending is also widely distributed because they travel to several places, often to the places that are less popular than mass tourism destinations, and even off the beaten tracks. This is important especially for a country like Indonesia that has numerous and extremely spread-out travel destination points. In addition, backpackers value, above all else, natural and cultural experiences. Since Indonesia offers both in abundance, attracting this segment of tourists is something that requires little effort from the country.

Further research on social and economic implications of backpackers for the destination and the extent of traveling as cultural capital are needed to develop a more comprehensive input towards a better tourism of Indonesia.

#### **D. CONCLUSION**

Based on the empirical study, backpackers choose budget accommodation and transportation, interact with other people, stay much longer, wing their travel schedule, and fancy nature and culture related activities. These findings are in accordance with the literature review, but there are two other elements that strongly emerged and have never been comprehensively discussed in the previous backpackers or tourism literature, it is that they move from one place to another, and they exclude themselves from other tourists.

They claim homogenous motivations, which are to see different natural environments, to experience different cultures, and to meet new people. However,

it is problematic to assume that just because they are in the same demographic character, showing similar travel behaviour, and even claim a similar motivation, that they possess the same values and reflect the same experience. They are said to be the type of tourist that always seeks for authenticity and is on a quest for deep meaning along the backpacking journey, yet this paper reveals that backpackers exhibit heterogeneous experiences, and that one backpacker does not necessarily assign the same meaning to the journey as another. Consequently, this study proposes a brand new categorization of backpackers' real experience, the *Backpackers' Experience Spectrum* [Fig. 6].

Backpackers potentially provide meaningful contributions to the development of tourism in Indonesia, considering their long length of stay, their travel behaviour that stimulates sustainable development, their widely distributed spending, and their seek of natural and cultural experiences that match with what Indonesia offers.

#### **ACKNOWLEDGEMENT**

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encouragement from Simon Wurster, M.Sc. throughout the entire process. To them, the author expresses sincere gratitude and deep appreciation.

This work has built upon the courage to dig into deeper meaning of traveling. It is dedicated to those who are in the quest of meaningful experience, and those who make the best out of their journey.

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# Overview of Indonesia's Maritime Axis Policy on National Education Development

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**Abstract.** Indonesia is the world largest archipelago country that stretches between its islands and seas. It is expected that the elected President Joko Widodo and his government started mention it at the beginning of his leadership that Indonesia should be the world maritime center. It is certainly an encouraging news for the Indonesian population in remote areas, in which the access to transport from one area to another need to be improved. It should also give a very large effect on the education in Indonesia, because Eastern Indonesia, which consists of smaller islands, generally has higher rate of uneducated than the Western Indonesia. The gap between rural areas and urban areas are also larger in Eastern Indonesia than in Western Indonesia, access to transport is allegedly one of the causes of the low education participation in the eastern region. In addition to the lack of central government's control due to distance to the capital, the problem also may come from the transportation issues. The government's maritime policy will advance Indonesia education and have positive impact on Indonesia, even internationally. This paper will explain more about the picture of education in Indonesia based on the islands division of Indonesia from its western most point to the eastern end, based on the performance of each region, distinguishing characteristics and constraints faced by each region related to education so that the government can rightly determine what is the best policy for education across Indonesia.

**Keywords:** *Education, Maritime Axis, Regional Gap, Policy*

## A. INTRODUCTION

Basic education has been the objective of generations of teachers, parents and government leaders. It is a fundamental human right, both in international convention on economic, cultural, and social rights of the child. In 1872, Japan's educational code promised that there would be "no community with an illiterate family, nor a family with an illiterate person" (Ogata et al [1]). Similar campaigns of education for self-reliance were advanced by Ghana's Kwame Nkrumah, Tanzanian's Julius Nyerere, Kenyas's Jomo Kenyatta and others in post-independence Africa (Nkrumah et al [2]). Unfortunately, Indonesia as one of developing countries,

the largest economy in Southeast Asia still faces the problem of uneducated children.

Inequality is important because its close relation with growth and poverty. Another reason why inequality matters in development is that people incessantly compare themselves with their neighbors (Suryadarma et al [3]). One's welfare is not solely determined by how many goods one is able to buy but also how many goods one could buy relative to his or her neighbor. For this reason, high inequality has been blamed as one of the causes of social unrest in countries where economic grow relatively strong and poverty is low and manageable, for example in Indonesia in 1998 (Booth [4]).

In 1998, large portions of education managements are delegated to the regional provinces. Although various policies have been developed by its government to increase the national education equality, these policies are still not well-implemented and well-distributed. The education level varies unevenly across its provinces. There are several types of regional segregation in Indonesia, in this paper we focuses on the Western Indonesia versus Eastern Indonesia segregation. Western Indonesia consists of Java, Bali, Sumatra and Kalimantan, while Eastern Indonesia are made up of Sulawesi, Nusa Tenggara Archipelago, Maluku Archipelago, and Papua. Western Indonesia, especially Java and Bali, are significantly more developed than Eastern Indonesia in terms of economic activity, infrastructure, and population. Because of that in some studies Java and Bali are often grouped together and discussed separately from the other region. Eastern Indonesia, which consists of smaller islands, generally has lower education quality compared to the western Indonesia [5]).

In addition, when we disaggregate the country into urban and rural areas, one can find that the gap between rural areas and urban areas are also larger in Eastern Indonesia than in Western Indonesia (Suryadarma [3]). One of main cause of low education participation in eastern region is the low access to transportation. The maritime policy was proposed by Joko Widodo at the beginning of his leadership to improve Indonesia economic condition through effective and efficient sea transportation and logistics. The government's maritime policy can be expected to advance Indonesia education and have positive impact on Indonesia.

Utilizing data based on Indonesia national representative household surveys by Indonesian Central Bureau of Statistics (Suryadharma et al [6]) (BPS [7]), we discuss the education gap across Indonesia regions In Section B. In Section C, the discussion on the disparity is expanded to the human development and related socio-economy factors. We will describe the main policy of maritime axis policy in Section D and analyze it relation with national education equality in Section E . Finally, we will summarize our finding in Section F.

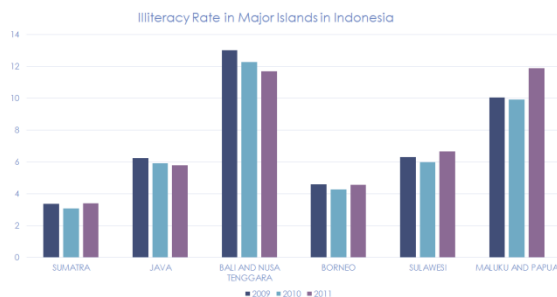
## **B. EDUCATION DISPARITY**

In Indonesian Principal Constitution, the 1945 Constitution stipulated that every Indonesian citizen should have the right to obtain a quality basic education. Compulsory primary education for children aged 7 to 12 years of age was made a national policy in 1985. In 1994, Indonesia extended basic education by including 13 to 15 years old, that is, the lower secondary years. In 2005, tuition fees were abolished under the Free Basic Education policy and block grants were made to schools to compensate. Most recently, in 2013, the Ministry of Education and Culture (MOEC) has extended the need for compulsory education to include the upper secondary years (equivalent to high school, up to 18 years old). Although the bar has been raised, in recent years, the high illiteracy and children uneducated rate in eastern Indonesia, in comparison to western Indonesia (BPS [7]), is still a central concern of government policies and NGO's activities across its region.

Since 1998, regional provinces in Indonesia received greater autonomy due to the commencement of a reformation movement across Indonesia. Large portions



of education management were delegated to regional governments with the objective of empowering these regional governments to manage education in their area, especially from the levels of preschool to high school. Decentralization may seem to be beneficial (Namukasa et al [10]), however there is concern about the consistency with which national quality standards are being applied at local levels. There is also concern that funds intended for schools are sometimes diverted to support other local priorities. Regional governments now play an important role in managing the education system, and school principals exercise far more responsibility as managers than in the past (Komatsu [11]).



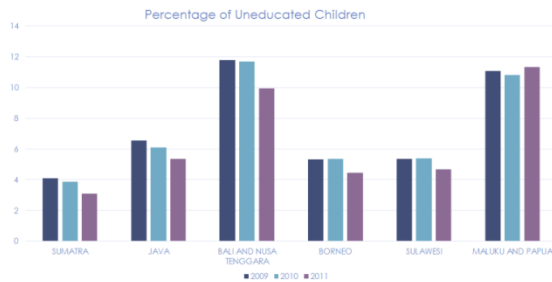
**Figure 2. The illiteracy of Indonesia regions in recent years. The value is the averaged value of the provinces. The low illiteracy region: Sumatra, Java and Borneo are in the western Indonesia [7].**

Disparity between provinces in Indonesia is still severe especially in economic and education aspects. This condition has been the real problem particularly between the Western and the Eastern part of Indonesia. The picture of disparity in education, for example, is obviously seen on the facilities provided in some regions. It is common to see a primary school with a permanent building, good tables and chairs in Medan (capital

city of North Sumatra), while in East Nusa Tenggara the students might have to be satisfied with a school building with old roofs with leakages and limited adequate tables and chairs (Samosir [12]).

The attempt to improve education growth through education infrastructure can be seen from the number of teacher. The growth in teacher numbers during the past decade in Indonesia has been spectacular (BPS [7]). It is estimated that, since 2004, the number of primary school teachers has increased by 30%, while the number of primary school students has remained more or less constant. However, the increased student-to teacher ratios are not happening evenly across Indonesia (Azzizah [5]). The major improvements were never beyond Java and Bali areas. Teachers employed in rural and remote regions continue to be the less qualified. Because of the decentralization, the capacity of MOEC to do much about these geographic disparities is limited. Whether the quality of education has improved as a consequence of the improvements in student-to-teacher ratios is now a matter of regional policy concern (ASEAN Secretariat [13]).

We can see how much the community pay attention to education by evaluating the education participation. In this regards, the regional education quality can be measured by the Net Enrollment Rate (NER) of the respective province. As we can see in Figure 4, there is an inequality in the distributions of NER across the western and eastern region. In the next section the relation between the regional education quality and regional development, emphasizing on the eastern-western gap is discussed.

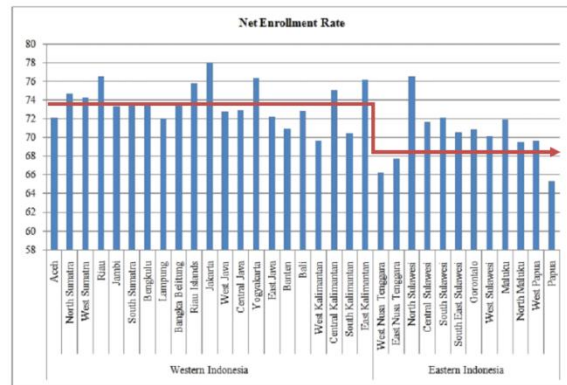


**Figure 3. The uneducated rate of Indonesia children per regions in recent years. The value is the averaged value of the provinces. Western Indonesia (includes Sumatra, Java and Borneo) has low uneducated rate [7].**

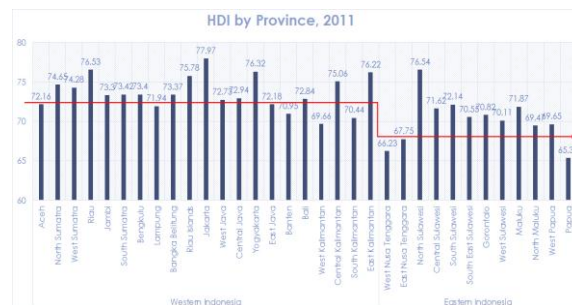
### C. EDUCATION AND REGIONAL DEVELOPMENT

There is a pressing need across the country to develop human resource capacity at the district education office level, especially in the poorer regions of the country. The development of human resources can be measured by Human Development Index (HDI). HDI is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions (UNDP [8]).

The condition of human development, as represented by HDI from the western to the eastern region of Indonesia can be seen in Figure 5. The average value of the provinces' HDI is 72.77. The lowest value of 65.36 corresponds to Papua, the eastern most region of Indonesia, while the highest value of 77.97 corresponds to the capital region, Jakarta (BPS [7]). One can



**Figure 4. Net enrollment rate (NER) of Indonesia provinces. Eastern Indonesia generally has lower NER than Western Indonesia [7].**

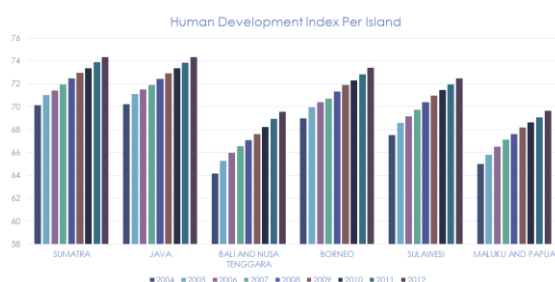


**Figure 5. Human Development Index (HDI) of Indonesian provinces. HDI of provinces in Western Indonesia are generally higher than in the Eastern [7].**

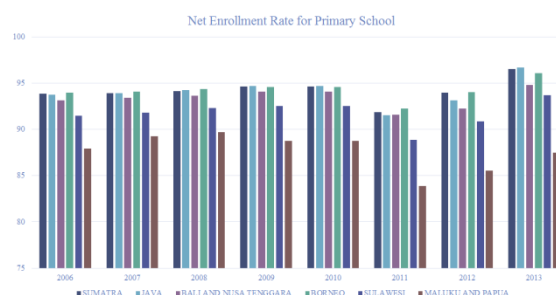
Also notice that the western regions of Indonesia tend to have higher HDI than the eastern (provinces in Sulawesi, Maluku, Papua and Nusa Tenggara). Although the national quality of human resources is increasing in the recent decade, we can still see a clear disparity between eastern and western provinces by examining the HDI growth of islands groups in Figure 6. The increase of national human development is also due to the increase of national education quality in recent years. Although,

similarly, the disparity can be clearly seen (Figure 7).

