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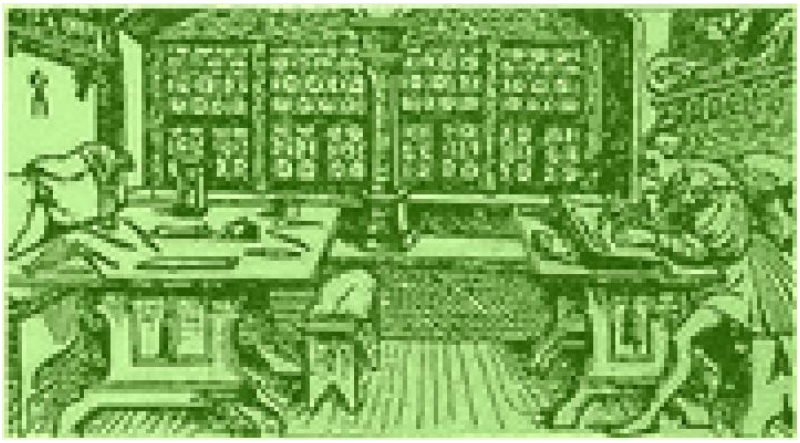

Physical and Technical Geography Issues in Urbanism

Volume 15, Special Issue

International Conference on Urban Sustainability, Environment, and Engineering (CUSME 2020)
Bali, Indonesia, 20-21 January 2020

Guest Editors: *Wayan Suparta (Chief)*
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A special issue on Physical and Technical Geography Issues in Urbanism

2020 International Conference on Urban Sustainability, Environment, and Engineering (CUSME 2020)
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The development of sustainable urban is a necessity where megatrends 2030 triggered by the Industrial Revolution 4.0 estimates urbanization will increase sharply, especially in Asia. City authorities must make appropriate policy choices to protect the provision of equitable housing, health, and transportation services in the future. If the authorities fail to provide services on the policy and regulations, it would clearly endanger the long-term environmental and could threaten economic productivity.

To address various issues faced by urban phenomena, man-made activities, and the political will run by the authorities along with the major role of scientist to contribute to the urban sustainable development, Universitas Pembangunan Jaya (UPJ) and Naresuan University Thailand, Universiti Teknologi MARA (UiTM) Perak Branch, Malaysia, and Udayana University Bali, Indonesia have hosted and organized the meeting which focused on the theme `*Urban Life and Technology*`. The meeting was named The 2020 International Conference on Urban Sustainability, Environment, and Engineering (CUSME 2020) which was held on January 20-21, 2020 at Prime Plaza Hotel Sanur, Denpasar, Bali, Indonesia.

In this meeting, we want to give solution like, what is the current information on urban studies that drive digital transformation and efficiencies. How can we respond to the effects of climate change in our environment, urbanization, and other related areas? Can we encourage various sectors to participate in urban sustainability management? And the most important question is, what can we do to harmonize our lifestyle with the consequences of enabling technology? This is still big questions. We hope to find out the solution.

Two big key topics in the area of urban sustainability, environment, engineering has been discussed during the conference: (1) track on Environment Science and Engineering, and **(**2**)** track on Management and Tourism**.** For the first track, it covers such as climate change and mitigation, green energy, infrastructure and ecology, development and planning, pollutions and reduction strategies, urbanization of rural areas, remote sensing and geospatial analysis, sustainable transport and mobility, urban environment and management. For the second track, it covers such as urban economics, urban policy and government, urban lifestyle and quality life, finance and accounting, and tourism in the Digital Era. These broad topics will bring together experts and researchers in related fields, making it fertile ground to share and discuss ideas, knowledge, perspectives, methods, research results, and policy ideas in urban contexts. For the second track, only selected paper that related to the journal theme is proposed for the special issue.

The format of the meeting consisted of opening remarks, invited talks by five keynote speakers from a different background that covers various urban sustainability, environment and engineering. The talks delivered and papers presented in four brain-storming technical sessions were categorized into the four sessions. For the first time, we received and presented 127 papers from eight different countries. For the academic efforts, we only consider proposing research articles with high quality of 18 articles for publication in the Special issue

and 10 articles in the regular's issues of *Geographia Technica*, an International Journal of Technical Geography.

It is an honour to present this volume to *Geographia Technica* and we are very grateful to the authors for their enthusiasm for attending and sharing knowledge at the conference. We express our sincere gratitude to committee members and all those who have helped us to organize the conference successfully and develop a very interesting program. Finally, we would like to extend our sincere gratitude for making CUSME 2020 a tremendous success: Keynote Speakers, Reviewers, Collaborators, Sponsors, and Participants.

Guest Editor
Wayan Suparta (*Chief*)
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THE LINKAGE OF EFFECT CLIMATE CHANGE FOR DETERMINING DESIGN FLOOD OF TENGGANG RIVER

***Marelianda AL DIANTY*[1], *Rizka ARBANINGRUM*[1], *Frederik Josep PUTUHENA*[1]**

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ABSTRACT:
Extreme Flood events due to climate change have been hit Semarang City several times. The disaster usually occurs because of the development of flood protection generally does not include climate change factors on the design flood. The paper was appointed to characterize rainfall run-off with 10 years of historical data from three rain gauge stations likely Wolo, Brumbung, and Maritim. The analytical showed annual rainfall and maximum daily rainfall tends to increase on average 2.139 mm per year, the number of rainy days tends to decrease two days per year. The future Intensity Duration Frequency (IDF) is needed to anticipate global temperature increases more than 2 degrees. Whereas the analysis for drainage capacity showed by the intensity return period of rainfall for 2, 5, 10, 25, 50, 100 years were 81.656 mm/ hour, 104.262 mm/hour,116.00 mm/hour, 126.511 mm/hour, 132.773 mm/hour, 138.030 mm/hour. With the findings, it is expected to develop a flood control system, simply considering the impact of climate change. Hence, the research is successful to predict the flood in a small catchment, with historical data only. The result contributed to one frame that it should take into account the necessity of flood mitigation, including the climate change impact.

Key-words: *Flooding, Hydrograph, Intensity, Rainfall, Climate Change*

1. INTRODUCTION

Nowadays, the occurrence of flooding in Semarang City significantly tends to increase from time to time. It caused by several factors likely land-use change, the impact of climate change and land subsidence. The effect of land-use changes as well as land subsidence have been thoroughly studied and discussed (Fu et al., 2003, De Paola et al., 2014, Califano et al., 2015). While the effects of climate change in terms of hydrological factors have not been much discussed. As well this problem might take into account in the drainage systems and flood control management. According to Suripin & Hilmi (2015), climate change has brought modification in the rain characterization. It is shown by the duration of the dry season is getting longer where the number of rainy days tends to decrease, while the maximum daily rainfall and intensity tend to increase.

Climate change due to global warming is no longer an issue but has become a reality, the effects and the damages have been we felt together. Climate change occurs because of internal natural processes or external forces, or due to human activities that continuously change the composition of the atmosphere (Shrestha & Zinck, 2001, Murdiyarso, 2003). Climate change is characterized by changes in climate events. One of the indicators is rainfall. Rainfall as seen as the most important climate change variable because it is prompt to

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the activities of human life in various sectors such as agriculture, transportation, trade, health and the environment. In the same way, rain is one of the most unpredictable atmospheric variables, and it is still a big challenge for meteorological researchers (Emanuel, 2005).

In the tropical country, rainfall acknowledges as the most varied physical element of the environment. This region does have a high level of non-linearity, so the atmospheric conditions of this region are more difficult to predict in compared to the other regions with high latitudes. So far, empirically scientists have been found that global warming will increase the rainfall. Since the extreme rainfall in the tropics is more sensitive to the effects of climate change than other regions of the world. But the mechanism of the increasing intensity of rainfall is not yet well understood (O'Gorman, 2015). The impact of high intensity of rainfall is evoked potential extreme flooding on the tropical countries. Hence, the modelling should provide a sufficient rainfall run-off analysis, especially for the equatorial region like Indonesia. As identified Pravalie (2014), the rainfall run off analysis needs data of mean monthly and annual temperatures (°C), and monthly and annual amounts of rainfall (mm) and potential evapotranspiration (mm). Generally, the diversity of rainfall in Indonesia is influenced by its presence on the equator, monsoon activity, the stretch of the Pacific and Indian oceans as well as very diverse forms of topography (Diaz et al, 2006). According to the World Wildlife Fund in the period of 100 years, the average annual temperature in Indonesia was increased to 0.72-3.92 degrees involved the intensity of rainfall was become decreased to 2-3 percent. In the same way, the study also a summary in the southern part of Indonesia, the rainfall has been shifting to one month slower with an increase of the intensity of rainfall up to 10 percent in the rainy season and the reduction of rainfall intensity about 75 percent in the dry season (WWF, 2012). Furthermore, Wayan & Yatim (2019) was reported similar situation from the neighbouring country of Indonesia that annual mean temperature increased from 0.99 to 3.44°C /100 years.

From those issues, this research provides flooding control and development of the drainage system by rainfall run-off analysis. Despite other findings are still conventional, it does not include climate change parameter in determining design flood. Based on this condition, we aim to find the rainfall run off by historical data analysis. More importantly, we develop the analysis of rainfall Intensity Duration Frequency (IDF) which is the amount of rainfall expressed by height and volume of rainfall. The effort requires the IDF modelling to design extensive drainage systems. The analytical solution of this study, it is expected to develop drainage systems and or flood control, especially in a small catchment area.

2. STUDY AREA

2.1 Characteristics of Tenggang River

Tenggang River is a unique river because it is located in several sub-districts in the city of Semarang from upstream to downstream. The upstream part of the river is located in Pedurungan while the downstream is in Genuk and the rest of the part is in Gayamsari. The catchment area of Tenggang River has around 25.48 Km^2. Currently, Tenggang River has less functioning with poor drainage channels due to the frequency of flooding in the Catchment Area in Tlogosari. Instead, the river Tenggang is quite large and able to flow through the existing water flow, but there are several things that make this channel runoff or flood. What often happens is silting up and the presence of illegal buildings that hinder the flow of water towards the downstream.

The soil type in the Tenggang river is dominated by the Gray Alluvial about 64.21percent, Mediteran Dark Brown around 27.02 percent, Regosol 7.82 percent and a small

portion of Reddish-Brown Latosol about 0.73 percent and next Alluvial 0.22 percent. Soil Alluvial Gray and Alluvial Association are found in the upstream part, while the downstream is dominated by the brown mediteran and a little Grumusol. Alluvial soil type is soil formed from river mud that settles in the lowlands which have fertile soil properties and is suitable for agricultural land. While grumusol soil is soil formed from soft clay material. This soil type is black gray and is fertile. Grumusol soils generally have a clay texture and break easily during the dry season. While, the composition of land use planning around the river consists of Tambak 7.64 percent, 15.96 of urban, settlement 30.42 percent and rice fields around 45.99 percent (Pintubatu et al., 2013).

2.2. Rainfall Stations

Tenggang River is a river that stretches from around the area of Tlogosari Raya street, Muktiharjo Raya street, Kaligawe Raya street then until the North Sea of Java. Those areas were often affected by floods and tides. There are three rain gauge stations located close to the Tenggang river likely rain gauge station Wolo, rain gauge station Brumbung and rain gauge station Maritim. Moreover, the study area was divided into 23 sub-basins as follow showed in (**Fig. 1).**

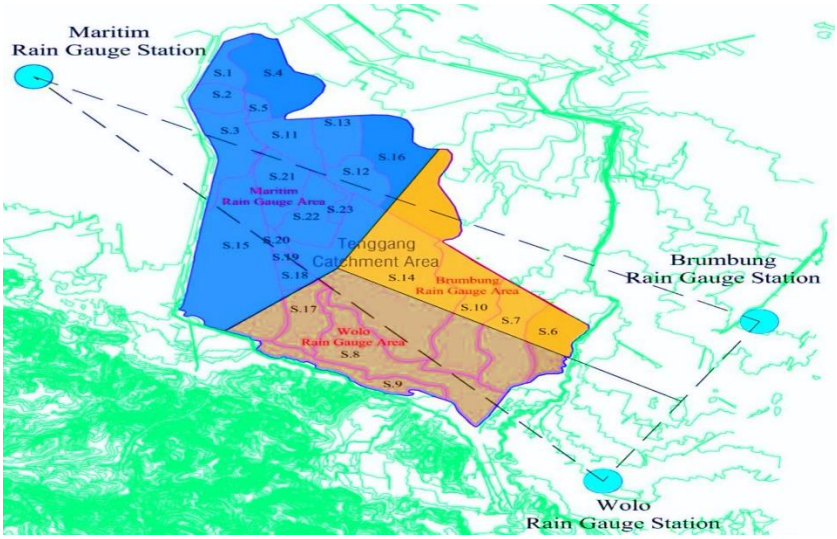

Fig 1. Map of Tenggang River

3. METHODOLOGY

3. 1 Rainfall Analysis

Rainfall analysis is carried out by analysing regional rainfall and performed it on the peak of annual rainfall, number of rainy days and maximum daily rainfall. Where it is useful to characterize the rainfall run off. In determining rainfall elements from recording data, only rainfall is obtained at a certain point (rainfall point) used in the analysis. The techniques used to analyse rainfall trend were the rain gauge data from 2006 – 2015. Furthermore, to get the rainfall characterization the area is calculated using the Thiessen Polygon method, as follow**:**

$$R = \frac{A_1R_1 + A_2R_2 + \cdots A_nR_n}{A_1 + A_2 + \cdots + A_n} \quad (1)$$

3.2. Hydrological method

3.2.1 Intensity Duration Frequency (IDF)

Rainfall intensity is the height or depth of rainwater per unit time that occurs at a time period where the water is concentrating. The general nature of the rainfall is the shorter of the rainfall occurs, the intensity tends to be higher and the greater of the return period so the intensity of rainfall will be higher. The relationship between intensity, duration of rain and frequency of rain is usually expressed in the curve Intensity - Duration - Frequency (IDF). Short-term rain data is needed to form the IDF curve. This type of rainfall data can be obtained from rain gauge stations. To calculate the intensity of rainfall can be used equation as follows:

$$I = \frac{R_{24}}{24}\left[\frac{24}{t_c}\right]^{2/3} \quad (2)$$

In the process of converting the rainfall into flow, there are several characteristics of rainfall that used including the intensity of rain (I), length of time (t), depth of rainfall (d), frequency (f) and the area of influence by rainfall (A). The rainfall component with its properties can be analysed in the form of point the rainfall and average rainfall which covers the catchment areas. It can be used daily rainfall to calculate intensity in mm per hour. The analysis of the relationship of two important rainfall in the form of intensity and duration can be statistically related to a frequency of occurrence to find calculation planning of flood discharge by rational method with the equation as follow:

$$Q = C\ x\ I\ x\ A \quad (3)$$

3.2.2 Flood hydrograph model

Hydrograph is defined by the relationship between surface flow or base flow with time. While, flood hydrographs itself are a graph to illustrate a drainage basin which will responds to the period of rainfall. The method is predominantly useful for observed floods and catchment characteristics (Hall & Minns, 1999). Flood hydrograph in a catchment area depends on various factors, its related to runoff and the elements that express the physical characteristics rainfall. It is valuable for deriving flood hydrographs that incorporate realistic floods peak and volume of rainfall were distributed realistically in time. As well Virginia et al (2016) have been demonstrated flood hydrograph on the large amounts of unconsolidated material such large wood under different unsteady flood scenarios.