Furthermore, poverty, which are the most influencing socio-economy factor to education, is decreasing in recent years. However the disparity is also remaining throughout the years (Figure 8). Although, poverty is a condition of various deprivations due to a lack of empowerment and command over resources (Handayani [14]), it is a sad reality for a resourceful region to have high poverty. Therefore a significant change on Indonesian systems is needed for the improvement of its condition, particularly for eastern provinces, because the increase of education level will increase its human development more than western (Azzizah [5]).



**Figure 6. The development of HDI of Indonesian provinces in the recent decade. The value is the averaged value of the provinces in the respective island groups [7].**



**Figure 7. The recent development of NER in Indonesian provinces. Since 2011 NER are increasing, but the eastern area are constantly has low enrollment rate [7].**

To overcome this disparity, under the vision of "Developing the national education system into a strong and respected social institution which empowers all citizens of Indonesia to become enlightened human beings who are able to keep abreast of the challenges of the time", various policies have been developed by the Indonesian government. However these policies are still not well implemented or well distributed.

The issues faced by education authorities in delivering the teaching to rural, even remote areas have been an ongoing challenge, especially for developing countries (Chimombo [9]). Even the research and methodology on this provides no easy answer. However, in our previous research, we were able to quantify and confirmed the education western-eastern disparity and found that there is also a disparity on how the regional education quality is influenced by socio-economic factors in Indonesia (Azzizah [5]). Those socio-economic factors are, in the most influencing order,

### 1. Poverty,

Eastern education will increase more than western when the poverty decreases.

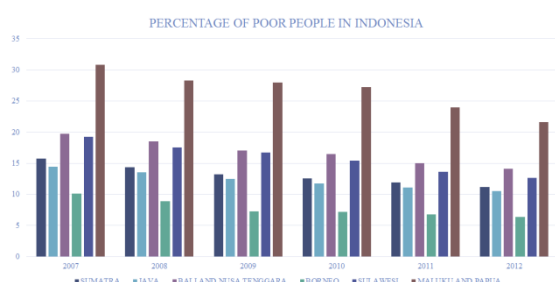
### 2. Gross Domestic Product (GDP) Growth,

The education growth will increase the GDP growth of eastern more than western.

### 3. Income Inequality measured by Gini index.

Eastern education will increase more than western when the income inequalities decrease.

This result means that the eastern education quality can be increased by reducing the poverty and income inequality. Furthermore the other hand when the education improves, GDP growth of Eastern Indonesia will increase more than Western. These conditions indicate that the current socio-economic of eastern Indonesia is low and the current GDP growth isn't supported by Educated Human resources.



**Figure 8. The drop of poverty across Indonesian provinces in the recent years.**

The value is the averaged value of the provinces in the respective island groups. Western Indonesia (includes Sumatra, Java and Borneo) has low percentage of poor people [7].

## D. MARITIME AXIS POLICY

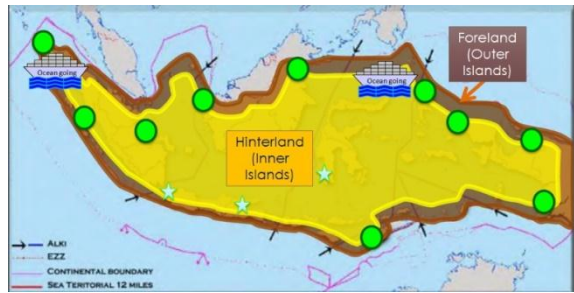
The elected President Joko Widodo first came up with the idea of reviving Indonesia as an archipelagic state in his preparation for presidential election campaign in May 2014 (Pattiselanno [16]). On the later the presidential election debate, he elaborated the idea that Indonesia will aim to become the World Maritime Axis under his leadership (Shekhar [17]). After Joko Widodo got elected, he reaffirmed his maritime vision in the speech where he claimed his electoral victory and in the following inauguration speech in the parliament (Xue [18]). He also elaborates the concepts in the ASEAN Summit in Myanmar on November 13, 2014. He developed his concept of the World Maritime Axis and broke it down to five pillars that need to be strengthening (Manggala [15]):

1. Maritime culture
2. Maritime resources
3. Maritime infrastructure
4. Maritime diplomacy
5. Maritime defense capacity

If successfully combined, these pillars can strengthen Indonesia's national identity, security, economy and even its soft power. Which in return will elevate the country's status and position among ASEAN countries and the world (Nelson et al [19]).

Maritime axis policy emphasizes the importance of the islands near the border as ports to connect the economics and protect national resources, especially the ocean natural resources, from piracy. Answering the demand and vision of Joko Widodo, the ministry of marine and fisheries of Indonesia has focus the policies to protect the resources from external piracy (Widhiarto [20]). As result, the drop of

resources piracy has been the media's focus in the past year.



**Figure 9. Foreland and hinterland areas as new focuses in maritime axis policy.**

**The ship symbols indicate the International hub ports, which are in Kuala Tanjung, North Sumatera and Bitung, North Sulawesi, star symbols indicate the established ports, and green circles indicate the potential ports as a new economy centers [21].**

Since the eastern Indonesia consists of more small islands, the maritime axis policy will certainly induce a significant improvement for eastern Indonesia. One of maritime axis policy's targets is to improve the activities of eastern Indonesia as foreland, i.e. area connected by islands near the border of Indonesia, as can be seen in Figure 9.

In maritime axis policy, sea ports play a great role. Sea ports are the new economic centers that connect the economics of the neighboring islands and create a national network, as seen in Figure 10. To support the ports as the center of economics in maritime axis policy, effective sea transportation from one island to another is needed. Current government proposes a national project called sea toll. Sea toll is a connections of effective sea transportation, in the form of frequent and scheduled sea

transportations from Indonesia western most region to eastern most region.

In building the sea toll, some elements are set and planned (Prihartono [21]). In our study, we discuss and analyze the following priorities of sea toll

1. Scheduled and frequent
2. Effective inland access
3. Shipping industry
4. Reliable sea ports

A glance over the priorities and the five pillar of the policy in section D, one can see that a large number of good qualities of human resources are needed. Alongside this, various kind of job opportunities in various levels of expertise are demanded. These job opportunities will certainly induce a large wave of education awareness. We will discuss how the sea toll priorities can induce the increase of national education equality in next section.



**Figure 10. The 24 Sea Ports for Indonesia Maritime Axis Strategy: Optimizing the major and feeder ports was necessary to be in line with Jokowi's concept of Indonesia becoming renowned once more as a global maritime axis [21].**

## **E. SEA TOLL AND EDUCATION DEVELOPMENT**

From the fact that Indonesia is the world largest archipelago country that stretches between its islands and seas, it should be expected that the elected

President Joko Widodo and his government mentioned that Indonesia should be the world maritime center at the beginning of his leadership.

However a lot have to be worked out to improve the current condition. The recent condition of the quality of the sea transportation can be seen from the following comparison of prices. The price of 1 kg flour in Surabaya is Rp 7500, while in South Kalimantan it costs Rp 9500 and in Maluku it costs Rp 10000. Another comparison is the price of 1 piece of instant noodle. In Jakarta it costs Rp 3500, while in Kalimantan it costs Rp 5500 and in Papua it costs Rp 8000 (Prihartono [21]). The current quality of sea transportation has resulted in that large difference of price. Although the products mentioned are available across the country, they are mainly produced in Java and distributed across the country utilizing the sea transportation.

The shipping cost is an immediate problem that is aimed to be tackled by the sea toll policy. Currently, the shipping cost of 20 feet container from Jakarta to Padang, West Sumatra is around \$ 700. While from Jakarta to Papua it costs \$ 2500. On the other hand, the international shipping from Jakarta to Shanghai only cost \$ 450. It is surprising that the national shipping cost is more expensive than the international shipping. Because of this the price of the same product are more expensive in the Papua (east most region) than Jakarta (capital), more than 200%. The high shipping cost make the price of imported products (from China, Australia) cheaper than the product of the country's far region. As a result, the logistic cost waste of domestic products reached 24.5% of Indonesia total GDP.

The implementation of sea toll and its priorities can improve the current economic condition and also increase the education development.

### **1. Scheduled and Frequent**

As we can see in any developed countries, they key of effective and efficient transportation and logistics is a scheduled and frequent transportation and logistics. Because of that, it is the most important priorities f sea toll policies.

One of the reasons of the current expensive price in eastern Indonesia is the uncertainty of the availability of the products. This uncertainty causes the speculation of prices to increase the profit. With scheduled and frequent shipping, the uncertainty of the products' availability will dramatically decrease which will result in the drop of the price. The drop of price will increase the economic condition and consequently the education quality. Cheaper education tools logistic can be achieved.

### **2. Effective Inland Access**

The next priority is to connect the sea toll to inland logistics and transportation. Not only will it increase the equality of the region in term of economical income, it will increase the education access in remote part of Indonesia.

In recent years, the education access in eastern Indonesia is still very difficult. Students often need to travels kilometers to go to school. By the implementation of the effective inland access, the inland transportation will also be improved. The education access is also expected to get easier. So that the children in the remotest region has the same education opportunity as in the urban area.

Furthermore the inland access will improve the interregional human resources



transfer. Good quality human resources can be easily transferred, particularly the eastern area. Therefore the disparity of human development in the island can be reduced, as the result the regional education quality will certainly be improved.

### **3. Shipping Industry**

For an effective sea toll logistics, strong shipping industries are absolutely needed. Strong shipping industry needs a good insurance, which will reduce the uncertainty. It reduces the shipping cost because no double cost of shipping is needed. The shipping cost of education materials will also reduce. Easier, cheaper logistic will also improve the logistic of education infrastructure, which will reduce the cost of education tools (textbooks, whiteboard, etc.) in the remote areas. The quality of the education tools will increase and the regional disparity will reduce.

Furthermore the interregional trade will be enhanced. Then the Human Resources quality will also improve. Good quality human resources can be easily transferred, especially to the eastern area. Therefore the disparity of human development between the islands can be reduced, as the result the national education equality will certainly be improved.

### **4. Reliable Sea Ports**

Reliable sea ports need a quality standard that will reduce the interregional disparities and increase the security. A better security will reduce the uncertainties. Which will result on the drop of the prices and better economy. A reliable sea ports also need good quality human resources, in other word, a better education is needed. Therefore the education awareness will increase and it will induce the increase of trained and educated human resources both in quantity and quality.

Sea ports in foreland are expected to be the international ports that act as the entrance for all foreign ships. The needs of human resources that meet international standard are further needed. It will drastically increase the education awareness even in the remotest area of Indonesia.

## **F. CONCLUSION**

To summarize, in 70th year after its independence, Indonesia education and human resources quality are continuously improving. However, Indonesia still have to face the inequality issue of development between the western and eastern part of its provinces. We pointed out the eastern–western disparity in education, human development and socio-economy factors, such as poverty. To overcome this disparity, various policies have been developed by the Indonesian government. However these policies are still not well implemented or well distributed. Therefore a significant change on Indonesian systems is needed for the improvement of its education condition, particularly for eastern Indonesia, because the increase of its education quality will improve its GDP growth more than western (Azzizah [5]).

Through the ambitious policy called maritime axis policy by President Joko Widodo, a better economy can be aimed. Alongside the improvement of economy condition, a better education quality can be expected. We described the sea toll as the main part of maritime axis policy. Sea toll includes inland effective access, resulted in better inland and interregional access. These will reduces cost, time and uncertainty even in the most remote area of Indonesia. We pointed out the priorities that are needed for the efficient sea toll. We

analyze these priorities and showed their relation with education equality.

Utilizing the relation of education, human development and socio-economy factors that previously researched, we analyze the main policy of Maritime Axis Policy emphasizing on its influence on education equality. Maritime axis policy will have positive impact on Indonesia education across the region. Through it central government's focuses will be decentralized, particularly to eastern which has many foreland. The decentralization also accompanied by need of better human resource.

The five pillar of maritime axis policy, together with the sea toll priorities will induce the increase of education awareness due to demand of well-educated and well-trained human resources. Furthermore the policies also enable and enhance the interregional human resources exchange. Therefore the national disparity will reduce and the education awareness will increase.

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# Developing Research Competence of Pre-Service English Teachers Through *Teachers' Diary*

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**Abstract.** Due to the urgency of engaging in Asean Economic Community, it is important to the Asean countries' young generation to prepare their best. One of the demands that should be well-prepared, as stated in the Asean Charter, is that the Asean people must have a strong research competence in order to be able to enhance their academic performance. This goal goes to several sectors of development, including education. Based on the previous studies, as the frontliner of education, teachers are expected to have high professionalism, in which one of the ways to fulfill it is through an accomplished action research performance during their teaching practices. This is in line to the previous studies that the most recommended features of research competence are as similar as the process of conducting Action Research. It is said that *Program Profesi Guru* or Teacher Professional Program held by the government of Indonesia has been able to develop the teachers' research competence. To accommodate the goal of having high research competence, this research aims at developing a prototype of learning materials in the form of workbook. The objectives of this study are to provide a practical workbook on conducting action research. The setting of this research was in English Language Education Department, Islamic University of Indonesia. There were 6 students involved in this research under the pre-service program or PPL Sekolah in order to conduct the needs analysis on the research competence preparedness. The information wrapping and literature review was conducted afterwards. The next step was designing the workbook and the last one was asking for internal validation of two lecturers whose expertise on Asean studies and action research. The workbook covers the elements of action research such as indentifying problems, planning, action, encating the action, and self-reflection. The instruments of this research were interview questions, a questionnaire for internal validation, the related sources on action research and Asean Economic Community development. The method that was applied in the research was a research and development studies of Richey and Klein (2004) at stage one. The results are the workbook still needs an improvement on the last two processes in the matter of enrichment of the resources. The final workbook is accomodative to help improving research competencies of the 6 pre-service teachers in Islamic University of Indonesia significantly.

**Keywords:** Action Research; teachers' Professional Development; Research Competence; Workbook; Asean Economic Community

## A. INTRODUCTION

ASEAN community which is started in 2016 is expected to support the ASEAN countries to share similar opportunities on the growth of economy, the raising

number of micro and macro industries. These objectives consequently require high qualified human resources in all sectors, including educational sectors. This may affect to forms of teachers research

collaborations, exchange program of teachers throughout Asean countries, pre-service teachers exchange in Asean countries, and other forms of educational improvement in Asean. As the frontliners of education sector, it is necessary for teachers, especially in Indonesia to upgrade and prepare their professionalism.

The idea of teachers' professionalism has been defined by [1] on CamTESOL conference 2015 together with LeiA, in which each Asean countries education practitioners shares their research experience into a compiled book [2]. This reference is recommended for the theme is on the potential opportunities in education sector to engage in Asean Economic Community. [3] highlight that Indonesian teachers can engage in AEC by tracing to one year intensive training program (*Pendidikan Profesi Guru*), henceforth (PPG).

It involves pedagogical enrichment and action research is recommended to support the competence to face ASEAN community. To some extent, it implies that developing research themed-material is promising to help the pre-service teachers to enhance their professional-ism. By adapting the sequence of PPG, the writers drop the first sequence about pedagogical knowledge enrichment due to the focus of this material package is on the research competencies. Begining from this reflection, the writers are interested to have an initial investigation on the needs of the pre-service teachers to face the opportunities of ASEAN community. The result describes that an English teacher needs to be professional to engage in ASEAN community. All of them unanimously agree that research competence is the most prioritized one after completing 4

years undergraduate degree to accomplish pedagogical enrichment. Therefore, the writers decide to extend the investigation for preparing a prototype of learning materials package which help the pre-service teachers to develop their research competencies, especially in action research features. To support the investigation, the research questions are how to develop a workbook that is based on action research procedures and how the workbook is potentially able to develop the research competence of the pre- service teachers in English department, Islamic University of Indonesia.

## **B. ACTION RESEARCH AND RESEARCH COMPETENCE**

One of the prominent action research practitioners is Anne Burns. She ~~defined~~ defines action research as the research which requires series of cycles ~~and~~ And for each cycle will be started by problem identification and ended by reflective teaching practice [4]. Burns [4] said that the benefits of action research practices are also described by Burns on the teachers' point of view. Action research has helped the teachers to evaluate what s/he was doing in the classes. It gave the teachers opportunity to reflect on the decisionn behind what they do. It also increased self-awareness and valued personal insight. Throughtout these benefits, it can be concluded that action research practices indirectly improved the teachers' professionalism. It is on how they became more careful to decide the treatment for their students in the classroom, and on how it stimulated the teachers to keep questioning towards the strengths and weaknesses that they encountered during the teaching-learning process. In other

ways, action research also helps teachers to build critical thinking skills.

~~Fisher (2003) in Zahabi (2011)~~[5] suggests seven types of questions work to stimulate critical thinking. Those are thinking about the context, the temporal order, the particular events, the intentions, the choices, and the meaning of a series of event. Action research seems accomodates those thinking guidelines that a teacher should keep thinking about the context of their teaching, the temporal order, and etc. According to ~~Nugent, et.al. (2012)~~[6], good teachers and educational leaders conduct their own investigations to identify and sole problems and analyze informations about their classroom, their schools, which they will further develop their own profesional competence by the process. Critical thinking is one of the indicators of research competence.

Based on [7], research skills are divided into six facets. Each facet has its own indicators which fall into five level of student anatomy. The first facet demands the researcher to be able to embark on inquiry and so determine a need for knowledge. The second facet suggests that the researcher find and generate needed information or data by using appropriate methodology. It is indicated by the ability to generate questions or aims based on experience, expertise, or by literature. The third facet is that the researcher should be able to critically evaluate information/data and the process to find the information/data. Facet D asks the researcher to organize the information. The next facet is that the researcher should be able to synthesize, analyze, and apply new knowledge by performing curiosity and confirmation of the information that they have gained. The last facet asks the

researcher to be able to communicate knowledge and the process with an awareness of ethical, social, and cultural issues. This facet is indicated by the ability to demonstrate the knowledge and understanding through mostly discipline-specific language and appropriate genre. Over these six facets, action research steps in each cycle have met the highest level of research autonomy. The steps of action research (Burns, 1999), in one cycle are exploring, identifying, planning, collecting data, analyzing / reflecting, hypothesising, intervening, observing, reporting, writing, and presenting. Shortened by [8], the steps are planning, action, observation, and reflection. Whereas, [6] summarize the steps into more comprehensive practices. They are identifying a problem and pose a question, create an action plan, enact the plan, study the plan in action in which data collection and data analysis should be comducted, report results to get feedback, modify the plan, and the last one is to try and study it again. These steps are then manifested into a workbook as a practical guidelines for pre-service teachers. In compared to the systematic steps of [8], this research prefers the proposals of [6] due to its flexibility to be applied in the classroom. Therefore the workbook should accommodate the seven steps of action research.

### C. METHODOLOGY

This research is a research and development study that involves the first model of development by [9]. According to [9], research and development is a systematic study on how to design a product, to produce, or to develop a product and also evaluate it. [9] present three models of development. The first one

corresponds to the aim of this study which is a research and development that aims to investigate instead of to test a product. This model deals with the step as explained in Fig 1.

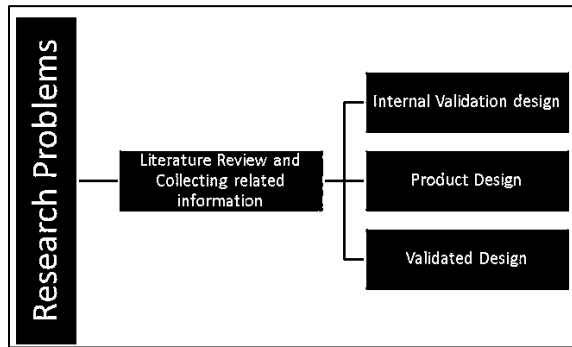


Figure 1. Richey and Kelin's Research and Development Stage 1

The writers have conducted the potential problems identification through deep interview technique in which the instruments conformed to the related information of the goals of ASEAN community. The literature review related to ASEAN community are also collected through a documentation technique in order to develop the concept of research-themed materials. The documents were in the form of eight previous studies ASEAN community that has been compiled through CAM Tesol 2015 and LeiA. It describes the efforts and the recommendation for ASEAN English teachers to engage in ASEAN community. The recommendation given by the scholars in the previous research is that Indonesia is highly suggested to adapt the one year training program or *PPG* that involves action research as the element of profesional development. Further literary review was focused on action research itself, the elements that support its process. After concluding and deciding the steps

that should be put in action research for practical guidance, the researchers then developed a design of workbook that manifested the steps of action research. These whole process took around 3 months. The design was then sent to two lecturers of English education department, Islamic University of Indonesia by also equipped them with a questionnaire on material validation. The instrument measured three aspects, such as the material delivery, the usability of the material, and the language aspect. These three aspects are derived by [10].

The first aspect covers five points, such as 1) the similarity of action research concept in the workbook to the theory of action research, 2) the materials are well-organized, 3) the materials are suitable to the cognitive development of the user, 4) the materials contain some topics that are applicable to the daily life, 5) and the updated information presented through the materials in the workbook. The usability aspect deals with 3 criterion, such as 1) the materials enable the students to learn easily, 2) the workbook is flexible to use, and 3) the materials delivery enable the students to learn independently.

The last aspect deals with language use in the workbook. There were 4 criterion to be measured, such as 1) a communicative language use, 2) the language use is suitable to the students' language development, 3) the activities are impressive and directs the students to comprehend the materials, 4) the diction selection to describe the materials. Each element was measured through a range of scale 1 to 5 which was represented through the statement of Very good, Good, Fair, Below Average, Not-recommended. The instrument was adapted

from the previous study that has been conducted by [11] whose research on developing a module based on inquiry learning.

After the *teachers diary* had been assessed by two expertises, the next step was conducting a try-out to the pre-service teachers of Islamic University of Indonesia. In this research there were six pre-service teachers in SMA UII Yogyakarta (henceforth UII Highschool) who used the *teachers diary*. They were considered to be potential as the participants of this research because the students who were appointed to teach in UII Highschool should have greater ability to identify the problem in the school, especially about the mean students, plan and action the plan to answer the problems. The *teachers diary* was used as the instrument for the pre-service teachers during their discussion and supervision sessions with the school teachers and the lecturer.

The previous studies on developing research competence, [12], and [3] mentioned that there should be a clear explanation on how the tool, in this case is the *teachers diary*, is used. The steps of developing a research competence must involve activities, the learning outcomes, and the assessment. These steps became the basis of the data in the try out session, which were the pre-test and post-test, and the score of each components in the *teachers diary*.

The learning outcomes of the pre-service program in Islamic University of Indonesia, especially in English Education Department, cover five points. Those are; 1) the students are able to identify the problems in their teaching practices, 2) the

students are able to create a plan to solve the problem, 3) the students are able to design a lesson plan for their students according to the plan, 4) the students are able to perform the lesson plan during their teaching practices, 5) the students are able to solve the problems that they have found in the teaching practices. The *teachers diary* was designed to cover each points above.

The six pre-service teachers were given a pre-test before their duty to UII Highschool. They were then given the *teacher diary* and the school teacher supervised them by considering the *teachers diary*'s subthemes. The school teacher and the lecturer collaborated to supervise the pre-service teachers. The first supervision on identifying the problems was conducted with the lecturer and the school stakeholders. The second supervision was on lesson plan design which also assisted online and offline by the lecturer and the school teacher. On enacting the plan, the students were fully supervised by the school teacher, and the last one on reporting their teaching practices, the lecturer played a more intense part.

#### **D. RESULTS**

The results of this research are divided into two, the result of the *teachers' diary* development and the result of the diary's use to the pre-service teachers. According to [10], the formula of conversion over the data that have been collected through expert judgement is prescribed in the table below:

Table 1. Quantitative Data Conversion to Qualitative Data on Scale 5

Quantitative Data	Range	Qualitative Data
5	$X > X_i + 1,80 S_{bi}$	Very good
4	$X_i + 0,60 S_{bi} < X \leq X_i + 1,80 S_{bi}$	Good
3	$X_i - 0,60 S_{bi} < X \leq X_i + 0,60 S_{bi}$	Fair
2	$X_i - 1,80 S_{bi} < X \leq X_i - 0,60 S_{bi}$	Below Average
1	$X \leq X_i - 1,80 S_{bi}$	Unrecommended

$X_i$  is the mean which can be gained through calculating the average number of maximum and minimum score. Whereas  $S_{bi}$  is the deviation standard which is gained by calculating the one sixth of the summing of the the maximum score of 25 and the minimum score. Whereas  $X$  is the actual score.

On the first aspect, the 5 criteria as presented in the questionnaire has the maximum score of 25 and the minimum score of 5. The standard deviation of the first aspect is 5 and the mean is 15. Since the actual score of the two expert judgements is 3,92. Therefore, the first aspect reach the *good* range because the actual score is between  $4,24 < x < 4,89$ .

On the second aspect, the result reflects that this is the best part for the range is in *very good* one. The two experts scored the workbook 4,16 which is higher than 3,79 as the standard deviation. On the last aspect, the researcher should trigger more engaging activities and language use because the two experts consider it in the *fair* range. The score is 3,25 which is among  $3,09 > x \geq 3,79$ . Based on this quantitative result, it is necessary

for the researchers to have more literary review of some practical exercises of action research for pre-service teachers. The suggestions given by the experts are summarized in the table below:

Table 2. Qualitative Data of Internal Validation

No	Topic	Suggestions
1	Materials Delivery	Should have more theories on action research as an introduction instead of going directly to the practical use
2	The Usability of the Workbook	Print it as a pocket book seems interesting Add more ICT instruction such as audiobook or digital portfolio
3	The language use	The activities are too fast in display Unclear distribution of tasks (pre-, while, and post-activities)

The teaching diaries that had been revised by considering the result above was then used by the participants of this research. There were six students who had pre-service program or *PPL Sekolah*, who was given the *teachers diary* since the pre-service program was started.

The result shows that there is an improvement by using *teachers diary* to develop the research competence of the pre-service teachers.

Table 3. Data Analysis of Research Competence Development

TEST	Before (Mean) n=6	After (Mean) n=6	Note		
			IM	C	NI
Pre & Post	8,2	12,4	4,2		
Supervision	19,4	23,2	3,8		

The Improvement is considered to be significant for the pre-service teachers could improve their research competence

twice better than their previous experiences. The *teachers diary* helped the students as the pre-service teachers to consider the program as not merely four credits subject that must be taken in order, but that the program is a chain of sincerity on really knowing what happened to their students, what should they do to solve the problem, to find some ways to solve the problems, and to enact the lesson plans. All students are mostly improving in enacting their plan. One remarkable result happened to pre-service teacher AM who identified a serious problem in the second year students. In class C, there was five students who label themselves as a gank and they were very disrespectful to their teachers. The pre-service student acknowledged that the core problem was that the gank members did not have much time with their parents. Thus, the members asked for an attention to prove that they were the centre of attention. Pre-service teacher AM implemented games in the classroom and all the students in the class including the gank loved to join the game and engage to the class activities sincerely for the first time. Although the class was distracted by one of the gank members who kicked his chair, and shouted to pre-service teacher AM, yet the class could still run well.