Flood hydrograph in this research is developed by Hydrologic Engineering Centre's Hydrologic Modelling System (HEC-HMS). The software is used in water resources management planning. HEC-HMS is used for hydrological analysis by simulating the rainfall

and runoff processes of a river basin. Flood hydrographs are obtained by comparing flood hydrographs due to rainfall at various re-times. Additionally, the analysis of the design flood is performed using "HEC-HMS" software. Outputs of this software include rainfall intensity and flood hydrograph. Model hydrograph that we used in this case is using Soil Conservation Service (SCS) model. The model was recognised have accurate results therefore it is broadly applied (Gyori & Haidu, 2011). Besides, HEC-HMS gives an accuracy answer and a reliable model with reasonable approximations to perform the rainfall-runoff modelling (Haidu et al., 2017). Moreover, to complete this hydrological analysis on flood hydrograph is used by analysing some of its parameters as follows:

$$T_c = \left(\frac{0.87\ x\ l^2}{1000\ x\ \Upsilon}\right)^{0.385} \qquad (4)$$
$$L = 0.6T_c$$

L : lag time (hours), Tc : time concentration (hours), l : length (km), Y: slope

4. RESULTS AND DISCUSSIONS

4.1 The characteristics of rainfall

The rainfall characteristics have been done by regression analysis to discover the correlation between rainfall parameters and the time. The parameter included annual rainfall, number of rainy days, and maximum daily rainfall. The analyses of the trends in rainfall were identified using the Thiessen polygon method. it carried out on three rain gauge stations that have historical data, in this case, 10 years. The watershed areas were divided into 50 % of Maritime rain gauge stations, 30 % of Wolo rain gauge station and 20% of Brumbung rain gauge station. The rainfall characteristics are shown in **(Fig. 2)**. The figures illustrated Brumbung rain gauge station has the significance of the linear trend is compared to other rain gauge stations. Subsequently, Maritim rain gauge station revealed to high intensity of rainfall each year. While, Wolo rain gauge station perform contrarily significant for all years. Moreover, it also found in the year 2010 indicated as the peak of rainfall in all rain gauge stations. The analysis revealed that a large number in the same rainfall event has contributed to extreme rainfall. Therefore, it needs an additional rain gauge station at the catchment area. As demonstrated by Yavuz & Erdoğan (2012), it is necessary to have sufficient rain gauges distributed in the optimal locations.

From the result, it can be seen, the annual rainfall and maximum daily rainfall tend to increase, while the number of rainy days tends to decrease. The annual rainfall from Brumbung station appears to have more consistency. While the average daily rainfall tends to vary in Maritim rain gauge station from month to month. Hence, it needs to have a reliability assessment in those stations (Martin et al., 2015). Peak annual rainfall increased by an average of 12,094 mm per year, while the maximum daily rainfall increased by an average of 2,139 mm per year, and the number of rainy days decreased by an average of 2 days per year. From the result, the peak of annual rainfall it seems to have similarity with research conducted by Mello et al (2013) in Brazil, the characteristics of rainfall in Tenggang river was present potential high intensity of rainfall. Hence, its essentials to be taken into account for hydrological and water management in this area.

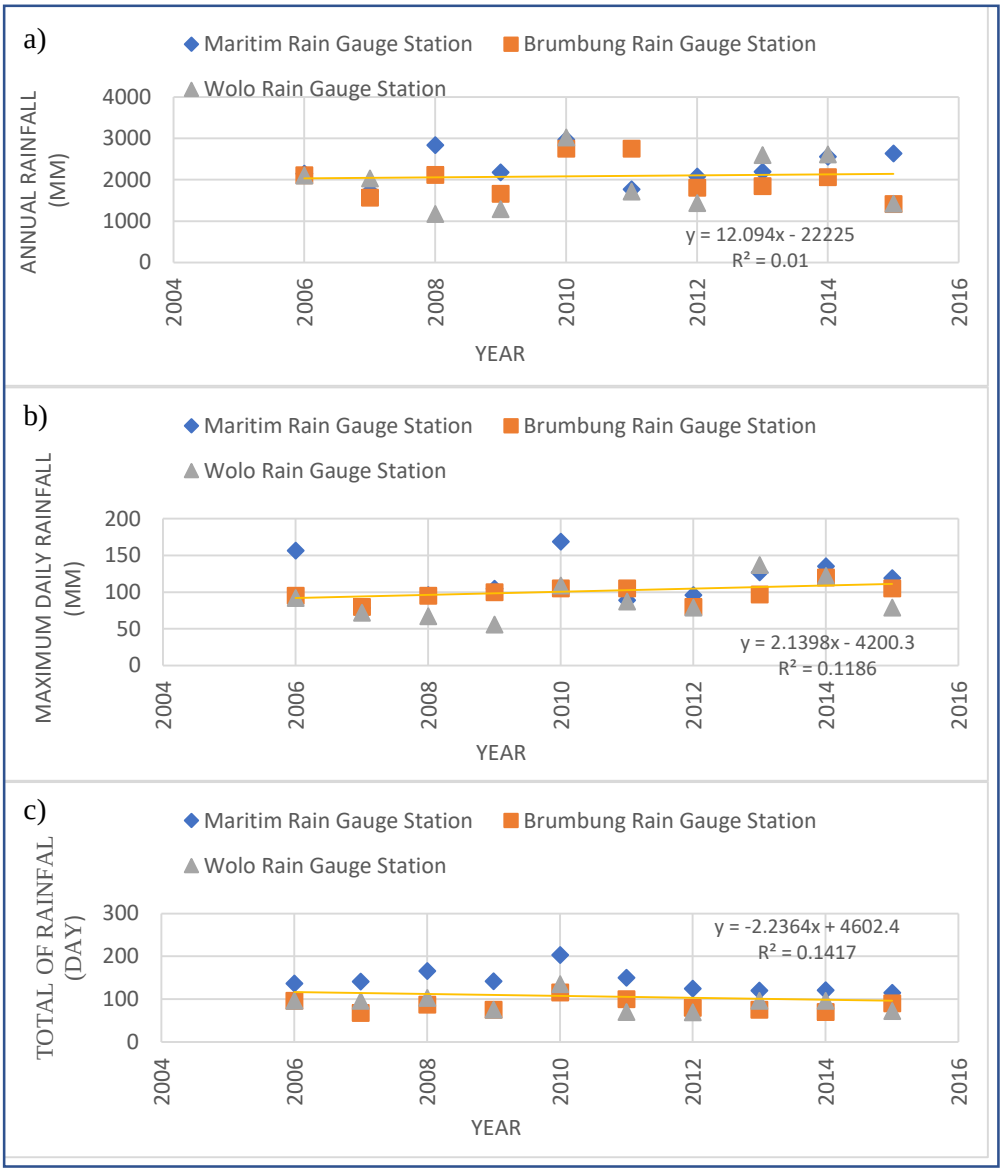

Fig. 2. Rainfall Characterisation Each Rain Gauge Station

4.2 Design Flood

4.2.1 Rainfall Intensity

The simulation of rainfall intensity was demonstrated by the IDF curve (Intensity Duration Frequency) showed in **(Fig 3).** The empirical formulas are used to construct the rainfall IDF curve. The curve in the figure was evaluated using the daily rainfall, for different return periods T. In particular, the obtained IDF curve underestimates values less than four

hours while overestimates values greater than four hours, in contrast with the curve developed by Soro et al. (2010) which obtained IDF curve showed underestimates values less than one hour while overestimates values greater than one hour. Although overall the curve is dissimilar to that developed by Soro et al (2010), it probably caused by the probability parameter used in the analysis. They used Log normal, GEV and Gumbel distribution fitted by maximum likelihood. While this research used a Log Pearson III distribution approach, we were considering a poor data contained, using this kind of distribution it may be preferable to fit with a distribution that requires an estimate of the skew coefficient, such as a log-Pearson Type III distribution. The data can be plotted to determine the adequacy of the curve. Since 1967, the U.S Water Resource Council has recommended and required the use of LP3 distributions for all U.S analysis (Millington et al., 2011). At the same time LP 3 was recognise as a recommended basic distribution for defining the annual flood series (Xiao et al., 2009).

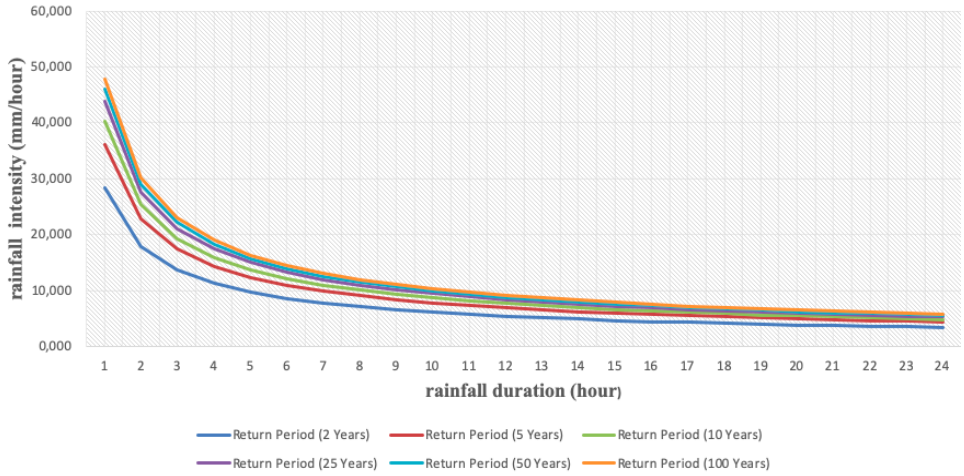

Fig 3. Intensity Duration Frequency Curve

Intensity corresponds with the duration and frequency can be expressed by the curve Intensity-Duration-Frequency (IDF). IDF curves can be used to calculate flood plan. The maximum rainfall using an algebraic average of 10 years of observations derived from the 3 rain gauge stations, namely Maritim, Brumbung and Wolo. Then looking for the patterns of rainfall distribution through normal distribution and statistical parameters logarithmic and analysed the design of rainfall by Log Pearson III method. The intensity of rainfall calculates by using the rational method. The analysis calculated using the method of flood discharge plan to use rational methods to obtain flood peak discharge flow in the area research areas prone to the flooding. Then result calculation of drainage capacity in the research area showed by the intensity return period of rainfall for 2,5,10, 25, 50, 100 years were 81.656 mm / hour, 104.262 mm/ hour, 116.00 mm / hour, 126.511 mm / hour, 132.773 mm / hour, 138.030 mm / hour.

4.2.1 Flood hydrograph analysis

The design of flood hydrograph has been analysed through rainfall analysis from 2006 until 2015 where then we calculated the flood discharge. It was associated with the downstream discharge station. The result found the flood discharge will increase in line with

the characteristics of rainfall, where the peak of maximum daily rainfall tends to increase 2.139 mm per year. The time to peak and the total duration of the hydrograph scenarios have been scaled compared to recorded flood waves (time to peak and the total duration may be up to 2 times shorter in some cases). The flood scenario from prolonged rainfall occurred in Tenggang river showed in (Fig. 4). Based on the result, it is defined the flood peak reached close to 10 hours after the beginner of flood wave where the total of flood duration equals to 25 hours. The shape of the hydrographs reflects the shape of flood waves occurring in the Tenggang river with a rising limb being steeper than the falling limb.

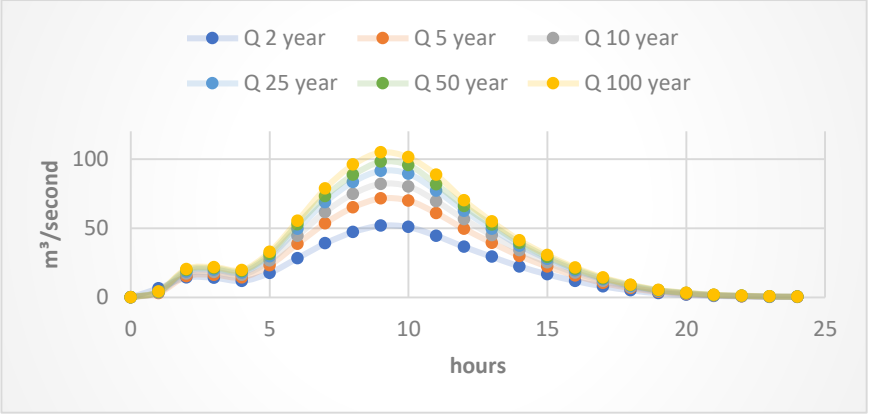

Fig 4. Flood Hydrograph of Tenggang River

Some suggestions from the research are the analysing of the effect of climate change on rainfall required longer historical data. It needs more than 10 years, so accurate results would be achieved. Next, the number of rain gauge stations especially in the Tenggang river is actually adequate however the availability of data (continuity, quality, and completeness) was still insufficient. It is necessary to rationalize the climatology station. Finally, the lack of data on flood hydrograph results in the difficulty of validating research results. Therefore, it is recommended to install and or operate an Automatic Water Level Recorder (AWLR) station in each river. To elaborate on some methods for future climate change it needs the analysis of propagation of the flood and simulated some of the deposit influence the river with the typical channel as well as showed by Virginia et al., (2014). At the same time, we need the analysis of future IDF through climate change such if the temperature increases 2 degrees, it needs to change the IDF pattern. Hence, the future rainfall run-off analysis is also needed numerical analysis (Li et al., 2009, Virginia et al., 2014) and or experimental data analysis such as ANFIS (Suparta, 2011). It is worthwhile as a synthetic method of flood estimation that can be presented the flood forecasting. Otherwise, multicharacteristic synthesis index (MSI) proposed by Xiao et al., (2009) was might be another suitable method for a new way for derivation and reassessment of the design flood hydrograph.

5. CONCLUSIONS

The research conclusion revealed the annual rainfall and maximum daily rainfall tends to increase, whereas the number of rainy days tends to decrease. Annual rain height increased by an average of 12.094 mm per year, while the maximum daily rainfall increased by an average of 2.139 mm per year, and the number of rainy days decreased by an average of 2 days per year. Subsequently, the IDF produced based on historical data where the maximum daily rainfall was increased by an average of 2 mm per year. Flood discharge with high return times quantitatively increased compared with lower return times. On the contrary, in percentage, the flood discharge with a low return period has higher compared to the flood discharge with a high return period. Flood discharge measurements constitute the most important data for improving the rating curves and for addressing the hydrological issue. Furthermore, it needs more than 10 years data to confirm the accurate climate change effect in Tenggang river.

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SPATIAL ANALYSIS APPROACH RELATED TO THE RELATIONSHIP BETWEEN PROXIMITY AND SECURITY PERCEPTION IN ENCOURAGEMENT OF PUBLIC SPACE PARK USE: THE CASE STUDY OF KALBU PALEM PARK (BANDUNG, INDONESIA)

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ABSTRACT:
The existence of the park must provide a sense of security for its users in social interaction so as to increase public awareness through their relationship with the urban environment in creating sustainable urban life. From previous studies, the purpose of this study is to elaborate proximity (geography) with security perceptions (as part of environmental psychology) in encouragement of public space use. There is a debate about the aspects of proximity and encouragement to use the park, but related to the perception of security is still limited, especially in Indonesia. Proximity is much discussed in the science of geography, while the security perception in this study is an important entry point in park planning which plays an important role in strengthening urban communities. People perceptions might be indicated as one of the most interesting parts of human-geographic researches. This research uses descriptive quantitative method that aims to explain the extent of the encouragement of park use based on security perceptions through the stages of spatial mapping, data collection and through questionnaires. The spatial analysis conducted in this study is to calculate analysis through the proximity between the locations of the house from the respondents to the park with the use of transportation modes through Shortest Path Trace (SPT) and Security Perception (SP) method of spatial analysis spatial mapping using ArcGIS 10.3 and compare it with the answers from respondents related to security perceptions with the proximity of the park location. The results of this study indicate that proximity has a low significance on security perceptions of the respondents' that there is a weak link between proximity and park usage based on security perceptions in encouragement use of park.

***Key-words**: Proximity, Security Perception, Kalbu Palem Park, Sekeloa Urban Village, Bandung.*

1. INTRODUCTION

Various studies have shown the park is a representation of the initial identity of public place as a place that is freely accessed by various communities without any profit motive as a space for interaction, negotiation, sharing information from various community characteristics that will support the survival of urban communities (Shaftoe, 2009; Low, 2010). Social aspect is defined as the relationship between individuals (Fujiki and Renalds, 2019). Related to its social function, the park is a location where people from various backgrounds, ethnicities and genders gather to carry out various social activities (Roberts, 2014). According to Byrne and Wolch (2009) parks play a role in making the lives of urban communities more quality, more "healthier", more moral, more socially-minded, wiser, and

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smarter (strengthening the urban communities). This is in line with other studies that show that park use can reduce social problems (including anti-social behavior), as a social bond between urban community groups and a space that can protect the rights of user groups in the learning process of living together as a community through interaction and information sharing in an environment (Holland et al., 2007; Roberts, N, 2014). Thus the use of parks by the community in relation to their social functions plays an important role in raising public awareness about their relationship with the natural environment so as to create sustainable urban life.

Based on the previous discussion related to social functions, it turns out that the park has a problem in terms of its use by the community, one of the aspects that is influential in building a user base in improving the quality of the park as part of public space is related to the aspect of proximity (CABE, 2005; Mowen & Confer, 2007; Roberts, 2014). Actually the relationship between proximity to the encouragement of park use has been examined in several previous studies including geography and environmental planning. The results of the study show that shorter proximities are very important to build a strong user base. Hanan (2013) shows park visits are influenced by several factors one of them is park location that is easily accessible that provides a sense of security and comfort for its users (allows people to carry out social interactions). Ilmiajayanti and Dewi (2015) show that one of the factors that has an influence in increasing the time of social interaction in the park is the accessibility of park users. Annerstedt, et al. (2012) mentioned that one of the variables that determine park use and activities is proximity. McCormack, et al. (2014) also define that proximity are important attributes to encourage park use. In contrast to Gamal's (2010) statement which explains the pattern of park used no longer based on the proximity but on the ease of access to information and the similarity of interests. From these results it turns out that research that looks at the relationship between proximity and the encouragement of park use based on security perceptions in Indonesia is still limited. It is hoped that this research will be carried out to supplement new empirical information that is practically useful for public space park planning in Indonesia.

In this research, perception in the realm of environmental planning and geography becomes an entry point in understanding complex of human aspects. People perceptions might be indicated as one of the most interesting parts of human-geographic researches (Martinát, et al., 2019). By accommodating people participation in urban public space such as park in this research will develop healthy communities and the equity of economic, social and, environmental aspects (Soemardiono, et al., 2019). With this, perception provides a basis in understanding the condition of society in predicting social characteristics and activities as well as people's acceptance and views of public spaces (parks). There is still debate, criticism, in encouraging the use of parks that can accommodate people's sense of security is an indication of the gap between planners and the community. Perception is one of the factors driving the formation of behavior in the environment (Blobaum and Hunecke, 2005 in Fitri, 2018). According to Blobaum and Hunecke (2005) in their research related to psychological and socio-demographic aspects, security perception is an important factor in public spaces (parks) that is influenced by physical features and design variables on security. Security Safety perception is also a psychological state which is an empirical and sensory experience and process of an individual towards the environment in which he lives, both social environment, built environment or natural environment (free from danger, free from insecurity and free from fear) (Fitri, 2018). Planner’s perceptions cannot fully represent the views of the community because planners often do not have in-depth information on public spaces (Fitri, 2018).

Pugaslis (2009) states the role of planners in urban public spatial planning tendencies in visual aspects, on the contrary the user's perception of the community itself is more emphasized on aspects of social value and cultural experience. Therefore Based on this research, community participation is needed in contributing to provide input on how their security perceptions of the existence of the park.

Therefore, the purpose of this research is to elaborate aspects of proximity and aspects of security perception in encouraging the use of public space (case study of park). focus of this research is related to the proximity and the use of park as social function based on the security perceptions. Some considerations regarding this can be traced to the theory of hierarchy of need which shows that the need for security is a basic representation of human needs that are free from danger, fear and insecurity. According to Carmona, et al. (2003), the success of public spaces (parks) depends on their ability to create a sense of security in the community, it means that the sense of security that is presented by public space to improve the quality of life of the community is an important goal that needs to be considered in the planning process and designing urban public spaces to overcome social threats such as conflicts and crime.

2. STUDY AREA AND DATA

The location of the park which is the study area is Kalbu Palem Park, this park is an active and conducive park (safe) in the middle of the location of residential settlements in RW 13 Sekeloa urban village (25,699 people in 2018), Coblong sub-district, Bandung, West Java Province, Indonesia which was inaugurated on January 31, 2018 with area of 485 m^2. From various spatial development policy directives in Coblong sub-district, it is stated that this area requires intensive control regarding the use of existing land, especially for community settlements. Coblong sub-district has the potential to develop in other zones such as education, trade, public service facilities, green open space.

3. METHODOLOGY

3.1. Quantitative approach through spatial analysis and descriptive analysis methods in research

In this study data analysis will be performed using quantitative methods, namely spatial and descriptive analysis methods. The spatial analysis method in question is a method based on the data collection of community locations from the house to the park that is transformed through Shortest Path Trace (SPT) and Security Perception (SP) method of spatial analysis mapping using the ArcGIS 10.6 application (Handayani et al., 2005). GIS applications are commonly used for spatial analyses in the engineering and environmental fields (Nistor et al., 2019). Next, the descriptive method is a statistical technique that functions to see an overview of each variable examined in this case through questions related to how the security perception of the community is related to the proximity to the park. According to Creswell (2009), quantitative research is a method for testing certain theories by examining the relationships between variables accompanied by assumptions to prevent bias, control alternative explanations, be able to generalize and re-apply their findings. Although this research is large scale, contact with the community is faster than qualitative research. The stages of the research are shown in the figure below.

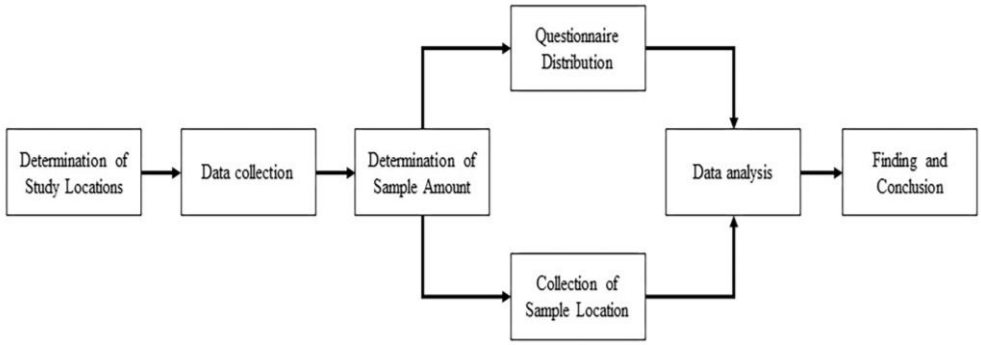

Fig. 1. Flowchart of research work *(Source: authors).*

The main characteristics of Geographic Information System is the ability to analyze systems such as statistical analysis and overlays called analysis spatial namely by adding the dimension 'space' or geography. Spatial analysis is done by overlaying two maps which then produce a new map analysis result. Spatial Analysis Process includes creating buffers around points, lines and areas (polygons), analyzing maps with points, lines and areas that are overlaid using the intersection, union, identity, delete, and clip. The working procedures of spatial geographic system analysis can be seen in **Fig. 2** below:

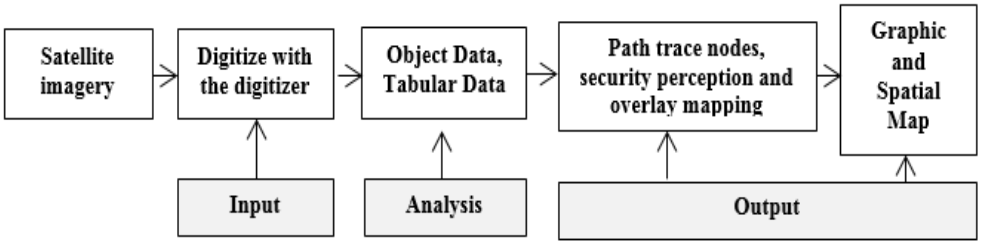

Fig. 2. The working procedures of spatial geographic system analysis *(Source: authors).*

Descriptive method includes an overview related to the profile of respondents as well as the main variables of the study. The question for the respondents is whether proximity affects respondents security perceptions in encouragement of park use ?. The question asked was whether the existence of the proximity to the park location made them (community in Sekeloa, urban village) feel unsecure using the park. For categorical data, the descriptive method used is the frequency value (f) and percentage (%). As for numerical data, the descriptive method used is the average value (mean), standard deviation (standard deviation), minimum value and maximum value. For variables with a Likert scale of 5 categories, the average value is calculated and then classified into five categories according to the number of alternative answer categories. The categorization of scores is based on standard rules by dividing the score range (5-1 = 4) into five categories with the same interval (4/5 = 0.80) so that the guidelines for interpretation of average scores are obtained as follows:

Table 1.

Guidelines for interpretation of the average score.

Score Interval Average	Interpretation	Code
4,21 - 5,00	Always / very important / very high	5
3,41 - 4,20	Frequent / important / high	4
2,61 - 3,40	Sometimes / quite important / moderate	3
1,81 - 2,60	Rarely / unimportant / low	2
1,00 - 1,80	Never / very unimportant / very low	1

(Source: authors)

For the use of the questionnaire, this study uses a closed ended questionnaire, this is necessarily done to explore perceptions of park use and the impact caused by technology. For variables on filling the questionnaire using a Likert scale of 5 categories with a scale of 5 (highest) to scale 1 (lowest). This quantitative research is used because the research process carried out is based on the synthesis of theories that previously existed. This research will later explain the causes of social phenomena through objective measurement and numerical analysis (statistics). This research uses hypothesis verification to answer the problem formulation. The use of both descriptive and inference statistical analysis also adds to the characteristics that this study uses quantitative methods as the main method (Sugiyono, 2010).

3.2. Descriptive analysis in explaining the relationship between proximity and the encouragement of park use based on community security perceptions

The respondents sampling method used in this study was purposive sampling. This method was chosen by looking at the sample used is the user community around the park location. In this case the population used is limited population where not all populations within the coverage radius are sampled in the study. The purpose of the sample and population is as a source of data and as a tool to generalize the characteristics of relationships in proving hypotheses or propositions that represent populations. The sampling time is from July 2019 to October 2019.

The determination of frame samples using the Slovin formula:

$$n = \frac{N}{1 + N \times e^2} \tag{1}$$

Information:
n: number of samples
N: Total population
e: error tolerance limit used (error tolerance 5%)

The Slovin formula is used when the population in the study area is known by the unit of analysis is individuals who are in settlements around the park location (Sevilla et al., 2007). Based on the calculation results, the number of respondents who filled out the questionnaire was 411 respondents who were residents of Sekeloa Urban Village and were also the visitors of Kalbu Palem Park. For the use of the questionnaire, this study uses a closed ended questionnaire, this is necessarily done to explore perceptions of park use and the impact caused by technology. For variables on filling the questionnaire using a Likert scale of 5 categories with a scale of 5 (highest) to scale 1 (lowest) (see **Table 1**). This quantitative research is used because the research process carried out is based on the synthesis of theories that previously existed.

4. RESULTS AND DISCUSSIONS

The proximity based on the distance between layers using the Shortest Path Trace (SPT) method, which analyzes to find the shortest distance from two locations using the Security Perception (SP) method, which is to know the position of the distance of a point in the same direction within a certain radius. The results of the spatial mapping related to the proximity and mode used by the community from the house to the location of the first park, the Kalbu Palem park (see **Fig. 3**). The location point of the house shown is the result of data collection on 411 respondents in 9 hamlets (Hamlet 1 through 4 and Hamlet 11 through -15) in Sekeloa urban village.

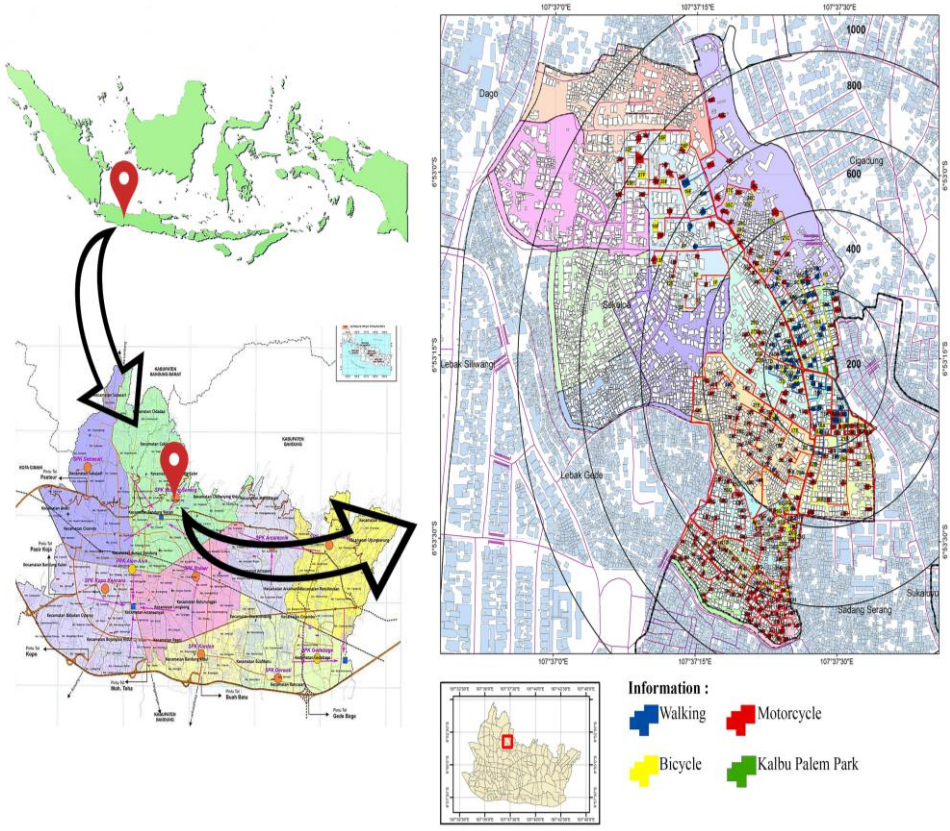

Fig. 3. Map of study location boundaries in Sekeloa urban village, Bandung City, Indonesia, based on the radius of coverage and mode used by respondents to the park *(Source: https://www.google.com/maps/place/Bandung (left), authors own processing (right)).*

Based on the analysis using the ArcGIS 10.3 application, the following results are obtained:

Table 2.

The average proximity from the respondent's house to the Kalbu Palem Park.

Average proximity to park (per range coverage classification) (meters)				
0 - 200	**>200 - 400**	**>400 - 600**	**>600 - 800**	**>800 - 1000**
190.17	422.28	649.7	885.28	962.42

(Source: authors own processing).

From the results of the table 2 calculation shows that based on the coverage radius shows only at the coverage radius >0-200 meters and coverage radius >800-1000 meters, the average location proximity shows the results according to the category of coverage radius to the park that is 190.17 meters and 962.42 meters. In Table 3 below will show an The analysis of Shortest Path Trace (SPT) the suitability of according to the proximity of the location of the house to the park based on the standardization of coverage radius and the perception of security from the community based on the results of the questionnaire (see **Fig. 4**). While in table 4 shows the use of modes from the community to the location of the park based on coverage categories radius.