## E. CONCLUSION

The challenges to facae ASEAN Economic Community requires English teachers to be professional. One of the way to achieve professionalism is through research competence. In the English teaching practice, the competence is more on action research elements. *Teachers diary* during the implementation of pre-service program is recommended to be used as a tool for supervision, discussion, and

reporting session. By tracing to the result, a 19% improvement is sufficient to conclude that *teachers diary* has enabled the pre-service teachers to improve their research competence. The improvement is considered to be significant as the some of the pre-service teachers could improve twice better than the beginning of the program. The diary helped the pre-service teachers at most for two reasons. It helps the students to keep thinking what really happened to their students and how the teaching methods could solve the problems.

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# Usat Liberty Shipwreck, Tulamben, Bali: Pilot Project Underwater Museum in Indonesia

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**Abstract.** It is undeniable that geographically, Indonesia is a maritime country with territories encompassing massive expanses of sea. The nation's wealth of underwater resources was strengthened by UNESCO report, which stated that from some 3 million underwater cultural heritage sites, ten percent of them could be located within Indonesia's national boundaries. Such sites could be remains of ships, airplanes, ceramics, weaponries and various other things. Historical records showed that the sea around the islands that made up the Indonesian Archipelago is home to an International collection of Shipwrecks; Asian ships, including Chinese Jungs, European trade and warships, 20th century trading ships, and of course a collection of World War 2 warship wrecks. According to Underwater Cultural Heritage Sites database, there are 33 sites that so far have been identified by the Directorate of Underwater Cultural Republic Indonesia Remains, consistings of planes and shipwrecks, some of them quite complete and in good enough condition. Another important aspect of such sites are the ecological context provided. This article is an idea based on literature studies, that is by doing researches on available written sources concerning, or applicable to what this article contains. On this article, the qualitative data analysis method was employed. This analysis included a general overview of maritime themed museums' condition, issues concerning contextual underwater archaeological remains and other variables not expressed in the form of numbers. The results is an alternative concept for the first underwater museum in Indonesia could be obtained. Results from the literary studies; This particular study took place at the USAT Liberty Ship at Tulamben, Bali. There are several ways to do conservation works underwater, but none have proven to be efficient so far. One of the proposed way of conserving the site is by building a museum. Museum is an informal educational infrastructure developed for the process of transferring knowledges to the populace. To date, there already are 4 maritime themed museums in Indonesia, however, none of them provided in-situ display of a site. Therefore, in an effort to present the greatness of *Nusantara's* maritime past an idea was proposed to build museums underwater on site, as a model for the first underwater museum in Indonesia with triple approach concepts; Corridor of Maritime Culture (CMC) approach, Humanistic approach, and Local Custom approach.

**Keywords :** *Heritage , Underwater Archaeology , Museum , Shipwrecks, USAT Liberty.*

## A. INTRODUCTION

Oceans reflect a nation's civilization. There is even a saying that stated; "if you want to see a great nation, take a look at the history of the nation". Historical records

and archaeological remains of related to maritime activities and technology could provide insights to the development process of a nation's maritime culture. Indonesia's geographical condition as an island nation

with wide expanse of territorial waters, and the abundance of underwater archaeological remains strongly supported the statement that Indonesia is indeed a maritime nation.

The expansive area of territorial waters of this nation is certainly very rich with diverse potential maritime resources. By reconstructing cultures and cultural products through the reconstruction of archaeological remains or artefacts, we can obtain knowledge concerning their life and cultural wisdom in managing and utilizing maritime resources of the surrounding waters. History records this island nation people's expertise in sailing through the fierce waves of the straits and open seas. The sea and waterways such as rivers were the source of people livelihood in the past, they were utilized as unlimited food sources and even transport lanes. So, it is unsurprising that the archipelago became an important area to either support or hinders the hegemony of an empire.

History showed, Indonesia is a country that sits on a strategic position, straddling a very lucrative international trade shipping lane which then resulted in the archipelago colonization by European powers. There still many archaeological remains that show the evidences of various activities, on land and on the sea. Shipwreck is one form of archaeological remains that showcase and linked the elements of maritime culture (Thufail [1]).

There are various things that could be revealed from underwater remains such as a shipwreck. In the book *Ship-wreck and Sunken treasure in Southeast Asia* in 1995, there are around 185 shipwrecks located in the waters of Indonesia, or 41 percent of total shipwrecks throughout the Southeast Asian waters. Furthermore, according to the Ministry of Maritime Affairs and Fisheries,

there are a total of 2.046 shipwreck sites in Indonesian waters; ten percent are believed to have commercial value. The number of archaeological remains under the sea that have historical value is a big capital for the nation to build a maritime spirit that can encourage people to optimally utilize marine resources in a sustainable way, as our ancestors did once upon a time (Prabana [2]).

As mentioned above; Indonesian waters contained numerous underwater archaeological remains. According to UNESCO [3], 10 percent of the world's 3 million underwater cultural heritage sites could be found in Indonesian waters. Such sites could be remains of ships, airplanes, ceramics, weapons and various other things. Based on the data set of Underwater Cultural Heritage, in Indonesia there are 33 locations of archaeological remains under water. Such data is the remains that have been identified by Directorate of Underwater Heritage. Some of the ships and airplanes wrecks remained quite complete and in good condition. Currently, utilization of shipwreck sites as an attraction that could impart historical and cultural knowledge of their time has not been optimized, despite their benefits for economy and science.

Museum according to *The American Association of Museums* (AAM) [4] is a institution of nonprofit public property. Neither State nor private owned, permanent, intended for educational and aesthetical purposes, that owned and cared for, or utilize objects and materials that are exhibited regularly. There are still only a few maritime-themed museum in Indonesia. Currently there are four maritime-themed museums in Indonesia, namely Jakarta Maritime Museum, Maritime Museum of

Yogyakarta, Samudraraksa Ship Museum, and the Pasopati Submarine Museum. According to Arsyhadi [5], the existence of those maritime-themed museum have not been able to effectively communicate their purposes to visitors. Overall communication model employed resulted in one-way communication, without any elements of feedback from the visitors, resulting in ineffectiveness. Maritime-themed museums have not been able to increase public maritime awareness well. Therefore it is necessary to design a new, more effective communication model. Furthermore, it require serious efforts from the government to do the preservation of archaeological remains. One such conservation efforts is the construction of museums.

Location of this museum case study is the wreck of USAT Liberty, Tulamben, Bali. USAT Liberty (ex AK-35 ex Liberty (ID 3461)) was an American freighter or cargo ship, built in 1918 by the Federal Shipbuilding Co. Hackensack, New Jersey. It has the dimension of 125.43 x 17 m with a tonnage of 4,809 tons and was powered by a single 2500 IHP steam engine. The ship was launched on June 19, 1918. At the time of launch USAT Liberty was boasted by the media as the largest steel cargo ship made at the time (Ridwan [6]).

This is idea of the pilot project for the first underwater museum in Indonesia, with an in-situ concept. The concept of in-situ offered by the author have several advantages. That is Coridor of Maritime Culture (CMC), the humanistic approach, and the approach of cultural rules and customs. These three approaches are expected to provide a new paradigm in museology aspects especially concerning underwater museums. The next is maritime educational tours utilizing the shipwreck as

an attraction, which hopefully will play an important role in supporting governmental efforts to increase the potential of cultural, natural and human resources, and ultimately to foster and nurture Indonesian mentality and identity as a maritime nation.

## B. IDEA

### 1. Only Memories Remains of USAT Liberty

The shipwreck has now become overgrown with coral reefs, serving as habitat for several species of fish. The relative shape of the ship could still be identified, although a part of the hull is buried in sand. USAT Liberty wreck lies on a north-south direction parallel to the coastline of Tulamben for 124 meters at a depth of 3-28 meters (Radigan [7] ). Liberty shipwreck, as the case with all shipwrecks, falls under the category of Underwater Archaeological remains, or *Tinggalan Arkeologi Bawah Air (ABA)*. ABA is the Indonesian term for Underwater Archaeology which is part of the discipline of archeology who studied the past based on relics found under water such as lakes, rivers, swamps, and seas and oceans.

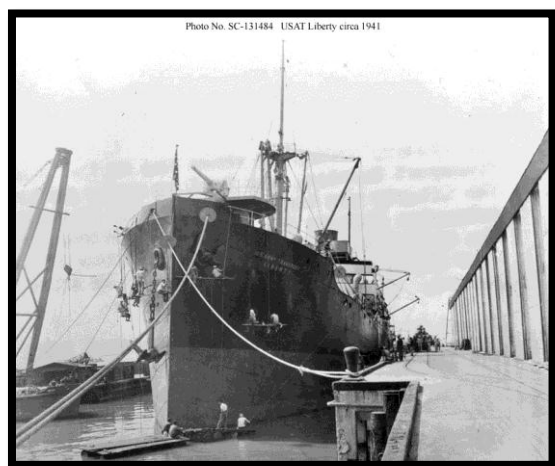


Fig 1. USAT Liberty tahun 1941.  
(Source. US Army signal Corps Photo SC 13 1484, National Archieves[7])



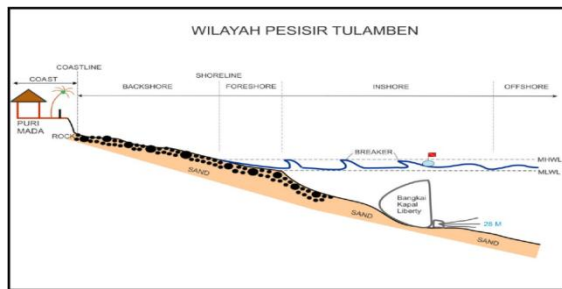


Fig 3. Deepness Position of USAT Liberty  
(Source: Pratama [10])

### 3. Concept for the First In-situ Underwater Museum in Indonesia.

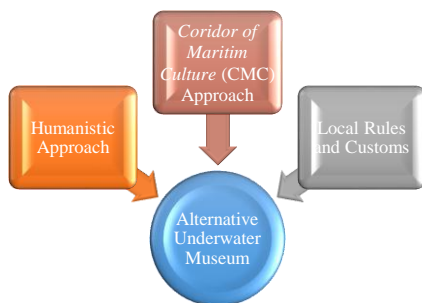


Fig 4. Underwater Museum Concept.

The concept for future museum is a museum that is able meet the needs and generate more environmentally friendly designs, which is not limited and renewable. Cultural Heritage Act No. 11, 2010 [12] states that cultural heritage include treasures with unknown owners. On the basis of this law, shipwreck of USAT Liberty at Tulamben, Bali can be categorized as underwater cultural heritage that has significance for the understanding and development of history, science and culture.

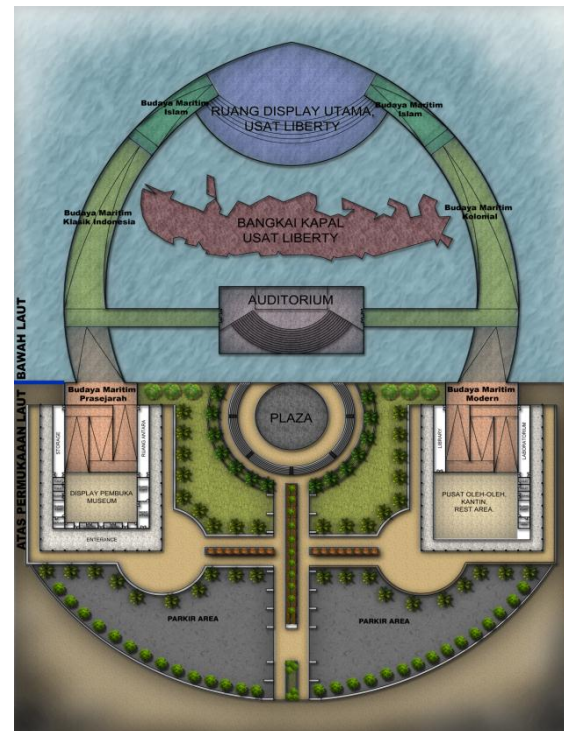


Fig 5. Plan design alternatives Underwater Museum USAT Liberty

The model offered by the author is the result of a literature study with comparative method between the literatures. In conservation efforts, the authors offer a concept of fusion between the study of Underwater Archaeology, Museology with Architecture. Until now there has been no underwater museum in Indonesia which is capable of displaying underwater remains present in its original context. Thus there is a tremendous potential to develop this idea further.

This concept presents the shipwreck in its original site and context, so that efforts to care for the remains is still performed in-situ. According to Prabana[2] There are several reasons why the concept of alternative underwater museum is far more beneficial than the existing museum, which are:

- Impresses the importance of locational context and the history of



underwater archaeological remains and their scientific significances.

- b. Provides the awareness that under normal circumstances, such remains would be better preserved underwater, due to their lower fragility and the lower oxygen level, preventing oxidation.

The idea of the underwater museum ship USAT Liberty meshed the two types of in-situ presentation presented before, Which presents an underwater museum that is more universally accesible, both by divers and non-divers. But more importantly, how to design an underwater museum showcasing Indonesia's maritime glory following Coridor of Maritime Culture (CMC) approach. CMC is a pilot project concept that tries to bring the atmosphere of maritime cultural heyday of Indonesian Archipelago, based on a division by era, from prehistoric, classical, Islam, colonial until the modern times. Visitors are invited to dive into the past and coherently follow the maritime history of the archipelago, era by era, supported by present technology that will help to present the displayed materials more attractively.