Table 3.

Conformity of the average proximity based on the radius of coverage along with the security perception to the Kalbu Palem Park.

Coverage Radius (meters)	Proximity Analysis (meters)		
	+	-	Security Perception (SP)
0 - 200	54.03	43.94	1.98
>200 - 400	111.76	87.45	2.10
>400 - 600	137.34	61.62	2.07
>600 - 800	180.81	91.45	2.21
>800 - 1000	222.66	173.28	1.88

(Source: authors own processing).

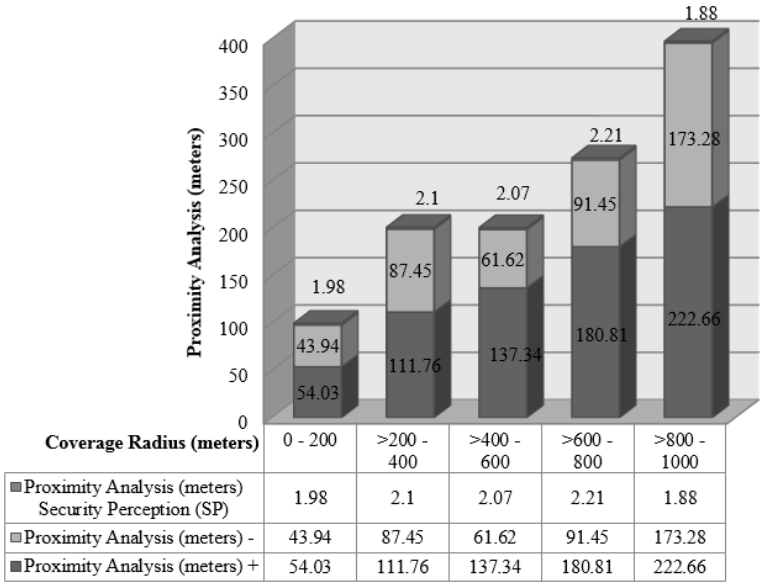

Fig. 4. Conformity of the average proximity based on the radius of coverage along with the security perception to the Kalbu Palem Park.

Information:

Proximity Analysis (+): The average value is based on the difference from the upper limit of the coverage radius with the proximity of the respondent's house to the location of the park.

Proximity Analysis (-): The average value is based on the difference from the lower limit of the coverage radius with the proximity of the respondent's house to the location of the park.

Security Perception (SP): The average of the results of the answers (based on Likert Scale) of respondents based on security perceptions related to the proximity in encouragement use of park.

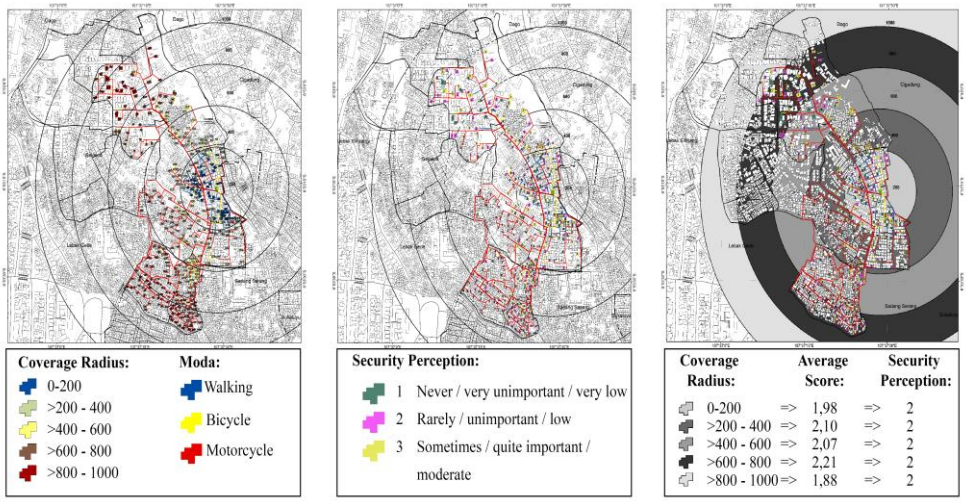

Fig. 5. The result of spatial map overlay (right) according to proximity (left) and security perception (middle) in encouragement of park use *(Source: authors own processing).*

Based on the proximity of respondents to the park exceeds the average category of existing coverage radius, but the perception of public safety regarding the proximity to the park shows the highest value in the category >600-800 meters which is 2.21 (low), with an average perception of community safety based on the proximity to the encouragement to use the park is 2.05 (low category) (see **Fig. 5**). It means that proximity has a low significance on respondents' safety perceptions of visiting the park. While in table 4 shows the use of modes from the community to the location of the park based on coverage categories radius. In Table 4, the average percentage of modes used by the community to the park mostly using motorcycle (54.98%), but in the category of proximity of 0-200 meters respondents prefer to walk in accessing the location of Kalbu Palem Park.

Table 4.

The use of modes is based on the coverage radius to the Kalbu Palem Park.

Coverage (meters)	Modes			Frequency mode is the most commonly used
	Walking	Bicycle	Motorcycle	
0-200	47	14	28	Walking
>200-400	27	28	63	Motorcycle
>400-600	5	34	45	Motorcycle
>600-800	1	24	32	Motorcycle
>800-1000	0	5	58	Motorcycle
Total	**80**	**105**	**226**	Motorcycle
Percentage (%)	**19.46**	**25.54**	**54.98**	

(Source: authors own processing)

5. CONCLUSIONS

From the results of research related to the relationship of proximity with the encouragement of the use of parks based on security perceptions, argued some of the views of previous researchers who stated proximity is an important aspect in public space (park) planning where they indicate that the proximity of the park location has a big impact on the community in the use of the park in the future in this research turns out to be a low impact.

Based on the coverage radius shows only at the coverage radius >0-200 meters and coverage radius >800-1000 meters, the average location proximity shows the results according to the category of coverage radius to the park that is 190.17 meters and 962.42 meters. The results of the calculation based on the mapping do not actually reflect the actual proximity because the existing calculations do not take into account the slope of the land from the study site. In the results of the questionnaire to the community around the park location shows that the perception of community safety regarding the proximity to the park shows the highest value in the category >600-800 meters which is 2.21 (low), with an average perception of community safety based on the proximity to the encouragement to use the park is 2.05 (low category). It means that Based on these results, there is a weak link between proximity and park usage based on security perceptions the proximity has a low significance of the respondent's security perception in encouragement of public space use (parks) visiting the park.

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IDENTIFICATION OF TRANSITIONAL SPACE AND ACTIVITY SPACE ON LINEAR URBAN SPACE (CASE STUDY: DI. PANJAITAN STREET AND KH. ALI MAKSUM STREET)

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ABSTRACT:
The increasingly congested road conditions as a result of the development and growth of the city led to meetings and clashes of various activities and interests of users. They caused the decline of urban space quality. The primary function of the road, which does not only as a transitional space, to accommodates traffic flows complicated ways, but it can also have functioned as a space for activities for the citizens of the city. This paper aims to identify the road functions based on the users' movement and to identify the capacity of the activity space and transitional space. By using inductive qualitative methods, clear identification of road use as a transitional space and activity space obtained on DI. Panjaitan Street and KH. Ali Maksum Street. It can be used as direction recommendations for improving the quality of the road to be more human and as an effort to enhance the quality of the city.

Key-words: *Urban Space, Activity Space, Transitional Space, Geography*

1. INTRODUCTION

The cities growth occurs due to population growth, urbanization, industrialization, and globalization. On the other hand, are less responsive to the design of the city almost always causes urban degradation. One that is easy to see is the increasingly crowded road conditions, meetings, and clashes of various activities and interests of users, thus causing the quality of urban space to decline.

Many urban planners supposed that roads were only as traffic infrastructure and only transition space. If it is planned based on that alone, opportunities for using the street as space for activities closed (Budiharjo, 2006).

The primary function of the road is correct as a vehicle and pedestrian transportation lane. Nevertheless, in Yogyakarta City, many roads found as a place for the social and economic activities of its citizens. This is a small part of the human geography aspect that needs to be considered so that urban degradation does not occur.

The study of human geography also learns about the movement which is known as migration on territorial planning. On a smaller scale, on urban planning, it can be described as transition, where the space known as transitional space.

Large and medium cities such as Yogyakarta, Semarang, and Solo, roads were not merely functioning as a transitional space that accommodating the traffic flow of people movement. Those cities also have worked as an activity space such as open space for social contact, a place for ceremonial activities, recreation, and even outdoor trading activities (Budiharjo, 2006).

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The need for roads as an activity space causes road quality fulfillment needs for its users. It can also be interpreted that the road, including pedestrian paths, are required to be able to accommodate the activities of its users so that they can carry out activities comfortably and can create a humane city for the residents. Beside, human communities are formed considering the transportation network. This confirms that there is corelation between activity and space for transportations (Magyari-Saska, 2019).

Thus the identification of road functions needs to be made seen from the activity of its use. Furthermore, those clear recommendations obtain or improving the quality of the use of roads that are more humane as well as efforts to improve the quality of the city. And the better environmental quality could be enhanced by the existence of the concept of sustainable urban lanscape aspect regarding social, economic, and ecological. (Soemardiono, et al., 2019)

The issues of this research are (1) how is the road function condition if seen from the activity of its users, and (2) how is the capacity of the activity space and transitional space in the linear urban space?

2. STUDY AREA

This research located in a part of DI. Panjaitan Street Yogyakarta and KH. Ali Maksum Street Bantul. It is a road corridor situated on the south side of the imaginary axis of Yogyakarta. This axis as an axis of philosophy, covers Tugu Pal Putih, Kraton Yogyakarta, and Panggung Krapyak.

DI. Panjaitan Street and KH. Ali Maksum Street is on the southernmost axis in this imaginary axis. Administratively, DI. Panjaitan Street is included in the Yogyakarta City area, while KH. Ali Maksum Street is part of the Bantul Regency.

Overall DI. Panjaitan Street is the road from Plengkung Gading extending to the south. But in this case, the focus of the object of research is a section of the road starting at the junction of Jogokariyan Street.

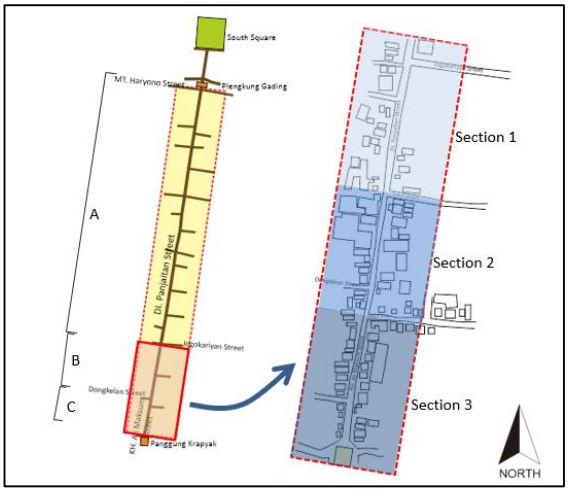

Fig. 1. Research Area Limits

DI. Panjaitan Street is an area along sections A and B **(Fig. 1)**, but the selected area for the study is in section B. This is because section B has more road activity to be observed than in section A. While section C is part of KH. Ali Maksum Street, which is also part of the focus of the research area. This section becomes essential because it is a continuous road from DI. Panjaitan Street up to the starting point of the southern imaginary axis, namely the Panggung Krapyak.

From the B and C sections, it divided again into 3 (three) fragments, namely:

1. Section 1: extending from the junction of Jogokariyan Street to the intersection of Cuwiri Street, is part of DI. Panjaitan Street Yogyakarta.
2. Section 2: extending from the junction of Cuwiri Street to the intersection of Dongkelan Street, is part of DI. Panjaitan Street Yogyakarta.

3. Section 3: extending from the intersection of Dongkelan Street to the Panggung Krapyak, is part of KH. Ali Maksum Street.

3. METHODOLOGY

This research approach is inductive and using qualitative methods, which implemented to build knowledge through meaning and discovery (Danim, 2002:36).

The main characteristic of qualitative research (abstracted from Danim, 2002): (1) Direct data sources in the form of natural situation management and researchers become the main instruments, (2) Descriptive, that is, data collected in the form of words, images, not numbers. Even if there are numbers, they are only as support. (3) It emphasizes the work process rather than results. The method which all phenomena encountered, translated to daily activities. (4) Data analysis is inductive, and abstractions arranged based on data that had collected and grouped through data collection during fieldwork at the research site, (5) Emphasize meaning, namely, the focus of the study directly linked to the problems of human life.

The process of collecting data and information is carried out directly in the observation area to get more information about activities, enclosures, and the architectural elements in the study area — the execution time not bound by certain days and hours. However, the observation was conducted on three-time frames a day, namely in the morning, afternoon, late afternoon, and evening. And it was held in a few days until the data is saturated. It had done to ensure the validity of the information obtained.

In collecting data, required instruments include stationary, drawing tools, and camera. Stationary and drawing tools used to draw spatial sketches while observing in the fields of study. The camera used to record physical conditions and other things that support the research implementation.

4. RESULTS AND DISCUSSIONS

The results of observations of the physical condition of linear city space in the study area in parts 1, 2 and 3 are as follows.

1. The general terms of Section 1 are : (1) On the west side, the road shoulder is in the form of land without pavement, (2) On the east side there are parks and quite wide space sidewalks (pedestrian ways), (3) There is a separation space between pedestrians and vehicles.
2. The general conditions of Section 2 are : (1) Both on the west and east side has concrete paved shoulders, (2) there are no sidewalks as pedestrian ways, (3) The separation space between pedestrians and vehicles is not clear.
3. The general conditions of Section 3 are : (1) Both on the west and east side has concrete paved shoulders that are narrower than Section 2, (2) there is no sidewalks as pedestrian ways, (3) The separation space between pedestrians and vehicles is not clear.

In addition to observing the physical condition of linear urban space, the author also notes the activities that occur. Several criteria affect the analysis of the setting of activity behavior, that is, person, standing pattern of behavior, physical milieu, zygomorphic, territory, and temporal (Hartono, 2017).

This research will not be discussed thoroughly on the six criteria. However from the six principles will be taken the basic things that can use in observation, namely: (1) users,

including pedestrians and motorists, (2) repeated activities that occur in the area observations, (3) physical boundaries, which defined as enclosures within the observation area.

The results of observations on activities and enclosures in the observation area is presented in **Table 1**.

Table 1.

The results of observations at Section 1.

Area	Observation	East Side	Street	West Side
SECTION 1	Activity	Street vendors on the path-space (shoulder of the road), throughout the day, there was a change in the type of street vendors, and stay longer.	Street vendors on the path-space (shoulder of the road), moving, dinamic.	Street vendors tend to not exist, sidewalks are also used for parking
	Enclosure	permanent fence, shade tree	Bottom enclosure: asphalt pavement	Trees, building facades.
	Element	Trees, electric poles, street lights.	-	Trees, electric poles, street lights.
SECTION 2	Activity	Street vendors on the path-space (shoulder of the road), moving, dinamic.	Street vendors on the path-space (shoulder of the road), moving, dinamic	Street vendors on the path-space (shoulder of the road), moving, dinamic.
	Enclosure	Fence with doors, shade tree	Bottom enclosure: asphalt pavement	Trees, building facades.
	Element	electric poles, street lights.	-	Trees, electric poles, street lights.
SECTION 2	Activity	Street vendors on the path-space (shoulder of the road), moving, dinamic	Street vendors on the path-space (shoulder of the road), moving, dinamic	Street vendors on the path-space (shoulder of the road), moving, dinamic
	Enclosure	Fence with doors, building facades	Bottom enclosure: asphalt pavement	Trees, building facades.
	Element	electric poles, street lights.	-	electric poles, street lights.

In the observation capacity of transitional space and activity space in linear urban space, using parameters as a limitation on capacity measurement. They can be used to assess linear urban space in its use as a transitional space and activity space. These parameters are as follows:

1. Linear urban space as a transitional space:
    a. The road is only a transitional space, connectors that are bypassed to go to one space to another.
    b. The vehicle only drove, the driver did not stop to perform activities on the roadside,
    c. Pedestrians only pass, do not stop to do urban activities.
    d. The greater the use as a transitional space, the road function as a circulation path is visible.

2. Linear urban space as an activity space:
   a. The vehicle stops to do activities in the road space, for example, buying and selling businesses.
   b. Pedestrians use street space and pedestrian paths to carry out activities, such as chatting, buying, and marketing.
   c. The higher the use as an activity space, then the more significant the streets and pedestrians using pathways as a place for the activities of the urban community, both the main event, additional activity, and social activity.

The relationship between the capacity of the transition space and the activity space can be seen in **Fig. 2**.

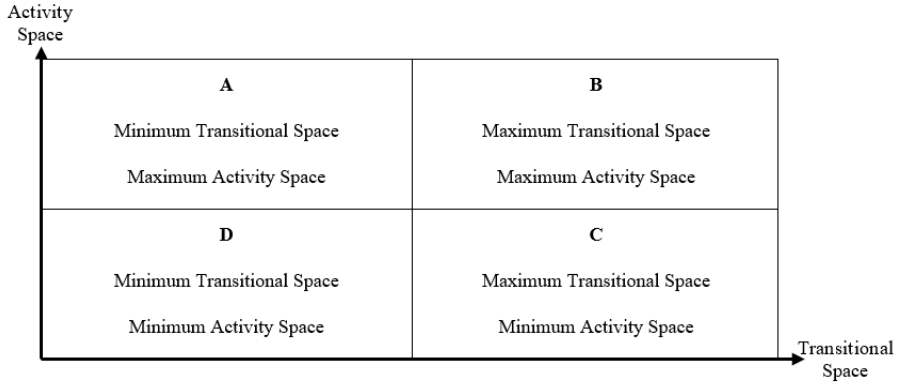

Fig. 2. Capacity Relationship Diagram of Transitional and Activity Space

The results of the observation of the transitional space and activity space in Section 1, 2, 3 are shown in the following table.

Table 2.

The results of observations on Transitional and Activity Space.

Observation	East Side	Street	West Side
Section 1	The vehicle stops for drivers to do activities in the road space, namely buying and selling activities, sometimes also chatting. Pedestrians also do the same activity.	The vehicle only drove, the driver did not stop in this area.	The vehicle only drove, the driver did not stop to perform activities on the roadside. Sidewalks are also used for parking
	Minimum Transitional Space (T min) Maximum Activity Space (A max)	Maximum Transitional Space (T max) Minimum Activity Space (A min)	Maximum Transitional Space (T max) Minimum Activity Space (A min)
Section 2	Many vehicles just drove. Many pedestrians just pass by. There are also many community activities along the way.	The vehicle only drove, the driver did not stop in this area.	Many vehicles just drove. Many pedestrians just pass by. There are also many community activities along the way.

Observation	East Side	Street	West Side
	Maximum Transitional Space (T max) Maximum Activity Space (A max)	Maximum Transitional Space (T max) Minimum Activity Space (A min)	Maximum Transitional Space (T max) Maximum Activity Space (A max)
Section 3	Many vehicles just drove. Many pedestrians just pass by. There are also many community activities along the way.	The vehicle only drove, the driver did not stop in this area.	Many vehicles just drove. Many pedestrians just pass by. There are also many community activities along the way.
	Minimum Transitional Space (T min) Maximum Activity Space (A max)	Maximum Transitional Space (T max) Minimum Activity Space (A min)	Maximum Transitional Space (T max) Maximum Activity Space (A max)

There are two ways to define the function of the space, street-side for vehicles, and shoulder or pathways for the pedestrian. This is the first reasoning to discuss the capacity of transitional space and activity space also the types of road function.

The condition in Section 1 can be seen in **Fig. 3**.

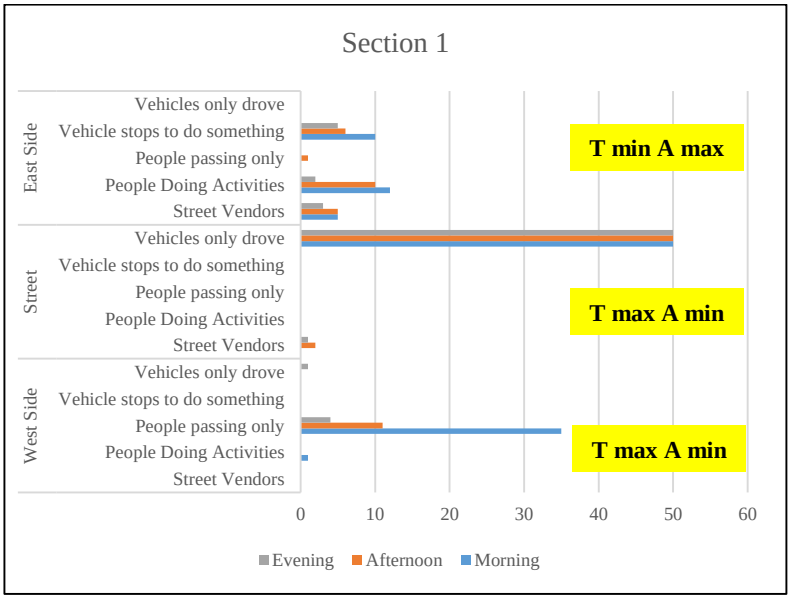

Fig. 3. Activities of Pedestrian and Vehicles at Section 1

In Section 1, the east side which is not a space for vehicles, but in fact, it is used for vehicle stops to do some activities. This is reducing the number of pedestrians using space to transition, but there is a lot of activity in the space. Causing the function of the road to be

disguished. Whereas on streetside, only vehicles that use as a transition space, there are no people passing and activities, so that makes the clear function of the road. At Westside, which is for pedestrian space, it is indeed using the space as a transitional space for pedestrians, so that causing the clear function as a pathway.

The condition in Section 2 can be seen in **Fig.4** while in Section 3 can be seen in **Fig 5**.

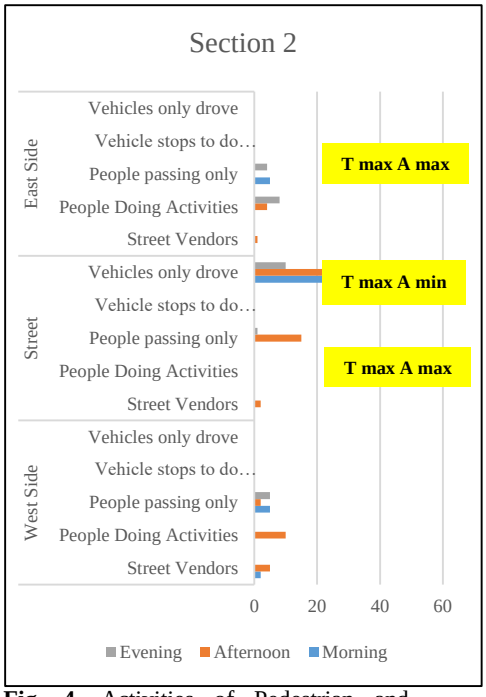

Fig. 4. Activities of Pedestrian and Vehicles at Section 2

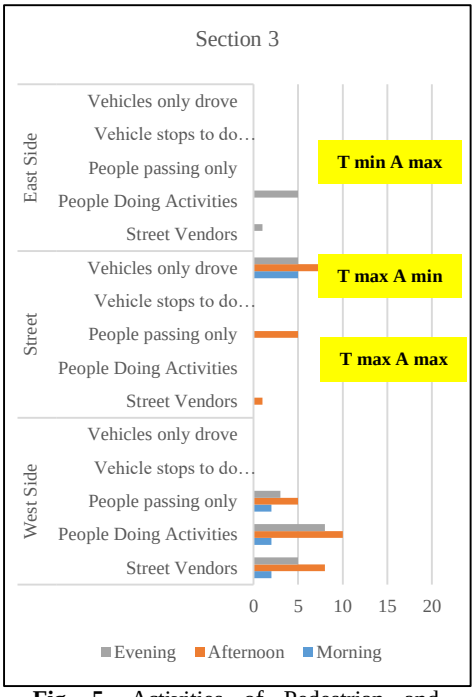

Fig. 5. Activities of Pedestrian and Vehicles at Section 3

In Section 2, both east side and west side as pedestrian ways, indeed used as a transitional space for pedestrians, but a lot of activities occur, causing a mixed-function to emerge, namely between the activity space and the transitional space. Whereas on the streetside, there are vehicles and a number of pedestrians who pass and function it as a transitional space, resulting in a mixed-function, which is between road users.

It can be shown at **Fig 5** that in Section 3, there is no enough space for pedestrian ways, causing disguished function. Whereas on the streetside, there are vehicles and a number of pedestrians who pass and function as a transitional space, resulting in a mixed-function, which is between road users. Exactly the same at the streetside in Section 2. On the west side which is indeed for pedestrian roads, it is indeed used as a transitional space for pedestrians, but there is a lot of activity, which causes a mixed-function, which is between the activity space and the transition space.

Observations in each section of the observation area can be grouped in the matrix of the relationship between the transitional space and the activity space **(Fig. 6)**

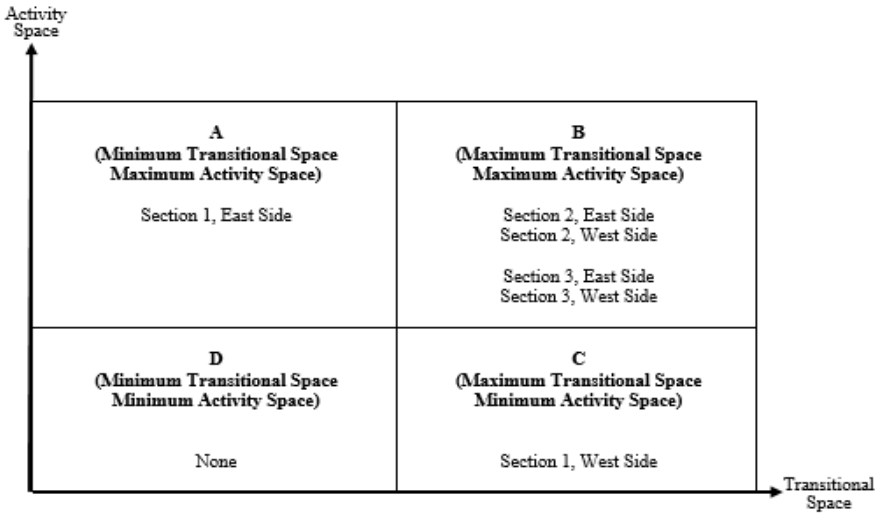

Fig. 6. Diagram of Condition of Observation Area Seen From the Relationship between Transitional Space and Activity Space

From the results of field observations obtained the following results:

1. The size of the activity space in linear space influenced by (1) favorable conditions of the space enclosure and (2) the space dimension.
2. There are three types of relationship between activity space, transitional space, and linear urban space, as illustrated in the following diagram.

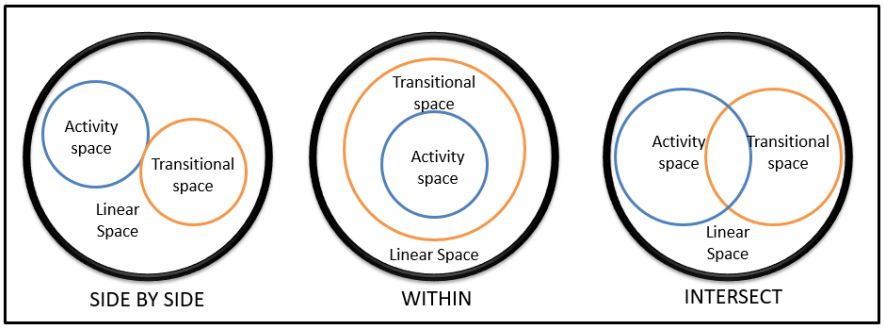

Fig. 7. Types of Relationship between Activity Space and Transitional Space in Linear Urban Space

3. There is no area has a minimum of transition space and activity space **(Fig. 6)**, meaning that the observed area is a quite crowded urban space.
4. Two of the three beheaded areas, namely Section 2 and Section 3, have the same maximum transitional and activity space, meaning that from the positive side, the use of linear urban space on DI Panjaitan Street and KH. Ali Maksum Street is always active. But from the negative side, there will be a mixture of activities and circulation in the same space, which can trigger urban space clutter.

5. The capacity of activity space, transitional space, and dimensions can affect the types of street functions, including streets with precise functions (only as a circulation way), roads with disguised features, and roads with mixed services.
6. All of the observation results could define in one diagram, which illustrates the capacity of space as an activity space and a transitional space in the connections between the types of space, including the road function and the pedestrian ways existence. The figure below is showing those connections.

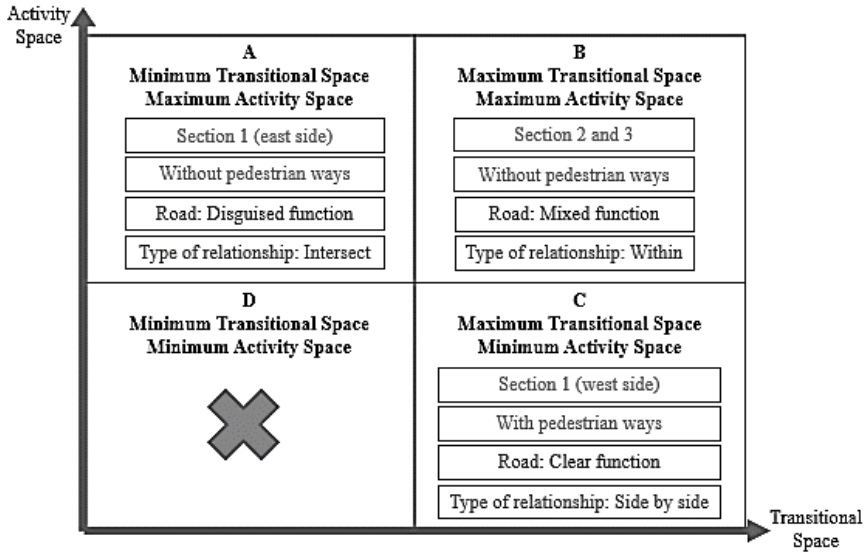

Fig. 8. The connections of the results

5. CONCLUSIONS

This paper has discussed the conditions of activity space and transitional space influenced by users of space, repeated activities that occur in the area observations, also enclosure and space elements. Each can not be separated from the influence of dimensions and the space enclosure. It found that road function allotment more clearly defines as transitional space if the activities occur on it are minimum (minimum activity space capacity). Then, the road will have a mixed-function when accommodating movement and transition on the same space (both activity space and transitional space capacities are maximum). It also can be interpreted that maximum activity space is obtained if the use of activity space within or intersect with transitional space (mixed-used space). Based on the observation, linear urban space could stay active and comfortable by maximizing or clearing up the allotment (function) of the space and by placing the appropriate space enclosures and space elements.