Fig 6. Main entrance to the museum

The second approach is the humanistic approach. Humanistic approach

here is how to make shipwreck sites to be more universally enjoyable. Humanistic approach to the museum is expected to change the paradigm of the public about the museum. Initially regarded as a boring and even barn-like museum, turned into a recreational water park that is fun for all ages as well as safe. The business paradigm change is done with the design concept of interesting museums. Interesting here is that visitors will be able to access information not only with the sense of sight alone but all the senses of human beings.



Fig 7 . Exhibition space at the Underwater Museum that presents a variety of topics archipelago's maritime heyday from time to time.

Beside the two above mentioned approaches, there is supporting approach, which is the Local Rules and Custom (or traditional) approach . Tulamben community has a distinctive feature in their living order. Such as customs regulations of *Awing-awig*. This local custom is a mutual agreement to regulates their life in an orderly manner. In *awig-awig* according Noerwidi [13] and Pratama [10] there are several regulations, among them are:

1. Fishing ban within a 100 metre radius of the shipwreck.

2. Prohibition on taking or utilizing remains of a wrecked ship for commercial purposes.
3. Prohibition on disturbing/damaging corals growing on the shipwrecks due to the negative impact on the underwater ecosystem of the shipwreck.
4. Prohibition on taking/removing rocks in the coastal area, dan various other prohibitions.

As *awig-awig* is binding to every member of the community to maintain harmony with God (*sukerta tata parhyangan*), and harmony between mankind (*sukerta tata pawongan*), and harmony with the natural world (*sukerta tata palemahan*) (Bawono [10]). This Local Rules and Customs approach provides a reference for the management procedure of the underwater museum in the future.



Fig 8. Display space at the Underwater Museum that presents USAT Liberty in the water directly.

4. Influential Parties in the Implementation of Idea
  - a. Directorate General of Culture
 

Directorate General of Culture holds the highest authority in the implementation of underwater

museum concept, because the Directorate General is at the top of the organization structure. Although basically above Directorate General of Culture there are the Minister of Education and Culture and the Deputy Minister of Culture, but in practice the Directorate General of culture holds the highest authority over the project.



Fig 9. Organizational Structure of the Directorate General of Cultures

- b. Directorate for Cultural Heritage Preservations and Museums of Republic of Indonesia

Directorate for Cultural Heritage Preservation and Museum is responsible for the formulation, coordination and implementation of policies and facilitating the application of the concept of under water museum and setting the technical standards in preservation of cultural heritages and museum building.

- c. Team of Experts

This team is the team that will be tasked with the implementation of the underwater museum concept. Such



team will be composed of Archaeologists, Architects, and Underwater construction experts. Archaeologist will function as the one with the knowledge in cultural heritage conservation, and museum, which is the object of the idea implementation, Architect will be tasked with designing the underwater museum, and the Underwater construction expert will be tasked with preparing the construction of underwater museum.

d. Department of Cultural Heritage Preservation Bali

Department of Cultural Heritage Preservation or BPCB (*Balai Pelestarian Cagar Budaya*) Bali is a technical implementation unit, or *Unit Pelaksana Teknis* (UPT) of the Directorate General of Culture that works on provincial level and in direct contact with cultural heritage sites and also with the community around those sites. Other than that, BPCB also responsible for the preservation and the protection of cultural heritage sites/object in their jurisdiction. Therefore, it is a foregone conclusion that BPCB will play an important role in the implementation of the above mentioned idea.

e. Balinese Community

It is undeniable that objects of cultural heritage do not only belong to the state, but also to the nation/people as a whole. This is due to the shifting paradigm cause by the amendment of Cultural Heritage act. Cultural Heritage act of 1992 was state oriented, but after the amendment into Cultural Heritage act of 2010 it

shifted to be more community/people oriented.

5. Strategic Steps in Implementing Underwater Museum in Indonesia

Implementation of this idea requires the cooperation and understanding of all concerned parties. Directorate General of Culture as the highest authority in implementing policies related to the conservation of cultural heritage objects instructed the Directorate for Cultural Heritage Preservation and Museum of the Republic of Indonesia to design the implementation of the concept of the underwater museum in Indonesia.

Once the design phase is complete, the team of the Directorate for Cultural Heritage Preservation and Museum of the Republic of Indonesia established a team of experts to formulate the most appropriate implementation of the idea. This formulation should consider aspects such as cultural research, underwater construction research and also find designs that will be universally acceptable for everyone in almost all conditions.

Directorate for Cultural Heritage Preservation and Museum of the Republic of Indonesia will coordinate with BPCB Bali for the implementation, after it they should present it to the public.

**C. CONCLUSION**

The greatness and wealth of the nation's maritime culture will gradually fade and disappear without any attractive public space showcasing the maritime culture. Museum could be an alternative informal education that could change the paradigm of Indonesian society about maritime culture in terms of history, culture and technology ,

USAT Liberty Tulamben was an American freighter ex AK-35, ex Liberty (ID 3461), built in 1918 by the Federal Shipbuilding Co. Hackensack, New Jersey. The ship was torpedoed by the Japanese in World War II in the waters of the Lombok Strait and eventually sank in the beaches of Tulamben, Bali. The current condition of the ship is very alarming, this is due to the high frequency of diver activity on the spot, causing damage to the vessel and the ecosystem around it. Thus further efforts are needed for the preservation of the Shipwrecks of USAT Liberty at Tulamben.

There are relatively few Maritime-themed museums in Indonesia. Currently, there are four maritime-themed museums in Indonesia, but there are none that offers a concept of in-situ museum, which offers a maritime museum located in the sea. The concept for USAT Liberty wreck museum is a museum concept that tries to offer solution for the maritime ecosystem problem by building the first in-situ museum in Indonesia. This Museum have three basic approaches, which are the humanistic approach, *corridor of maritime culture (CMC)* approach, and Local/Traditional Customs and Rules approach.

Humanistically, it is expected that USAT Liberty wreck could be enjoyed by everyone and not limited only to divers. *Corridor of maritime culture (CMC)* wanted a museum design that could bring forth and display the atmosphere of maritime glory through the ages. It is also expected that the presence of USAT Liberty wreck museum will not interfere, and even supported the existence of Tulamben local tradition.

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# Isolation and Antimicrobial Activities of Ironwood Extracts (*Eusiderxylonzwageri*) for Mouthwash Formulation

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**Abstract.** Ironwood (*Eusiderxylon zwageri*) is a leading commodity wood originated from Kalimantan. Ironwood contains various compounds such as flavonoids, triterpenoids, tannins, saponins and alkaloids. Flavonoids, triterpenoids and saponins are chemical compounds that has potential as antibacterial and antiviral compounds. Some people in Kalimantan have successfully cured toothache using water boiled with ironwood. This tradition causes speculation that ironwood contains a compound that kills germs which cause tooth pain and indicates that the ironwood provides benefit as medicine. The present study was aimed to isolate the active ironwood substances and to formulate the non-toxic mouthwash from the extraction of ironwood waste. Isolation of active ironwood was done by extraction in a soxhlet apparatus with 250 ml of water and ethanol, with comparison (1:1) at various time. Antimicrobial activity test against *Streptococcus mutans* and *Staphylococcus aureus* was evaluated by solid diffusion method at various extract concentrations. The extract that had strongest antimicrobial activity against *S. aureus* and *S. mutans* was mixed with all the chemicals needed for mouthwash formulation (formula 1 and 2). 100% concentration of ironwood extracted with ethanol in 2.5 hours showed the strongest antimicrobial activity against *S. aureus* and *S. mutans*. This research showed that the most abundant active compound of ironwood extracted with ethanol in 2.5 hours was 1,2,3-trimethoxy-5-(2-propenyl)-benzene, derived from benzene class compound (C<sub>12</sub>H<sub>16</sub>O<sub>3</sub>). Ethanol extract concentration in the formulated mouthwash was 10% while the rest 90% was excipients. The viscosity, pH and density of the mouthwash formulations were tested. Based on hedonic test, formula 2 was preferred than formula 1 in term of color, aroma and flavor. The results showed that formula 2 has pH level (5.85), viscosity (3 cPs) and density (0.98 g / ml) which is suitable as mouthwash to relieve dental pain.

**Keywords:** ironwood; toothache; *Streptococcus mutans*; *Staphylococcus aureus*; mouthwash

## A. INTRODUCTION

*Eusiderxylon zwageri* has an excellent wood quality. Its strength and durability is 1st grade. It is not vulnerable to termites, insects and fungi. *E. zwageri* is durable construction woods. It is widely used in heavy construction and large-scale production such as for house structures,

pillars, floors, roofs, walls, boat construction and bridge. They have earned 'ironwood' as a result of their very hard, dense, and heavy wood (Wahyuni [1]). The natural distribution of *E. zwageri* is mainly in the regions of Sumatra and Kalimantan (Irawan et al [2]).

Ironwood consists primarily of cellulose, hemicellulose, and lignin (Kurokawa et al [3]) in a matrix that provides structural support to the living tree and some resistance against microbial attack (Scheffer et al [4]). Ironwood also contains flavonoids, triterpenoids, tannins, saponins and alkaloids. Flavonoids, triterpenoids and saponins are chemical compounds that potential as antibacterial and antiviral compounds. Alkaloid is alkaline substance which is used widely in the medical field (Saxena et al [5]), while the tannins show antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*. These compounds indicate that the ironwood provides benefit as medicine. Ironwood is also one of wood species that produce traditional medicine (Wahyuni [1], Irawan et al [2]). Some local people in Kalimantan have successfully cured toothache using water boiled with ironwood. This tradition results in speculation that ironwood contains a compound that kills tooth germs. Hence the antibacterial activity test of ironwood should also be done to bacteria which present in the mouth and cause toothache [Ajizah et al 6]), such as *Staphylococcus aureus* and *Streptococcus mutans* (Dhinahar et al [7]). Over the past few years, many efforts have been made to discover new antimicrobial compounds from various kinds of natural sources such as microorganisms, animals and plants (Bhat et al [8]). Therefore, research for identifying antimicrobial agent in ironwood that are active against *Staphylococcus aureus* and *Streptococcus mutans* to maintain oral hygiene is an urgent need.

Mouthwash is widely used as an aid to oral hygiene because it is relatively easy to use (Kaur et al [9]). Mouthwashes are

non-sterile aqueous solutions. It is used to reduce oral bacteria, cleaning food remnants and to remove oral malodour (Ghapanchi et al [10]). A number of chemical agents mouthwashes which have antiseptic or antimicrobial action have been used. Commercially available mouthwashes containing chemical agents have several disadvantages (Kaur et al [9]). One of the most effective chemical agent for plaque control agent is cetylpyridinium chloride (CPC). As an active mouthwash compound, cetylpyridinium chloride has been reported to have a number of side effects such as mucosal irritation and desquamation (Rizwana [11]), staining of teeth and tongue and ulcerations (Haps et al [12]).

The widespread use of mouthwashes is a recent phenomenon in the developing countries. Hence to overcome the aforementioned disadvantages, the World Health Organization (WHO) advice researchers to investigate the possible use of natural products such as herb and plant extracts (Bhat et al [8]). Ironwoods have been utilized as an important source of medicines because they are a reservoir of chemical agents for mouthwash.

The aim of this research was to isolate the active ironwood substances and to formulate the non-toxic mouthwash from the extraction of ironwood waste. The research is conducted as an improvement to dental health products. Since the ironwood is commonly used in the medical field, this mouthwash is formulated as a new development to the use of ironwood waste.

## **B. MATERIAL AND METHOD**

### **1. Preparation of Wood Extract**

Ironwood powder were taken from the solid waste of sawmill industry in South Kalimantan. The ironwood powder were

separated by size with vibrator shieve shakers. Only certain sized particles passing through 40-mesh screens were selected for sample. Screened ironwood powders were air-dried to 15% moisture content and used for material that extracted. Moisture content was calculated by oven-drying method. 5 gram of dried ironwood powder was dried in the oven at 105°C±1°C until it reach constant weight. The initial weight and final weight were taken, the weight difference for samples represents its moisture content.

## 2. Extraction and Isolation

The conventional soxhlet extraction apparatus consisting of a condenser, a soxhlet chamber, and an extraction flask were used. A quantity (100 g) of ironwood powder was placed in a soxhlet apparatus and extracted with 250 ml of three kinds solvents for 2.5 hours, 5 hours, and 7.5 hours. Three solvents were used: (1) water; (2) ethanol and (3) water : ethanol in 1:1 comparison by volume (50% aqueous ethanol). The extract was filtered by filter paper 125 mm in diameter and evaporated to half the volume under reduced pressure in a rotary evaporator.

$$Y_{\text{extract}} = \frac{m_{\text{extract}}}{m_{\text{sample}}} \times 100\% \quad (1)$$

$Y_{\text{extract}}$  = yield of extract (%)

$m_{\text{extract}}$  = mass of extract (g)

$m_{\text{sample}}$  = mass of extracted ironwood (g)

All experiments with soxhlet apparatus were triplicate for statistical evaluation. The best extract based on the antimicrobial activity test was then subjected to Gas Chromatography-Mass Spectrometry (GC-MS) analysis. Compounds were identified by matching their mass spectra with those of pure

compounds. Identification of structures/compounds of the peaks was supported by comparison to commercial mass spectral libraries in NIST (National Institute of Standards and Technologies) and Wiley format.

## 3. Antimicrobial Test

Antimicrobial activity test against *Streptococcus mutans* and *Staphylococcus aureus* was evaluated by solid diffusion method at various extract concentrations of 2%, 4%, 6%, 8%, 10% and 100%. The method used solid diffusion technique with wells and Brain Heart Infusion (BHI) media. Each 100 ml sample was injected into the wells and incubated for 24 hours at 37°C in an incubator. The antimicrobial activities of all solutions were defined as the clear inhibition zone around the wells. Diameter of clear zone was measured by a caliper in millimeters. If the solution is effective against bacteria at a certain concentration, no colonies will grow wherever the concentration in the agar is greater than or equal to that effective concentration. This region is called the inhibition zone. The larger the inhibition zone around the wells, the more effective the solution is (Cheng et al [13]). Category of antibacterial activity is based on diameter of inhibition zones (Susanto et al [14]) as shown in Table 1.