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ANALYSIS OF LAND EROSION DUE TO MINING OF CLAY MATERIAL IN SIDOREJO VILLAGE, SLEMAN DISTRICT, YOGYAKARTA

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ABSTRACT:
Mining can cause changes in the shape of landmasses and lead to erosion. Erosion results from the interaction of climate, soil, topography, vegetation and human activity on natural resources. The purpose of this study is to analyze the level of soil erosion and provide direction for land conservation priorities. The analytical method using the Universal Soil Loss Equation (USLE) method. USLE has five parameters is rainfall erosivity factor, Soil erodibility factor, terrain factors: the slope length and slope steepness, land cover and management factor, Conservation practices factor. The soil erosion rate is composed of five classes; very low, low, moderate, heavy and very heavy. The final results of this study based on the danger level of soil erosion with analysis overlay the map could indicate that erosion very heavy consists of 30%, heavy 5%, moderate 25%, low 10% and very low 30%. Priority for land conservation is based on the land conservation index table which is from very heavy erosion to very low erosion. To minimize current erosion rates by adopting a vegetative method.

Key-words: *Soil Erosion, Mining, Clay, USLE, Sleman*

1. INTRODUCTION

Mining activities carried out both mechanically and traditionally always have impacts, namely positive and negative impacts. The positive impact is that the extracted minerals can be utilized to meet human needs in building infrastructure and the negative impact of mining activities is the occurrence of landform changes in the mining area where the changes in landforms generally result in erosion and soil mass movements (Indonesianto, 2008). Erosion is a process by which soil and rocks wear out, then transported by natural or anthropogenic agents and deposited elsewhere (Da Cruz et al., 2019); Verheijen et al., 2009), it can pollute water, cause land degradation, reduce soil fertility and increase the loss of organic matter (Cerdan et al., 2010). Soil loss brings concern all over the planet, as it is a source for food production (Abel et al., 2005). Argues that erosion is the erosion of soil from a place that is transported by water or wind to another place (Arsyad,1989). Soil erosion reduces the ability of the soil to hold water due to soft particles organic matter in the soil transported (Rifky et al., 2016).

The erosion process starts from the destruction of the soil as a result of rainwater blows that have greater power than the resistance of the soil, the destruction of soil particles that clog the pores of the soil resulting in decreased soil infiltration capacity so that water flows on the surface of the ground as surface runoff (Asdak,1995).

Erosion depresion by into three, namely empirical models, physical models, and conceptual models. Empirical water is a result of the power (Irimus et al., 2017). Soil

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erosion models can be classified models are based on important variables obtained from research and observations during the erosion process (Baver, 1972). Methods with empirical models are used, for example, the Universal Soil Loss Equation (USLE), which emerged in the late 1970s (Wischmeier & Smith, 1978) in the United States, but it is widely used in Brazil. This method presents great accuracy, as considers soil type, soil morphology, rainfall, cultivation practices and management, allows quantification and regionalization of the area with higher risk of erosion (Wischmeier & Smith, 1978; Bertoni, 2005; 2012).

2. STUDY AREA AND DATA

Sidorejo Village, Godean Sub-District, Sleman District, Yogyakarta was used as the study area. The Sleman region was a tropical climate and is located between the ranges of coordinates; longitude: 110°16'4" E and 110°16'3" E, latitude: 7°44'15"N and 7°44'21" N Study area is approximately 24 km the Sidorejo Village, by motocyle taken one hour. In this research, the method used is the survey and testing of soil samples in the laboratory. Field observations (field surveys) are conducted to observe or review conditions around the mining area that are specific to the location that will be used as data collection likes to measurement the slope length and slope steepness help by topographic maps, observation direct for land cover and management factor and conservation practices factor and determine value 6, and organic matter in order to calculate the value soil erodibility factor. The sampling is done by a random sampling method. The number of sides taken as many as 20 pieces at the clay mine site for primiry data collection can been seen in **(Fig. 1)** and for map sampling can been seen in **(Fig. 2)**

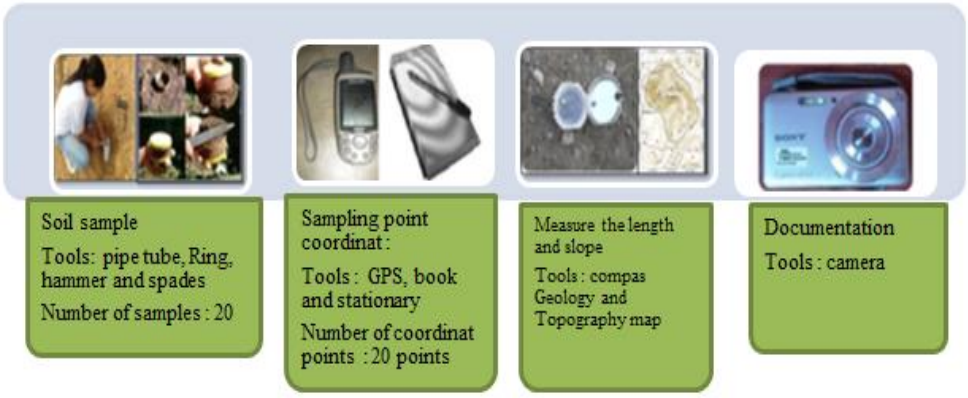

Fig. 1. Primary data *(Source: Author).*

In this study sampling locations can be divided into three locations, namely the first location in the paddy field area, the second location in the mining area and the third location in the dryland area. Twenty (20) sample points were taken using purposive sampling method. At the first location the number of samples taken was 5 samples, at the second location the number of samples taken was 10 sample points and at the third location the number of samples taken was 5 samples. In **Fig. 2** it can be shown that yellow is the first location in the rice field area, brown is the second location in the mine area and dark green is the third location in the dry area.

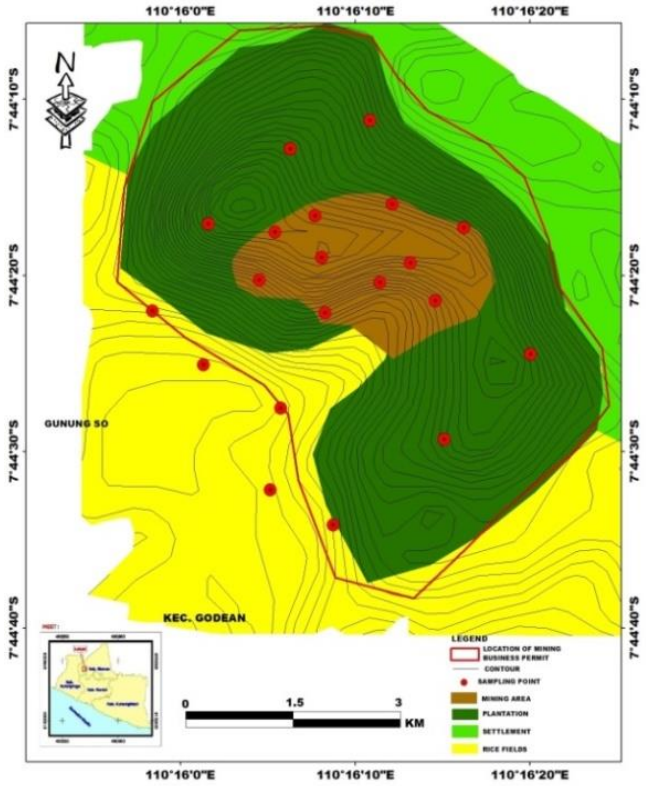

Fig. 2. Sampling Map (Authors).

3. METHODOLOGY

In this research used the methods study of literature and survey, to analysis to the soil rete erosion and erosion hazard level use the method Universal Soil Loss Equation (USLE).

3.1 Analysis Soil Erosion with Method Universal Soil Loss Equation (USLE)

The USLE model was applied to assess soil erosion in the Sidorejo Village Sleman District, Yogyakarta. The calculation of estimation of erosion rate by the USLE method is to multiply all factors that affect soil erosion (Wischmeier and Smith, 1978). Where the USLE formula can be written as follows;

$$A = R \cdot K \cdot LS \cdot C \cdot P \quad (1)$$

where:
A = The soil erosion rate (tons/ha/ year),
R = Defined as rainfall runoff erosivity factor (MJ mm ha/ year)
K = Soil erodibility factor (t ha MJ/mm)
LS = Length and Slope Factor (LS) (unites)
C = Land cover and management factor (unites)
P = Stands for conservation practices factor (unites).

Erosion Hazard Classes are given to each unit of land with a matrix that uses soil solum information and erosion estimates according to USLE formulas. Erosion classified as very low, low, moderate, heave and very heavy can be seen in **Table 1**. Based on the table, it can classified that the value of erosion is very low <15 tons / ha / year, the value of low erosion is 15-60 tons / ha / year, moderate erosion value is 60-180tons / ha / year, the value of erosion is including the heavy category is 180-480 tons / ha / year and very heavy erosion value is > 480 tons / ha / year.

Table 1.

Classification of Erosion Hazard Levels.

Class	Erosion hazard level (tons /ha /year)	Category
1	<15	Very low
2	15-60	Low
3	60-180	Moderate
4	180-480	Heavy
5	>480	Very heavy

Source: Morgan (1974).

3.2 Conservation Priority Analysis

Changes in the management and use of land resulted from human activities can increase soil erosion causing irreversible damage to the environment (Fiorio et al.,2016); (Da Silva et al., 2016). The vegetation withdrawal due to the insertion of plantations can increase up to 600% soil erosion (Chaplot et al., 2005). Conservation priority is given based on the class of erosion hazard level (Ministry of Forestry, 1998). The level of erosion hazard is very heavy, getting the priority means immediately to do land conservation. The conservation priority table is presented in **Table 2**.

Table 2.

Conservation Priorities.

Class	Erosion Hazard Class	Category
1	Very heavy	I
2	Heavy	II
3	Moderate	III
4	Low	IV
5	Very low	V

Source: Ananta (1987).

Based on **Table 2** Priorities conservation land for given to the value erosion is very heavy, the second for the heavy erosion, moderate erosion, very low erosion and the last for the low erosion. Conservation priorities land given base on class erosion. For detailed of the research methods can be seen in (**Fig. 3).**

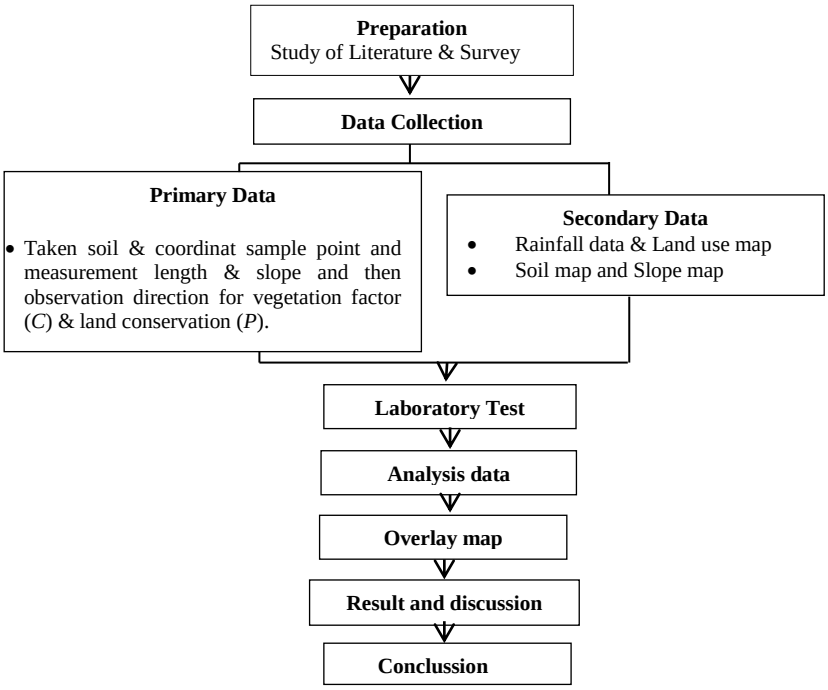

Fig. 3. Methodology Research Flowchart.

4. RESULTS AND DISCUSSIONS

4.1 Analysis of Soil Erosion Levels Using the USLE Method

The results of the analysis of five parameters namely rainfall erosivity factor, soil erodibility factor, Terrain factors: Length and slope factor (LS), Land cover or vegetation factor, Conservation practices factor are modeled overlapping map in the study area used the software ArcGIS 10.3. Data processing is performed using Microsoft excel software. Each parameter of the method has a value of the soil erosion rate from the product of all factors. The greater the value of the erosion rate, the value of the erosion hazard level is also higher.

4.1.1 Rainfall Erosivity Factor (R)

Rainfall erosivity factor demonstrates the kind of erosion triggered by runoff and rainfall on the soil surface of a particular region. Rainfall data were collected from Sleman region operated by department Statistic Meteorology Sleman Yogyakarta. The monthly rainfall average of 10 years (2008–2018) so that it was calculated with an average rainfall erosivity value of 1989 cm/years. In the literature (Mujiharjo,1989) to determine the magnitude of the rain aggressiveness index could use the formula as follow:

$$R = 2{,}21\ P1,\ 36 \qquad (2)$$

where: R = erosivity Index; P= runoff (cm).

4.1.2 Soil Erodibility Factor (K)

The soil erodibility factor is the value of soil sensitivity which is easy or not the soil experiences erosion. The amount of the soil erodibility value is determined by soil texture/grain size (M), organic content in the soil, soil structure, and soil permeability. The average value of soil texture (M) is based on the percentage (%) of dust, sand, and clay seen from the results of laboratory testing. Soil structure values are obtained from the soil structure class table, soil permeability properties and organic content values obtained from the laboratory test result, so that average value (K) from the laboratory teste result is 0,33. This K value is strongly influenced by the type of soil in the study area. The soil types affect the structure, texture, soil permeability, and organic content. This is indicated by the higher M value the greater the soil erodibility value (K value) and the greater amount of soil erosion that occurs.

4.1.3 Length and Slope Factor (LS)

Length and slope factor (LS) can be calculated using a topographic map of the study area. slope length measurement using ArcGIS software so that the actual slope length in the field is 693 meters. The slope of the slope is searched by the equation: CI = 1/2000 × Denominator of the scale and after the actual flat distance value is obtained the topographic height value is divided by the actual flat distance × 100% so that the average value for the slope is 2,8%. The total average value of the length and slope (LS) is 1,3 and for Maps of slop can be seen in **Fig. 4** while Maps of land use can be seen in **Fig. 5**.

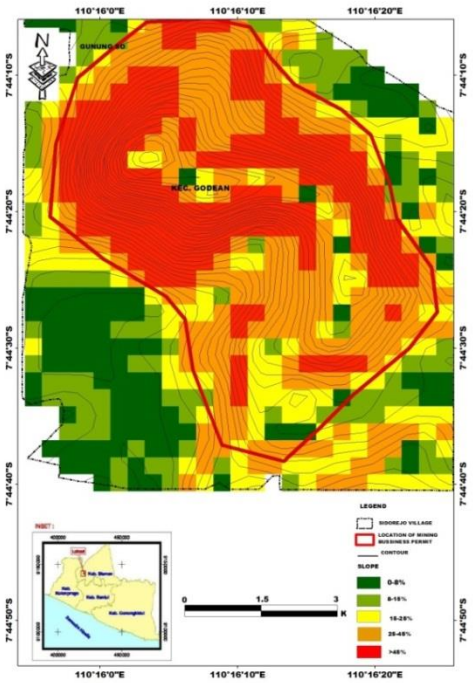

Fig. 4. Slope Map.