Table 1. Antibacterial effectiveness based on inhibition zones

Diameter of inhibition zones	The strength of inhibition
≤5 mm	low
6-10 mm	medium
11-20 mm	strong
≥20 mm	very strong

#### 4. Preparation of Mouthwash

The ironwood extract was formulated by using pharmaceutical excipients such as tween 80, sorbitol, sodium metabisulfite, sodium benzoat, oleum menta pip, aspartame into a mouthwash. The formulation was prepared using specific weight (10% w/w) of ironwood extract, in any single dose of the formulation. The total 100 µl of prepared liquid mouthwash formulated with the combination all the chemical components was presented in Table 2. The mouthwash prepared was tested for its physical properties including pH measurement, viscosity, density, and hedonic test including colour, aroma, flavor using 20 respondents.

Table 2. Formulation of mouthwash preparations

Ingredients	Concentration (% w/w)	
	Formula 1	Formula 2
Ironwood extract	specific weight	specific weight
Tween 80	1	1
Sorbitol	10	12
Sodium Metabisulfite	0,1	0,1
Sodium Benzoat	0,1	0,1
Oleum Menta pip	0,2	0,18
Aspartame	0,004	0,01
Water	Ad 100	Ad 100

Source: Rowe et al [15] and Amekhlafi et al [16]

### C. RESULT AND DISCUSSION

#### 1. Mass Yield (%) Analysis

Here ethanol and water were chosen as extraction solvents because ethanol/water formulations are relatively safe for human consumption as compared with other organic solvents (Wendakoon et al [17]), Chew et al [18]. Solvent and extraction time used for ironwood

extraction had significant effect on yield ( $P < 0.05$ ). The average yield (%) of different solvent of ironwood extract decreased in following order: 50% aqueous ethanol > ethanol > water as shown in Table 3. The extract of ironwood powder ranged from 18.5% to 23.5%. The highest yield was obtained when the ironwood was extracted with the 50% aqueous ethanol for 7.5 hours, indicating that added water, the most polar solvent used, caused further extraction of polar components. Solvent polarity influenced the weight of extract product. Polar solvents produced higher extract product weight than nonpolar solvents (Lathifah [19]). Our findings are in agreement with previous investigation. The walnut leaves can be extracted with different mixes of solvents and the most appropriate were proved to be mixes of ethanol and water. The best ratio of ethanol and water as antioxidant was 50:50 by volume (Alexe et al [20]). The other research proved that 50% ethanol extract of *Agathosma betulina* (buchu leaf) was relatively high activity against *S. aureus* (Wendakoon et al [17]). Ethanol-water were better solvents for effective extraction of antimicrobial properties as compared to solvents like water and ethanol. This may be because phenolics are often extracted in higher amounts in more polar solvents (Tatiya et al [21]). On the other hand, ironwood that was extracted with water showed lower extraction yield because water has affinity with polar compounds, the –OH group turns water in to a bad solvent for organic compounds (Paviani et al [22]).

Moreover, the mass yield trend for ethanol and 50% aqueous ethanol extraction was continuously increased, where 2.5, 5 and 7.5 hours extraction gave 18.6, 20.7,

20.9% mass yield respectively for ethanol extraction and 19.5, 21.4 and 23.5% mass yield respectively for 50% aqueous ethanol extraction. At 7.5 hours extraction time, 50% aqueous ethanol extraction gave the highest yield which was 23.5%; ethanol 20.9%; while water only resulted in 18.5% mass yield.

Table 3. Yield (%) of Ironwood Powder Extraction

Extracting solvents	Extraction time (hours)		
	2.5	5.0	7.5
Ethanol	18.6 <sup>A</sup> <sub>a</sub> ± 0.1	20.7 <sup>B</sup> <sub>b</sub> ± 0.2	20.9 <sup>B</sup> <sub>b</sub> ± 0.3
Water	18.6 <sup>A</sup> <sub>a</sub> ± 0.1	18.2 <sup>A</sup> <sub>a</sub> ± 0.1	18.5 <sup>A</sup> <sub>a</sub> ± 0.4
50% aqueous ethanol	19.5 <sup>A</sup> <sub>a</sub> ± 0.1	21.4 <sup>C</sup> <sub>b</sub> ± 0.06	23.5 <sup>C</sup> <sub>c</sub> ± 0.1

Note: Values (mean ±SD) are average of three replicates. Different subscript letters within the same row indicate significant ( $p < 0.05$ ) differences within the extracting time. Different superscript within the same column indicate significant ( $p < 0.05$ ) differences within the extracting solvents.

Thus we can conclude that ethanol and 50% aqueous ethanol extraction required longer time to obtain high mass yield.

## 2. Antimicrobial Activities of Ironwood Extract

All extracts exhibited prominent antimicrobial activity against all microorganism used in study (see Tab.4, Fig.1, Fig.2). The research showed that all the extracts exhibited strong antimicrobial effect against *S. aureus* and *S. mutans*, except for antimicrobial effect against *S. mutans* for water extracts in 2.5 and 5 hours as shown in Table 4. Extracts of 50% aqueous ethanol in 5 and 7.5 hours had

moderate antimicrobial activity against *S. mutans*. Ironwood extracted with ethanol in 2.5 hours showed the strongest antimicrobial activity against *S. aureus* and *S. mutans* with 17.75 and 13.95 mm diameter of inhibition zone respectively (Fig.1, Fig.2). Thus the maximum activity was shown by ethanol extract against *S. aureus* and *S. mutans*. In general, ethanol extract was the most active. According to previous research, the maximum concentration of phenolics as antimicrobial properties was achieved at extraction time of 2 hours (Chew et al [18]). Prolonged extraction would increase oxidation on phenolic compounds (Chirinos et al [23]). It means the antimicrobial properties with longer extraction time would be destroyed.

Previous studies stated that the water extracts could not kill *S. aureus* (Taemchuay et al [24]). On the contrary, in this study water extracts of ironwood inhibited *S. aureus* rather well (see Fig.1), but the effect was weaker against *S. mutans* (see Fig.2). The minimum activity was observed in the case of water extract of ironwood with 4.00 – 4.50 mm diameter of inhibition zone against *S. mutans* as shown in Figure 2. In general, antimicrobial activities in water extract were weaker than the other solvents. According to Phuong et al [25], the effect of antimicrobial activity is depended on the various types of extract and microbial species. In most case, water extract did not show significant result as antimicrobial. It might be due to the fact that the active principles were water insoluble (Taemchuay et al [24]).

This study is in agreement with previous study that stated in general, the water extracts showed weaker antimicrobial activities than the ethanol (Phuong et al [25]) and 50% aqueous ethanol extracts.



Water could not be the best solvent because water extract may contain a low concentration of antibacterial compounds or may not extract antibacterial compound or all of the identified components (Dahiya et al [26]). In general, the ethanol extracts had more potential antibacterial activity than the water extracts (Nath et al [27]). This study proved that ethanol and 50% aqueous ethanol are better than water for extraction of antibacterial properties of ironwood.

Table 4. Inhibitory activity of various extracts to some bacteria

Solvent	Extraction Time (hr)	<i>S. aureus</i>	<i>S. mutans</i>
Ethanol	2.5	+++	+++
	5	+++	+++
	7.5	+++	+++
Water	2.5	+++	+
	5	+++	+
	7.5	+++	+++
50% aqueous Ethanol	2.5	+++	+++
	5	+++	++
	7.5	+++	++

Note: +++ = Strong inhibitory activity, ++ = Moderate inhibitory activity, + = Low inhibitory activity

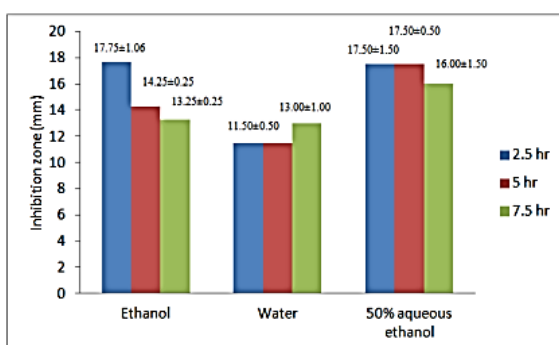


Figure 1. Antimicrobial effect of various extract against *S. Aureus* (results after deducting control)

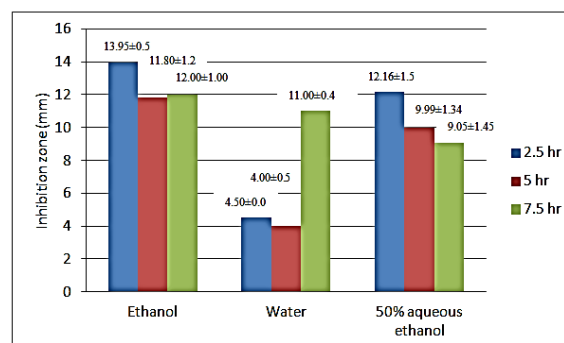


Figure 2. Antimicrobial effect of various extract against *S. Mutans* (results after deducting control)

Figure 3 showed the negative and positive control of *Staphylococcus aureus* and *Streptococcus mutans* in  $10^6$  cfu/ml. The highest inhibition zones for *Staphylococcus aureus* and *Streptococcus mutans* was observed with the highest concentration of 2.5 h ironwood extracted by ethanol (100%) as shown in Figure 4 and 5. Based on the ethanol control in various concentration (Fig.4, Fig.5), it was verified that in the study, as a control did not show antimicrobial properties because there was no inhibitory halo formation.

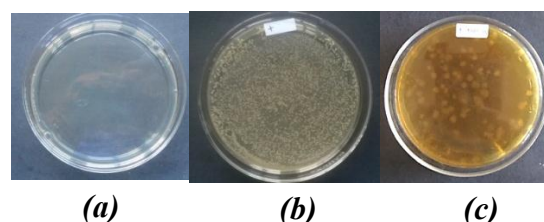


Figure 3. Negative control (a); positive control of *Staphylococcus aureus*  $10^6$  cfu/ml (b); positive control of *Streptococcus mutans*  $10^6$  cfu/ml (c)

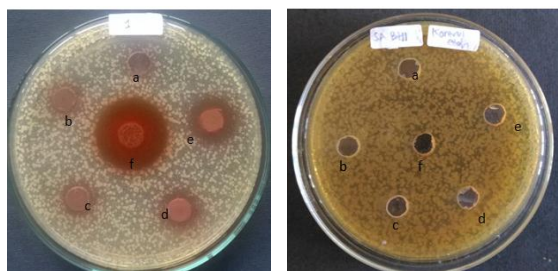


Figure 4. Diameter of inhibition zone *S. aureus*: (left) 2,5 h ironwood extracted by ethanol and (right) ethanol control in various concentration (a)2 %; (b) 4%; (c) 6%; (d) 8%; (e)10%; (f) 100%

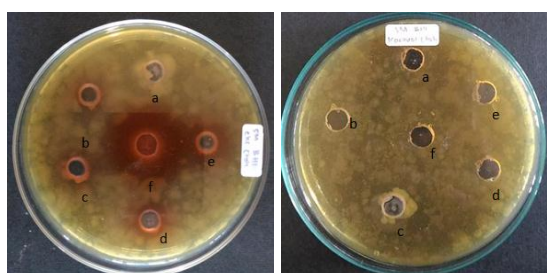


Figure 5. Diameter of inhibition zone *S. mutans*: (left) 2,5 h ironwood extracted by ethanol and (right) ethanol control in various concentration (a)2 %; (b) 4%; (c) 6%; (d) 8%; (e)10%; (f) 100%

The strongest antimicrobial activity of 100% ethanol extraction in 2.5 hours may be on account of the presence of terpenoids in its composition such as 1,2,3-trimethoxy-5-(2-propenyl)-benzene; 1,8-cineol; 2,6,6 trimethylbicyclo [3,1,1] hept-2-ene;  $\beta$ -caryophyllene;  $\alpha$ -caryophyllene; and ethyl linoleate and flavonoid such as 1,3-benzodioxole,4-methoxy-6-(2-propenyl).

### 3. Gas Chromatography - Mass Spectrometry Analysis

The chemical composition of the strongest antimicrobial activity was investigated by Gas Chromatography – Mass Spectrometry (GC-MS). 100%

concentration of ironwood extracted with ethanol in 2.5 hours showed the strongest antimicrobial activity against *S. aureus* and *S. mutans*. There were eight peaks in that ironwood extract which were greater than 1 % of total peak area as shown in Table 6. A wide range of functional diversity has been observed among bioactive compounds. Of the various chemical classes of compounds, terpenoids were the most abundant ones. According to the previous study, terpenoids have good antimicrobial capability in ironwood bark extract (Phuong et al [25]). In this research, the highest peak was 1,2,3-trimethoxy-5-(2-propenyl)-benzene as shown in Figure 6. It showed that the most abundant active compound of ironwood extracted with ethanol in 2.5 hours derived from benzene class compound ( $C_{12}H_{16}O_3$ ). This active compound was one of the pharmacologic active substance containing a single benzene ring derived from the herbal raw material (Wang et al [28]).

Table 6. Gas chromatography and mass spectrum analysis of ironwood extract

No	Chemical constituent	Peak Area (%)	Compound Nature	Biological Activities
1	1,2,3-trimethoxy-5-(2-propenyl)-benzene	65.86	Terpenoid	antimicrobial, anti-inflammatory
2	1,8-cineol	7.30	Terpenoid	antimicrobial, anti-inflammatory
3	1,3-benzodioxole, 4-methoxy-6-(2-propenyl)	7.15	Flavonoid	antimicrobial, antioxidant
4	2,6,6-trimethylbicyclo [3,1,1] hept-2-ene	6.31	Terpenoid	anticancer, anti-inflammatory, anticeptic
5	$\beta$ -caryophyllene	5.82	Terpenoid	Antimicrobial, antioxidant, anti-inflammatory
6	Benzaldehyd, 4,6-dimethoxy-2,3-dimethyl-(CAS) 2,4-Dimethoxy-5,6-dimethyl	3.29	Aldehyd	antimicrobial
7	$\alpha$ -caryophyllene	2.10	Terpenoid	Antimicrobial, antioxidant
8	ethyl linoleate	1.33	Terpene	Antimicrobial, antioxidant

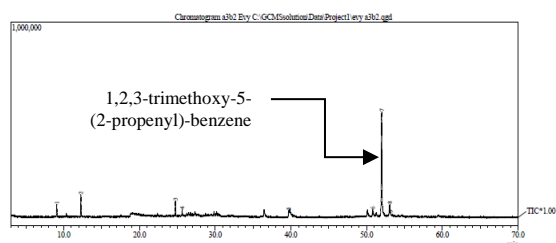


Figure 6. Chromatogram of ironwood extract

#### 4. Physical Analysis of Mouthwash Formulation

The ethanol extraction in 2.5 hours was chosen because of its good antimicrobial activity. Ethanol extract concentration in the formulated mouthwash was 10% while the rest 90% was excipients.

Table 6. Physical Properties of Mouthwash

Formula	pH	Viscosity (cPs)	Density (g/ml)
1	5.78 $\pm$ 0.02	3.83 $\pm$ 0.29	0.99 $\pm$ 0.00
2	5.82 $\pm$ 0.05	3.00 $\pm$ 0.50	0.98 $\pm$ 0.00

The pH of the formula 1 and formula 2 of mouthwashes were 5.78 and 5.82 respectively. Mouthwashes with pH  $\geq$  5.5 can be regarded as safe since tooth mineral will not dissolve at these pH values. Products with a pH below 5.5 may cause dental caries (Van Loveren [29]), Lee et al [30]), which at the surface of the tooth leads to a net loss of enamel and mineral structure on the tooth's surface (Lee et al [30]).

The viscosity of mouthwashes were 3.0 and 3.83 cPs for formula 1 and formula 2 respectively. Similar result was observed by Febriana [31], that stated viscosity of gambier mouthwash was about 2.75 – 4.75 cPs. These viscosity differences due to differences in the number of tween 80 were added to each formula. Lower tween 80 results in lower mouthwash viscosity. The addition of tween 80 above 2.5 mL in 50 mL of mouthwash will change the viscosity value significantly (Febriana [31]). However contrary to our finding, in the same dose of tween 80, viscosity of mouthwash formula 2 was lower than formula 1. This may be because the difference concentration of sorbitol

(humectant agent), oleum menta (aroma and flavoring agent) and aspartame (sweetening agent) were added to mouthwash. The viscosity depends on the concentration of the ingredients contained in the mouthwash. Surfactants, polyalcohols and lipids effectively increase the viscosity (Vummaneni et al [32]).

The density of formula 1 was 0.99 g/ml for formula 1 and 0.98 g/ml for formula 2. Overall, the products with low or no alcohol contained humectants such as sorbitol would help in reducing the dryness of the oral cavity after product usage and preserving the product. Based on hedonic test, formula 2 has a better point and preferred than formula 1 in term of color, aroma and flavor. The results showed that formula 2 has pH level (5.85), viscosity (3 cPs) and density (0.98 g / ml) which is suitable as mouthwash to relieve dental pain.

The estimated quantities of constituents in mouthwash formula 2 was in the following range (% by wt): ethanol extraction of ironwood in 2.5 hours : 10; tween 80 : 1; sorbitol : 12; sodium metabisulfite: 0.1; sodium benzoat : 0.1; oleum menta pip : 0.18; aspartam : 0.01; aquades : ad 100.

## CONCLUSION

Ironwood (*Eusiderxylon zwageri*) extracts represent very interesting source of bioactive compounds as new antimicrobial agents. Based on the research, it can be concluded that ethanol extract of ironwood in 2.5 hours extraction was the strongest antimicrobial agent against *Staphylococcus aureus* and *Streptococcus Mutans*. The most abundant active compound of ironwood was 1,2,3-trimethoxy-5-(2-propenyl)-benzene (C<sub>12</sub>H<sub>16</sub>O<sub>3</sub>).

The results showed that formula 2 has pH level (5.85), viscosity (3 cPs) and density (0.98 g / ml) which is suitable as mouthwash to relieve dental pain. The mouthwash composition in formula 2 was (% by wt): ethanol extraction of ironwood in 2.5 hours : 10; tween 80 : 1; sorbitol : 12; sodium metabisulfite: 0.1; sodium benzoat : 0.1; oleum menta pip : 0.18; aspartam : 0.01; aquades : ad 100. However, there is need for further study about the safety and in vivo efficacy to validate the results of this study.

## ACKNOWLEDGEMENT

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# LCGC Road Slope Based AFR Varying Control Using Hybrid PI-Fuzzy

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**Abstract.** LCGC is a car which has SI engine capacity up to 1.2 L, the product of Indonesia government policy in order to suppress national fuel consumption. LCGC is designed for urban commuting due to the limited capability of low capacity engine. Unfortunately, Semarang, although it is the capital of Central Java, has unusual terrains involving uphill and downhill. In order to encountering uphill, the performance output of LCGC should be increased in order to encountering uphill. This paper proposed an AFR varying control system using hybrid PI-fuzzy controller. The proposed system utilizes stoichiometric, lean, and rich operation of AFR in order to adjust the engine performance based on the road slope angle. The system uses gyroscope sensor to read the road slope angle and adjust the AFR to optimize the engine output power. In order to compensate the increase of fuel usage and keep the LCGC as a green car, the system is also varying the AFR in downhill in order to lowering the fuel consumption. From the simulation result, the proposed control system has good performance. The simulation result shows that the proposed control system has 29% shorter average settling time and 39% smaller average IAE. From the result, the proposed control system is considered as a reliable system and highly potential to be implemented in actual LCGC.

**Keywords:** *lccg, road slope, spark ignition engine*

## NOMENCLATURE

AFR : Air-to-Fuel Ratio  
LCGC : Low Cost Green Car  
IAE : Integral Absolute Error  
SI engine : Spark Ignition Engine

## A. INTRODUCTION

Indonesia is one of the many countries which has high number of vehicle usage. This led to high amount of nation's fuel consumption. Thus, the government develops National Car LCGC policy in order to suppress fuel consumption. LCGC has small SI engine capacity (up to 1.2 L) which designed for urban commuting. However, in Semarang city, although it is

the capital of Central Java, it has unusual terrains where there are many uphill and downhill roads, thus, the small engine capacity of LCGC is not able to handle the terrains and become the greatest weakness of LCGC. Thus, the engine performance of LCGC should be enhanced.

Enhancing the performance of SI engine can be done by various methods. Hedfi et al in [1] studied the enhancement of SI engine performance by changing the fuel types, using combination of biogas and hydrogen. Gong et al in [2] studied the effect of compression ratio on performance of direct injection spark ignition using methanol as fuel. Shadloo et al in [3]



redesigning SI engine in order to enhance SI engine performance by increasing thermodynamic efficiency, minimizing the internal friction, and decreasing the emission of the engine. The designed engine by Shadloo et al [3] still has weakness where the engine needs more components and become more complex. Another method which can be implemented is controlling the air-to-fuel ratio (AFR) of engine conducted by Haider [4]. From those methods, one of the most suitable to be implemented for LCGC is AFR control, since it is a low cost and can be used in all type of LCGC in Indonesia for now. Furthermore, AFR can also increase the efficiency of fuel consumption of a car. Thus, it is suitable to be implemented in a green car. Unfortunately, majority of researches nowadays, like in Alippi [5], Yar [6], and Liu [7] are focused in maintaining AFR on the stoichiometric value.

Stoichiometric AFR is an ideal and optimal value of AFR. If more air or less fuel is injected into the mixture, then it is considered as lean mixture. Meanwhile if less air or more fuel is injected into the mixture, then it is considered as rich mixture. Each mixture has characteristic. Kiencke and Nielsen in [8] show that stoichiometric AFR value provides optimal power output but it is not the maximum output value. The maximum power output is achieved in certain rate of rich operation, and lowest fuel consumption is achieved in certain rate of lean operation. Further explanation of AFR is explained in section AFR varying.

The proposed control system is varying the AFR utilizes the characteristic of stoichiometric, rich, and lean operation of SI engine. The control system is implemented in SI engine model by

Triwiyatno et al in [9] in MATLAB Simulink. In this paper, the system utilizes PI controller as simple and reliable control system as the controller. Fuzzy logic controller is combined with PI controller in order to optimizing the response of the system. The fuzzy logic controller uses the output of P and I controller as the input in order to develop smart system which can shorten the rise time. Since the derivative controller operates on the rate of change of the actuating error and not the actuating itself and provides high sensitivity controller [10], it is not suitable to be applied in the proposed system due to the high noise and disturbances (throttle position, brake, transmission, turning, etc.). The system performance is evaluated from the IAE, transient response, and steady state response in comparison with system using conventional PI controller.

## B. METHODOLOGY

### 1. AFR Varying

The ratio of air to fuel in a combustion process is very important. As in Kiencke and Nielsen [8], there are several effects that have an impact on the amount of air transferred into the cylinder : throttling of the air flow by the throttle butterfly, aerodynamic resistance and resonances in the intake manifold, rebounding the burned gas back to the inlet pipes, and other effects.

Stoichiometric AFR is AFR value which the mixture contains 14.67 parts of air and 1 part of fuel mixture. This AFR value provides the most optimal engine performance and low exhaust emission as studied in Lheywood [11]. The stoichiometric value 14.67:1 can also represented by  $\lambda$  value which is  $\lambda = 1$ . In rich operation, the ratio is no longer in

stoichiometric value and represented as  $\lambda < 1$ , while in lean operation is represented as  $\lambda > 1$ .

Figure 1 shows that the maximum power output can be reached with  $\lambda = 0.9$  which called as rich operation.  $\lambda$  value below 0.9 led to incomplete combustion in decreasing power output and fuel efficiency.  $\lambda$  value more than 1 is called lean operation where the thermodynamic efficiency of engine will increase until  $\lambda = 1.1$ .  $\lambda$  over 1.1 will cause thermodynamic efficiency drop. The common cars are operated with  $\lambda$  value approximately 0.9 to 1.3 as in Kiencke and Nielsen [8].

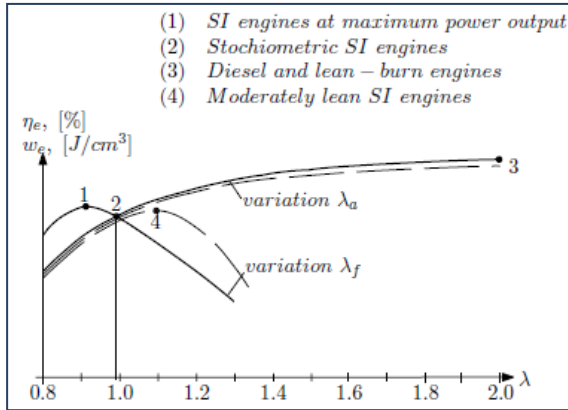


Fig. 1. Effective work and thermodynamic efficiency of combustion engine depending on variation of AFR

The proposed control system is focusing on varying AFR in order to achieve best power output based on the road slope angle. In uphill, LCGC needs more power to climb the slope. In this paper, for road slope  $0^\circ$  to  $45^\circ$ , the  $\lambda$  will be decreased linearly putting the engine into rich operation state and increase the power output. Greater angle of road slope will not cause further decrease of  $\lambda$  in order to avoid incomplete combustion. Thus, the LCGC

performance is increasing an able to encountering uphill.

In order to compensate the increase of fuel consumption, the system is changing the AFR value when the vehicle is in a downhill. At downhill, the system state changes into lean operation state, thus the vehicle is saving the fuel.  $\lambda$  value is raised from 1 to 1.3 linearly based on the road slope  $0^\circ$  to  $-45^\circ$ . Greater downhill road slope angle will not cause further increase of  $\lambda$  value since to low amount of fuel is making the engine impossible to operate. The proposed control system reads the road slope angle in one axis only shown in Figure 2.

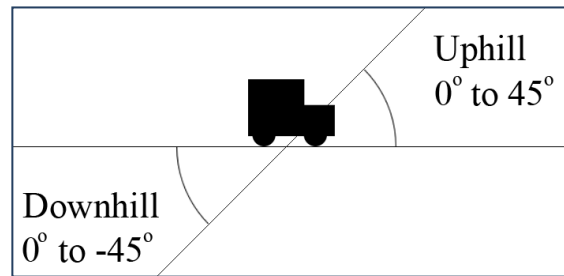


Fig. 2. Single axis angle reading

Gyroscope is used for sensing the road slope angle. The mechanism is modeled in MATLAB Simulink using block diagram shown in Figure 3.

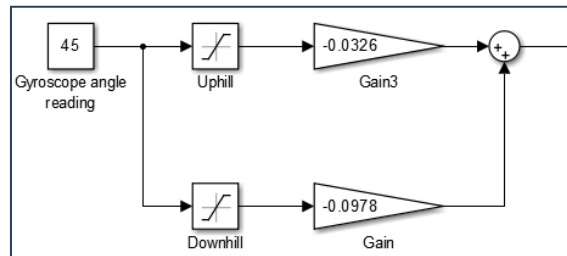


Fig. 3. Gyroscope modeling

The saturations are used to distinguish the slope, either uphill or

downhill. The gain is used as signal conditioning, the value of signal conditionings are determined as the angle value is converted into AFR value as a linear equation.