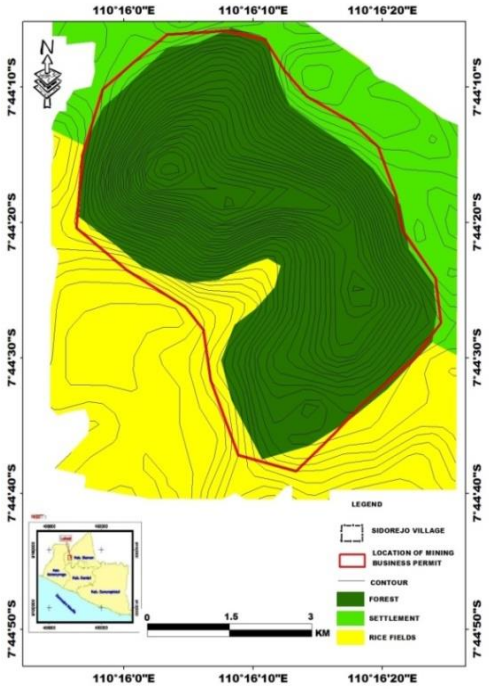

Fig. 5. Land Use Map (Authors).

The slope is one of the factors that influence erosion. The slope in the study area ranges from 0-45%. It can be shown in Fig. 4 that is dark green with a slope percentage of 0-8% being on a gentle slope, light green with a slope percentage of 8-15% on a slightly sloping slope, yellow with a slope percentage of 15-25 % is on a steep slope, and the color is red and light orange brown with the percentage of slopes 25-45% and >45% is a very steep slope. Land use in the study area includes forests, fields and rice fields. In Fig. 5, it can be shown that the yellow color is a rice field that is in a flat area, dark green is a forest that is on a steep slope and the land is being managed by the company as an area of clay material mining. and the light green color is a moor area that is in a sloping area.

4.1.4 Vegetation Factor (C)

Vegetation factors in the study area are the paddy field, open land without plants, and dry field. Research is done by direct observation in the field and then matched the criteria of the land conservation index table so that an average value of 0,6 was obtained.

4.1.5 Conservation Practices Factor (P)

The land management factor at the study area was carried out by direct observation in the field then matching the criteria of the land conservation index table so that an average value of 0,7 was obtained. Land conservation techniques consist of traditional bench terraces and no action on land conservation.

4.2 Soil Erosion Rate Analysis

Soil erosion rates can be calculated through estimation using the Universal Soil Loss Equation (USLE) Method. So the average erosion rate can be calculated in 358,3 tons / ha / year. The Overlay control (overlay.mbx) allows the merging of layers; the superposition is made by combining databases of thematic layers and the result is the creation of a new database (Bouhata et al., 2014), Bouhata, R. (2008), (Benabderrahmane & Chenchouni, 2010). All geographic data are integrated and processed in a GIS system using the software ArcGIS 10.3. For overlapping maps can be seen in **Fig. 6**.

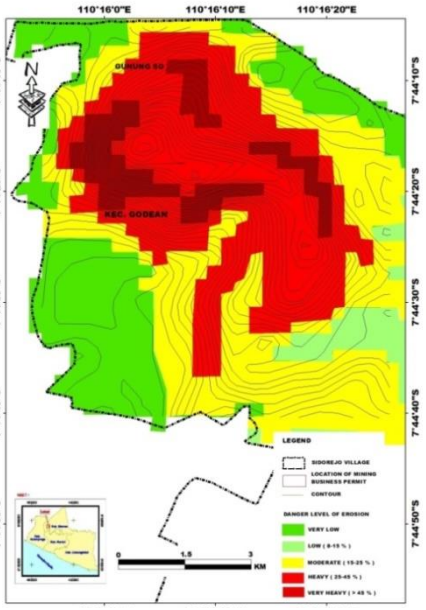

Fig. 6. Map of Erosion Hazard Level.

The level of erosion hazard that occurs mostly occurs in the mine area because the area has less vegetation due to mining activities so that soil erosion is easier to occur. In Fig. 6 it can be shown that the dark color is a very heavy level of erosion, red indicates a level of severe erosion, yellow indicates a moderate level of erosion, dark green indicates a mild level of erosion and light green color indicates a very mild level of erosion. A very heavy and heavy level of erosion is present in the mining area.

4.3 Land Conservation Priority

Conservation priorities given based on the class of erosion hazard level include:

- First priority is given to areas that fall into the class of very heavy erosion hazard levels and conservation actions must be taken as soon as possible to reduce soil erosion and even more heavy land damage.
- Second priority is given to areas that fall into the class heavy erosion hazard class and must receive serious attention so that land resources remain sustainable and there is no further damage to land
- Third priority is given to areas that fall into the class moderate erosion hazard class.
- Four priorities are given to areas that fall into the class low erosion hazard class and last priority is given to areas that fall into the class very low erosion hazard class.

5. CONCLUSION

The results of estimating the rate of soil erosion with the USLE method produce five classes of soil erosion rates namely 30% very heavy erosion rate, 5% heavy erosion rate, 25% moderate erosion rate, 10% low erosion rate and 30% very low erosion rate. Land that very heavy grade erosion value is by planting peanut plants, Land that heavy grade erosion value is by planting sugarcane, Land that moderate grade erosion value is by planting corn and sweet potato plants, Land that very low and low-grade erosion value is by planting corn and rice plants. For all plants that recommended to be planted because they can add nitrogen from the air and remaining crop, can be used as organic materials, can absorb water, the soil in an effort to increase soil fertility and erosion can also improve soil structure.

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MICROCLIMATE MODELS TO PREDICT THE CONTRIBUTION OF FACADE MATERIALS TO THE CANOPY LAYER HEAT ISLAND IN HOT-HUMID AREAS

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ABSTRACT:
This paper aims to study a microclimate model for predicting the role of façade materials to the Canopy Layer Heat Island. ENVI-met was selected to model the microclimate of four street canyons in Yogyakarta, which vary in façade materials, street orientation, and land cover. Three to four-day field measurements in each canyon were intended to obtain microclimate data at pedestrian level, wind speed and orientation at the boundary layer for simulation input and validation. The validation study confirms the accuracy of ENVI-met simulations in predicting air temperature and relative humidity when the initial wind speed at the boundary layer is > 1.5 m/s. These input data affected on the simulation results. However, the "comparison" feature offers a facility to analyze the modification in the air temperature and mean radiant temperature in the street canyon due to higher thermal transmittance and higher surface albedo façade materials. The results show that street orientation, big trees along the street and sky view factor significantly affect the pattern of air temperature modified by the increasing thermal transmittance and albedo of the façades.

Key-words: *Albedo, Canopy Layer Heat Island, Façade materials, Microclimate model, Thermal transmittance*.

1. INTRODUCTION

Many studied the role of surface materials in the microclimate of the surrounding and the Canopy Layer Heat Island (CLHI). Erell et al. (2014), Ghaffarianhoseini et al. (2015), Kyriakodis & Santamouris (2017), Lee & Meyer (2018), Santamouris et al. (2012), Taleghani (2018) proved the ability of high albedo (α) materials to remediate the extremely heat by reflecting a large portion of solar radiation to the sky that further reduces the sensible heat flux. The contribution of the combination of high α and high solar emissivity materials, so-called cool materials, to the reduction of the ambient temperature (Ta) has been observed by Santamouris et al. (2012) and Kyriakodis & Santamouris (2017).

Some of them (Chokhachian et al., 2017; Erell et al., 2014; Taleghani, 2018) argued the negative impacts of the radiative property on the surrounding thermal environment. Taleghani (2018) showed that altering the α of the roof may not influence the near ground surface thermal conditions. Using high α materials lowers the Ta, but elevates the heat stress at the pedestrian level (Erell et al., 2014).

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Meanwhile, Chokhachian et al. (2017) found that a light color wall with less solar absorption is worse for outdoor comfort during hot periods in Munich compared to dark ones. However, only few studies observed the effect of the thermal properties of the material on the CLHI. Thermal inertia of material causes delaying of material's thermal response. Materials with high thermal inertia can mitigate CLHI by moderating the rate of stored heat at night and the emitted heat to the atmosphere (Sen et al., 2015). It must be noted that the magnitude of reflected solar radiation and the effect on outdoor thermal comfort is highly context-dependent (Laureti et al., 2018; Lee & Mayer, 2018; Taleghani, 2018).

We found limited studies on the impacts of facade materials on the CLHI. Chokhachian et al. (2017) conducted a parametric study of facade materials with different α in Munich, which resulted in a proportionally reverse relationship among solar absorption, surface temperature (Ts), and mean radiant temperature (Tr). A higher solar absorption facade reflects less solar radiation, which further cools the surrounding space. Different facade materials affect smaller on local Tr values than the difference in solar absorption percentages. Gael (2014) carried out a study on the effect of facade properties (α and thermal transmittance or U-value) on the canopy layer microclimate within city blocks in Budapest. According to Gael (2014), change in U-values insignificantly modified the diurnal cycles. The effect of α on the Ta within UCL becomes very noticeable during the day.

The relationship between Tr and α is directly proportional with mostly limited effects on the daytime. Higher α reduces the Ts, but increases the Tr. The Tr within the canopy is a function of built form and facade density indicated by the uneven effect of α in time and per configuration. The canopy layer Tr is mainly driven by the change in α, but hardly affected by facade's U-value (Gael, 2014).

Except Fox et al. (2018), who used a terrestrial multispectral sensor calibrated with an empirical line method to measure and predict the distributions of spectral reflectance from urban vertical surfaces, most other studies employ ENVI-met program. Gael (2014) utilized ENVI-met to simulate the canopy layer microclimate and MATLAB to analyze the results. Aside from using ENVI-met to estimate the microclimate elements of the urban block, Chokhachian et al. (2017) employed TRNSYS to simulate the effect of different surface materials on the Tr and Ta inside a canyon. The Tr values resulted from TRNSYS replaced the values calculated by ENVI-met due to inaccuracy issues. The ENVI-met calculations of Tr tend to highly estimate compared to on-site measurements in studies conducted in Dhaka, Bangladesh (Sharmin et al., 2017) and Freiburg, Germany (Chen et al., 2014). A study using ENVI-met models to predict the Tr of an archaeological park in a tropical area confirms the inaccuracy ranging from 24.8% to 30.1%. However, setting up the solar radiation in "Solar Adjustment Factor" (SAF) feature and the cloud cover in "Cloud Condition" feature could improve 19.7% of the accuracy (Binarti et al., 2020a).

This study aims to predict the response of surface materials of building facade along the streets and the effects on the CLHI. Since the current developed simulation program is possible to predict large simulation area with acceptable accuracy, we employed ENVI-met and explored the advantages and limitations to model the microclimate of the street canyons at pedestrian level (CLHI), which varied in the facade materials of buildings along the streets.

2. CHARACTERISTICS OF THE STUDY AREA

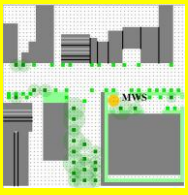
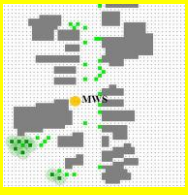
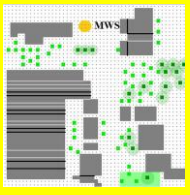
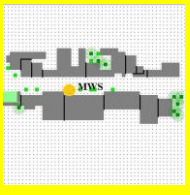
Four street canyons in Yogyakarta – i.e., Urip Sumoharjo Street (US), C. Simanjuntak Street (CS), Palagan Tentara Pelajar Street (PT), and Agus Salim Street (AS), – were selected based on the street orientation, façade materials, green area, building density and height. Ivan & Benedek (2017), Paramita & Suparta (2019) and Ursu (2019) mentioned that built-up area, green area, building density and height affect the land surface temperature and microclimate. The street canyons are situated at the latitude of 7º48'5"S and the longitude of 110º21'52"E that belongs to hot-humid climates (Koppen Aw).

According to Wicahyani et al. (2014), the UHI phenomenon also appeared in Yogyakarta. The strengthening phenomenon is described by the significant differences of the surface temperature between urban and rural area, which reveal on Landsat 8 OLI/TIRS satellite images retrieved on May 5, 2018, at 06:32:03 (9 K) and August 25, 2018, at 21:50:13 (13 K) (Binarti et al., 2020b).

As a medium-scale city, the height to width ratio (h/w) or the sky view factor (SVF) of the street canyons in Yogyakarta varies slightly. Despite the variety in building density and height, the average SVFs measured using a fish-eye camera and calculated by SVF calculator (Lindberg & Grimmond, 2010) look similar. They range from 0.82 to 0.89 (see **Table 1**). As busy commercial streets, window glazing and aluminum/metal cladding dominate the facades along US street and CS street. Whereas, timber and brick prevail on the façade along AS street. Large trees along the PT street appear more dominant compared to those along the other canyons.

Table 1.

Four street canyons and their characteristics.

Code	**US**	**CS**	**PT**	**AS**
Street name	Urip Sumoharjo	C. Simanjuntak	Tentara Pelajar	Agus Salim
Street orientation	90º	0º	0º	90º
Street view				
Fish-eye photos				
SVF: Maximum Average Minimum	 0.89 0.82 0.65	 0.92 0.89 0.85	 0.93 0.82 0.65	 0.90 0.85 0.79
ENVI-met 3D models and the instrument placements(MWS)				

3. METHODOLOGY

3.1. Field measurements for input data and validation

ENVI-met is the most widely used outdoor microclimate software due to the capability in predicting the outdoor microclimate at a very high spatial resolution (Taleghani, 2018) and the availability of free version with acceptable accuracy (Salata et al., 2016; Binarti et al., 2020a). However, several studies mentioned the inaccuracy of this software especially in predicting the Tr (Binarti et al., 2020a; Chen et al., 2014; Sharmin et al., 2017) and the wind speed (v) (Acero & Herranz-Pascual, 2015). To increase the accuracy, ENVI-met provides forcing method by inputting 24-hour for the simple forcing or annual microclimate data for the full one at a certain point within the study area.

To measure the microclimate of the street canyon – i.e., Ta, relative humidity (RH), v – a micro weather station (MWS) PCE FWS-20 equipped with ESPEC RS-13 with two channels was installed at the pedestrian level (± 1.2 m). One channel of ESPEC RS-13 connects the data logger to a globe thermometer to measure the globe temperature (Tg), and the other connects the data logger to a soil thermometer to measure the soil temperature (Ts). We used microclimate data retrieved from these instruments for input data and validation study. For the validation study, we compared field-measured data of Ta, RH, v, and Tr to simulated Ta, RH, v, and Tr. The Tr was calculated using the classical equation of Tr in ASHRAE Handbook (ASHRAE, 1997). The same micro weather station at the height of 10 m measured the v at the boundary layer for input data at initial time of ENVI-met simulations. All instruments comply with ISO 7726 (Johannson et al., 2014).

3.2. Modeling the microclimate using ENVI-met

This study employed the free version ENVI-met v.4.4.3 (ENVI-met, 2019) with 50 x 50 x 30 cells as the maximum grid number in x-, y-, and z-axis. Binarti et al. (2020a) mentioned several methods to maximize the capability of free version ENVI-met in predicting the Tr of an archaeological tourist area in hot-humid climate (at the latitude 7º45'S and the longitude of 110º30'E). Maximizing the spatial resolution is the first method adopted in this study.

Table 2.

Meteorological data for simulation input.