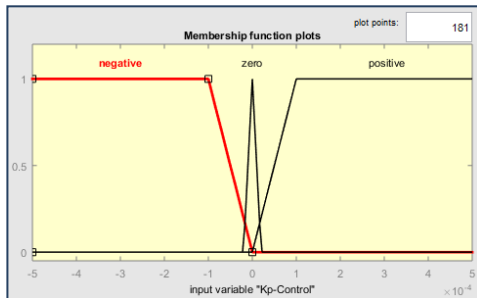
## 2. Hybrid PI-Fuzzy Control System

The proposed control system combines conventional PI controller with fuzzy logic control system. The fuzzy logic controller is used to optimizing the PI controller which adjust the control signal based on the output of PI controller. The fuzzy logic controller will increase the control signal more if the response still far from the desired output. The control signal will be adjusted automatically according to the rule base, thus the response system will be shorter. The PI controller parameter  $K_p$  (proportional constant) and  $K_i$  (integral constant) was tuned to achieve the best system response which is:

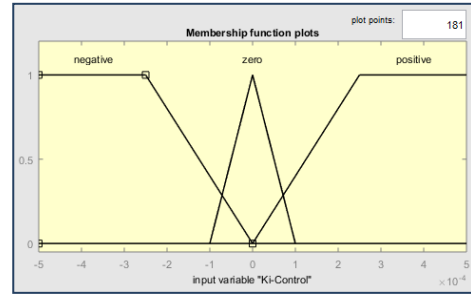
$$K_p = 0.00001$$

$$K_i = 0.0001$$

Both the output of controller P and I from the PI controller is used as input of the fuzzy logic controller. Figure 4 shows the membership functions of fuzzy logic controller implemented in the system. The rules of the fuzzy logic controller are shown in Table 1.



(a) Input from P controller output



(b) Input from I controller output

Table 1. Fuzzy rule base

Ki \ Kp	Ki		
	Negative	Zero	Positive
Negative	Negative	Zero	Positive
Zero	Negative	Zero	Positive
Positive	Negative	Zero	Positive

The output of the fuzzy logic controller uses Mamdani model which has simplicity and widespread acceptance considering the system is applied in LCGCs. Both input and output of the fuzzy logic controller combines trapezoid and triangular membership function. The proposed system uses trapezoid and triangular membership function since those types have simple formulas and computational efficiency [12]. The simplicity and computational efficiency are vital for the system since the system needs as fast as possible transient response.

## 3. Control System Structure

The control system is implemented on the engine modeling as shown in Figure 5. The hybrid PI-fuzzy controller output is used as engine modeling input shown in Figure 6. The system uses these following inputs: stoichiometric AFR value, gyroscope modeling, and feedback value of AFR. The inputs are summed and used as

the input of PI controller. Unit delay is used for signal sampling in order to convert to digital signal and read as inputs of fuzzy logic controller.

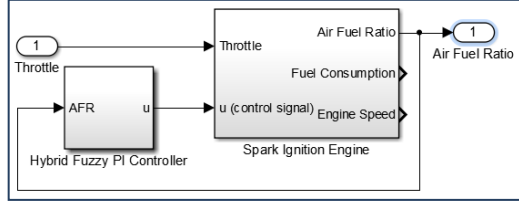


Fig. 5. Control Structure

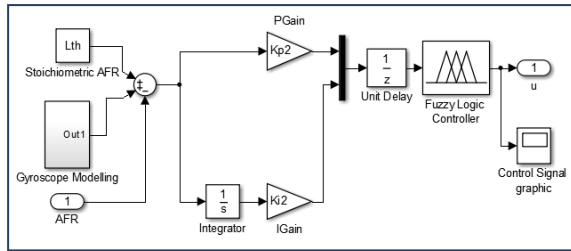


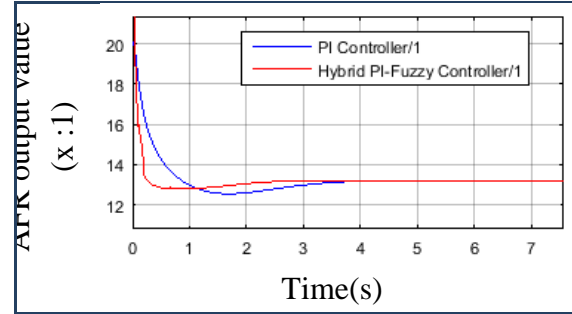
Fig. 6. Hybrid PI-fuzzy controller

The controller output is used as control signal for fuel flow dynamics in engine model based on [9]. The control signal is summed with the fuel injection function in order to compensate excessive or insufficient the amount of injected fuel based on the desired output in order to achieve zero steady state error.

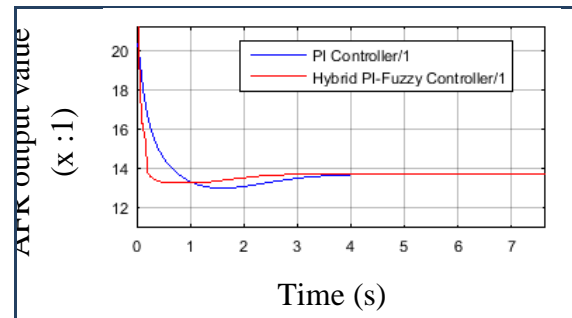
### C. IMPLEMENTATION AND RESULT

The proposed control system performance is evaluated in these following variations :  $-45^\circ$ ,  $-30^\circ$ ,  $-20^\circ$ ,  $0^\circ$ ,  $20^\circ$ ,  $30^\circ$ , and  $45^\circ$ . Figure 8 shows that the proposed control system has better steady state response which has smaller overshoots, shorter rising time, and shorter settling time. In road slope angle  $-45^\circ$ , the proposed control system has higher rate of transient response oscillation than the compared PI controller (see Figure 8 (d)). Even so, the

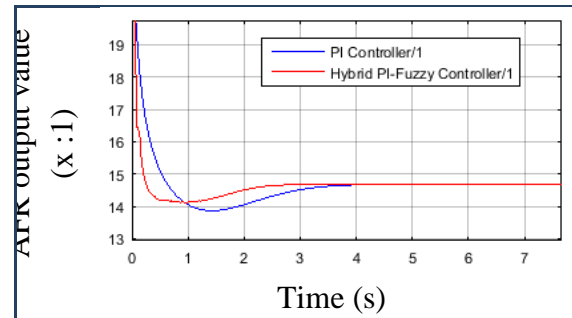
proposed control system reaches steady state faster in all variations.



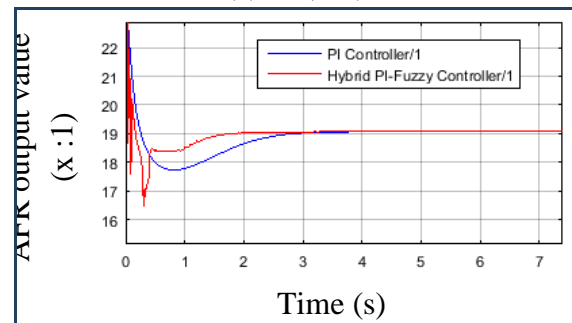
(a)  $45^\circ$ (extreme uphill)



(b)  $30^\circ$  (uphill)



(c)  $0^\circ$  (flat)



(d)  $-45^\circ$  (downhill)

Fig. 8. System output response comparison between system with PI controller and

system with Hybrid PI-Fuzzy controller  
AFR road slope angle

The proposed control system has shorter settling time and smaller IAE than compared PI controller (see Table 2). The output of system using hybrid PI-fuzzy has

capability to adjust the AFR with average value 29% faster than the compared system with PI controller. The proposed control system also has average value of IAE 39% smaller than the compared system with PI controller.

<i>Road Slope (°)</i>	<i><math>\lambda</math></i>	<i>Desire d AFR (x : I)</i>	<i>PI</i>			<i>Hybrid PI-Fuzzy</i>		
			<i>Final AFR Value (x : I)</i>	<i>IAE</i>	<i>Settling Time (s)</i>	<i>Final AFR Value (x : I)</i>	<i>IAE</i>	<i>Settling Time (s)</i>
-45	1.30	19.071	19.071	2.347	4.0	19.071	1.405	2.8
-30	1.20	17.604	17.604	2.343	3.3	17.604	1.486	2.2
-20	1.13	16.626	16.626	2.383	3.6	16.260	1.518	2.5
0	1.00	14.670	14.670	2.593	3.6	14.670	1.587	2.5
20	0.95	14.018	14.018	2.711	3.6	14.018	1.661	2.6
30	0.93	13.692	13.692	2.781	3.9	13.692	1.631	2.8
45	0.90	13.203	13.203	2.901	3.9	13.203	1.594	3.0

The comparison shows that the proposed control system has better performance than the compared system with PI controller in terms of IAE and transient response. Both system has zero steady state error, however the proposed control system reach the steady state faster. Thus, the proposed control system is considered as a good performance and reliable system.

#### D. CONCLUSION

The simulation results show that the proposed control system is reliable to varying the AFR value of LCGC in order to optimize the engine performance for encountering road slope. The proposed control system is managed to varying AFR accurately based on the road slope angle with average settling time 29% faster and average IAE 39% smaller than the compared system with PI controller. The system is also capable compensating the increase of fuel consumption in uphill by

decreasing fuel consumption in downhill. From the results, the study is managed to design a system to improve the LCGC performance in terms of encountering terrains which has uphill and downhill and the proposed system is highly potential to be implemented in LCGC in the future.

This system is highly potential to be developed further, adding another input parameter for varying the AFR of engine or combining the fuzzy logic controller with another control method to increase the performance of the control system.

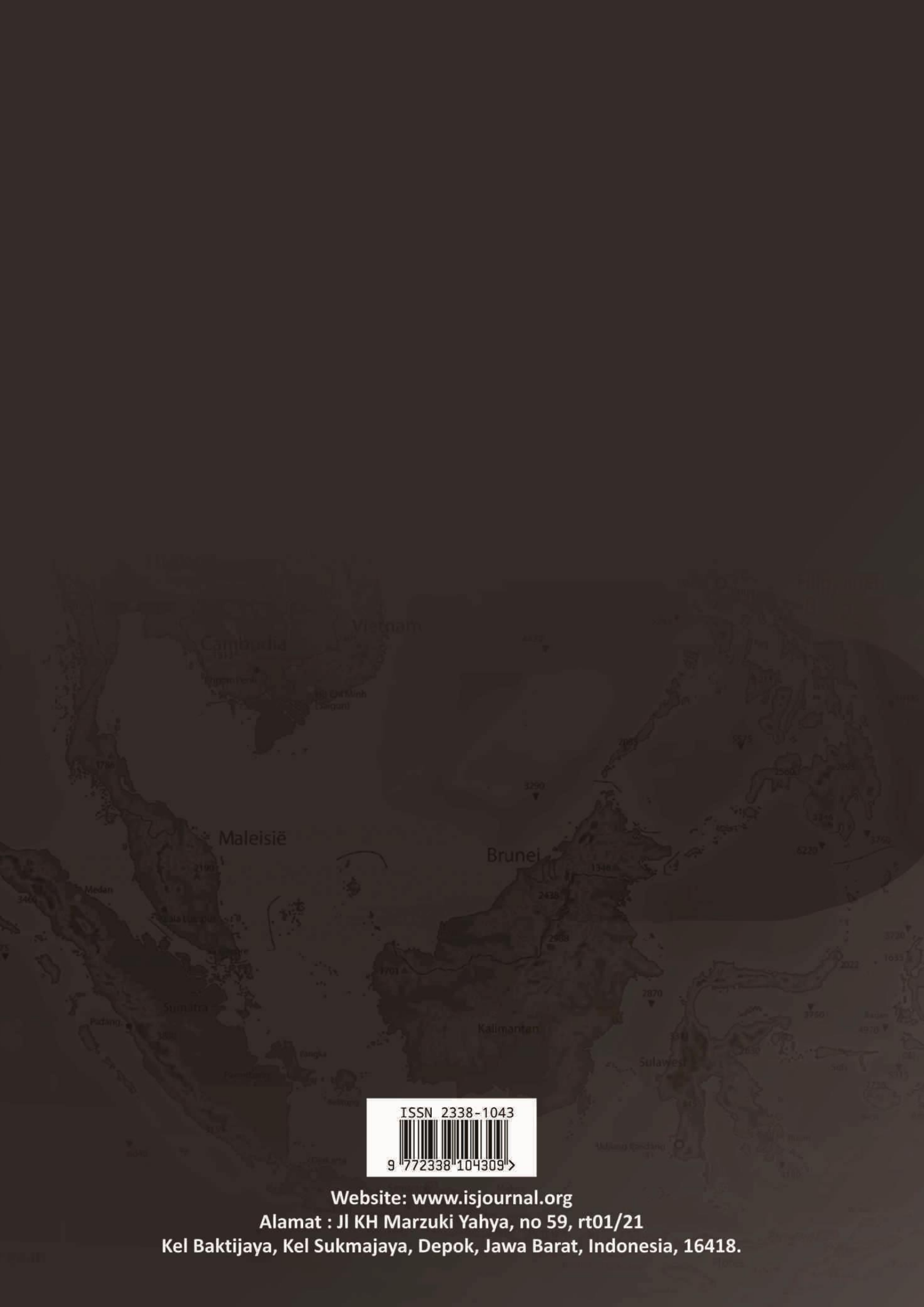
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