Street canyon	US	CS	PT	AS
Date	07/09/2019	30/09/2019	26/09/2019	10/09/2019
Ta max at 1.2 m (ºC)	32.54 at 12:00	34:67 at 14:00	35.24 at 13:00	36.03 at 13:00
Ta min at 1.2 m (ºC)	22.02 at 04:00	23.23 at 06:00	23:03 at 05:00	21.82 at 05:00
RH max at 1.2 m (%)	84.83 at 04:00	89.25 at 06:00	91.42 at 05:00	97.17 at 06:00
RH min at 1.2 m (%)	39.08 at 11:00	33.00 at 15:00	33.75 at 12:00	29.17 at 13:00
Initial time	14:00	14:00	12:00	08:00
v (m/s) and wind direction at 10 m high	2.97 & 270	1.89 & 180	1.56 & 135	1.08 & 270
Ts (ºC) and RHs (%) at the depth of				
(1) 0-20 cm	29.6 – 66.0	34.3 – 79.0	28.4 – 62.0	26.1 – 55.7
(2) 20-50 cm	28.6 – 74.0	33.3 – 87.0	27.4 – 70.0	25.1 – 63.7
(3) > 50 cm	27.0 – 78.0	31.5 – 91.0	25.9 – 74.0	24.3 – 67.7

By using 3 m resolution for dx and dy, the maximum grid number simulation area enables to cover 150 x 150 m^2. We did not apply the telescoping factor since the maximum building height only raises 23 m. In the study conducted by Binarti et al. (2020a), the "Solar

Adjustment Factor" (SAF) feature contributes to a 19.7% improvement of the accuracy in calculating the Tr. Based on the comparison between field measure and simulated solar radiation flux, Binarti et al. (2020a) used 67.6% for the SAF of simulations on September 21, 2018, and 74.4% for the SAF of simulations on October 17, 2018. Since the location of the study areas has proximity to the archaeological tourist area, this study applied 70% for the SAF. Cloud conditions were set up at 0 octas (clear sky).

Table 2 presents the meteorological data used for simulations of each area retrieved from three- to four-day field measurements. To obtain high accuracy of the simulation results, this study selected the initial time at the time when high v occurred.

4. RESULTS AND DISCUSSIONS

4.1. Results of the validation study

To validate ENVI-met simulation results, we compared simulation results of the Ta, RH, v, and Tr at the instrument installation points to measurement results of the same microclimate elements. **Fig. 1** presents the results of microclimate simulations of four street canyons with existing façade materials. By excluding the simulation results of AS street canyon, the accurate predictions of Ta with the discrepancy ranging from 0 (US street at 00:00 and 04:00 and CS street at 0:00) to -0.07 (CS street at 16:00) can be achieved. Predictions of the RH and Tr are less accurate compared to the one of the Ta. The discrepancies of RH range from 0 (US at 00:00 and 04:00) to 0.18 (CS at 16:00 and PT at noon); whereas, the discrepancies of Tr range from -0.02 (CS at 08:00) to -1.16 (AS at 04:00). Although all initial wind directions at the boundary layer are (mostly) parallel to the street orientation, **Fig. 1** shows significant discrepancies in the v prediction, which range from 0.01 (PT at noon) to 1 (PT at 0:00).

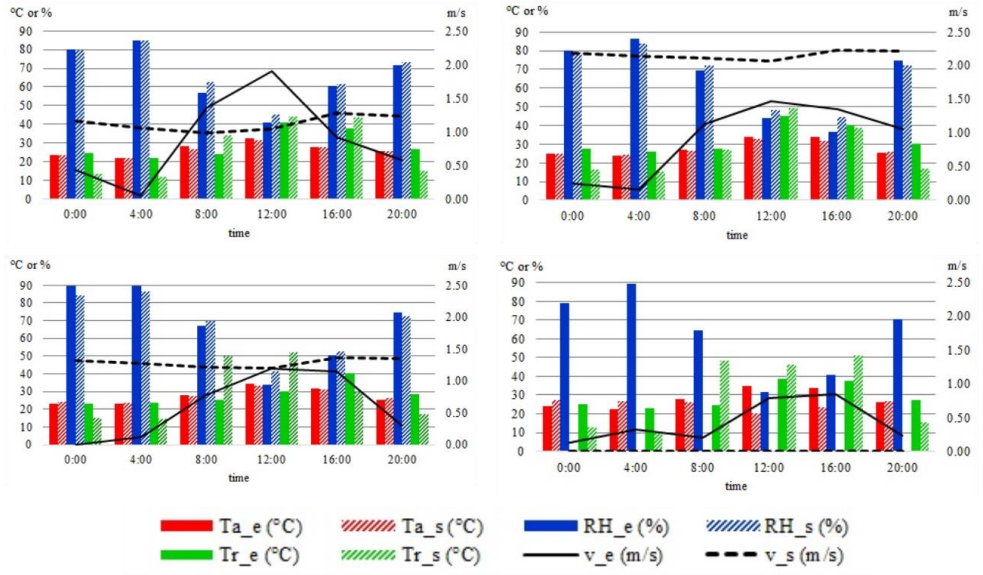


Fig. 1. Comparison between simulated and measured microclimate data of US area (left-above), CS area (right-above), TP area (left-bottom), and AS area (right-bottom) (Notes: _e: existing; _s: simulated).

The wind (speed) in CS and PT street canyon, which have north-south orientation, behaves similarly. ENVI-met tends to overestimate the v in the nighttime. At noon ENVI-met could predict the v accurately or with a slight discrepancy. Lower initial v at 10 m high resulted in lower accurate predictions shown in the predictions of the Ta (maximum discrepancy = -0.70), RH (maximum discrepancy = -999), v (no results) and Tr (maximum discrepancy = -1.16) of AS area. These results confirm the statements of Nyuk Hien et al. (2012) that low initial v at the boundary layer for the ENVI-met input data produces inaccurate simulation results.

4.2. The role of wall material with higher U-value

At the second stage, we replaced all wall materials with 45 cm-thick, burned brick. This material has high U-value and thermal inertia. Maps of comparison between existing façade materials and 45 cm-thick, burned brick walls of US and CS area show similar Ta differences (**Fig. 2**). In the whole day, Ta slightly increases due to high U-value walls. Only at 20:00 the change in wall materials in CS area slightly reduces the Ta. The increase in Ta in US area is much higher than that of in PT area. The maximum increase in the Ta occurred at noon - i.e., 027 K - 0.44 K for US area and 0.1 K - 0.2 K for PT area. In other areas (CS and AS), increase in the Ta due to higher U-value wall materials only occurred in the day. In the night, the reduction of the Ta in CS area is higher than that of in AS area. However, wall material with higher U-value generally tends to increase the Ta in the day (**Fig. 2**).

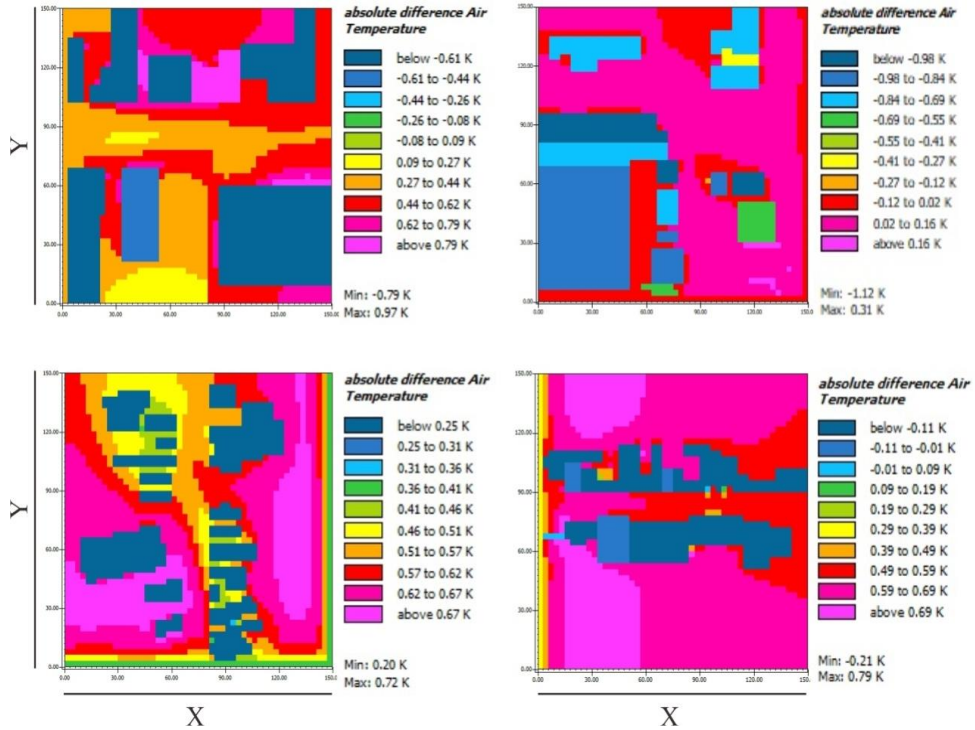


Fig. 2. Comparison map of Ta at noon between existing wall materials and 45 cm burned brick walls in US area (left-above), PT area (right-above), CS area (left-bottom) and AS area (right-bottom).

Increasing the U-value of wall materials in both areas cannot modify the v. Simulations of the Tr in US street canyon increase the Tr due to the 45 cm-thick, burned brick walls. The maximum increase (6.54 K) occurred at 04:00, and the minimum increase (2.27 K) occurred at 20:00. The simulation results of Tr in PT, CS, and AS street canyons show similar results with much lower Tr differences compared to the Tr differences in US area. From 20:00 to 08:00, the Tr in CS and AS street canyons decrease from 0.07 K to 0.16 K.

4.2. The role of wall material with higher α

At the third stage, we added a high surface albedo (α = 0.9) coating on the external surface of 45 cm-thick burned brick walls. Comparison maps of Ta between urban areas with existing wall materials and ones with 45 cm-thick burned brick walls combined with high surface wall α show that contributions of high external surface wall α to the Ta of street canyons are diverse and do not have a specific pattern.

In US street canyon, adding high α coating on the external surface walls reduces the Ta in the early morning and the night (16:00 – 04:00). This pattern also appears in PT street canyon. At 08:00 high external wall α materials reduces the Ta in both street canyons. At noon due to the increasing α, the Ta in US street canyon decreases. Whereas, the Ta in PT street canyon tends to increase. Although CS and AS street canyons have different orientation, the increase in external surface wall α created a very similar pattern of the Ta. The pattern of Ta as the effect of high external surface wall α materials is different from the pattern of v. Increase in wall α slightly raises the v in US street canyon, but it slightly reduces the v in AS street canyon. However, the increase in external surface wall α cannot modify the v in the north-south oriented street canyon (CS and PT).

Fig. 3 presents the comparison maps of Tr of street canyons between areas with existing wall materials and ones with high external surface wall α. Effects of high α on Tr at 08:00-16:00 in four street canyons are similar. During that time, Tr increases due to high external surface wall α, which the most significant effect appears in US street canyon. The whole day Tr in US and PT street canyons have the same pattern. These results confirm the results of previous studies on the role of α carried out by Chokhachian et al. (2017), Erell et al. (2014), and Taleghani (2018).

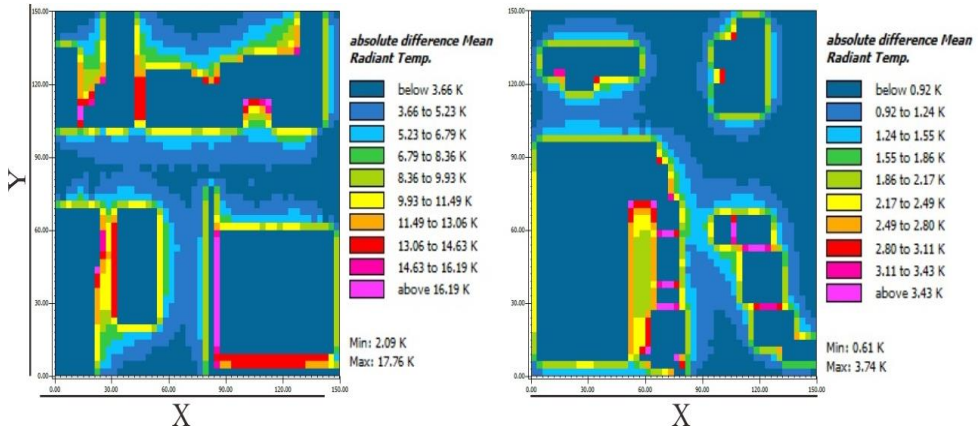


Fig. 3. Map of Tr at noon comparison between existing wall materials and high external surface albedo walls in US area (left), PT area (right).

4.3. High U-value vs. high U-value with high external surface α

Comparison maps between urban areas with high U-value and the ones with high U-value combined with high external surface α indicate the increase in Ta in the early morning and the night (at 00:00, 04:00, and 20:00) due to the additional high α coating (**Fig. 4**). Meanwhile, in the daytime (at 08:00-16:00), adding high α coating on the external surface walls tends to lower the Ta in the street canyons. However, adding high α coating on the external surface walls would raise the Tr the whole day as we observed in four street canyons.

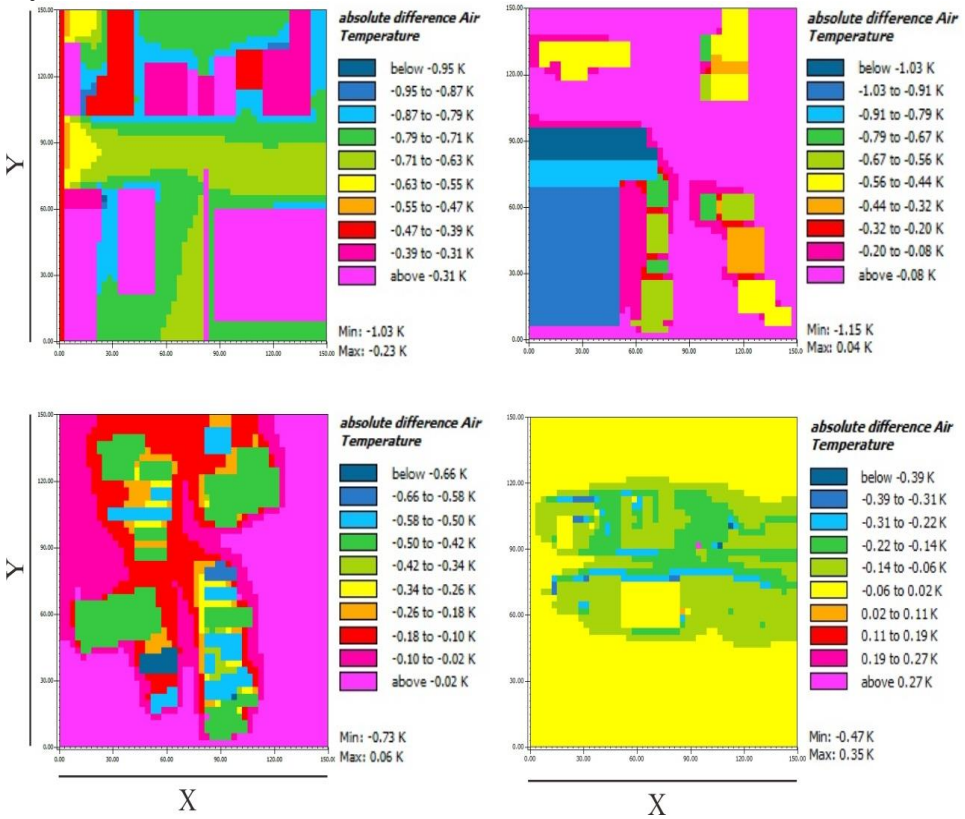


Fig. 4. Comparison maps of Ta at noon between existing wall materials and walls with high U-value and high external surface wall α in US area (left-above), PT area (right-above), CS area (left-bottom), and AS area (right-bottom).

Interesting results are shown by **Fig. 5**, which describes how street orientation determines the diurnal Ta profile. The Ta fluctuates especially in the daytime on the canyons with east-west orientation. Application of higher U-value and α on US canyons raises the Ta. Increasing the U-value and α of the façade in AS and CS canyons could reduce the Ta in the nighttime and the morning, but not at 12:00 and 16:00. The different effect on the Ta in US, CS, and AS canyons may be caused by the smaller SVF (the width and distance between buildings along the canyon) of the US canyon. In PT canyon, the presence of big trees along the street might moderate the effect of façade material change on the Ta.

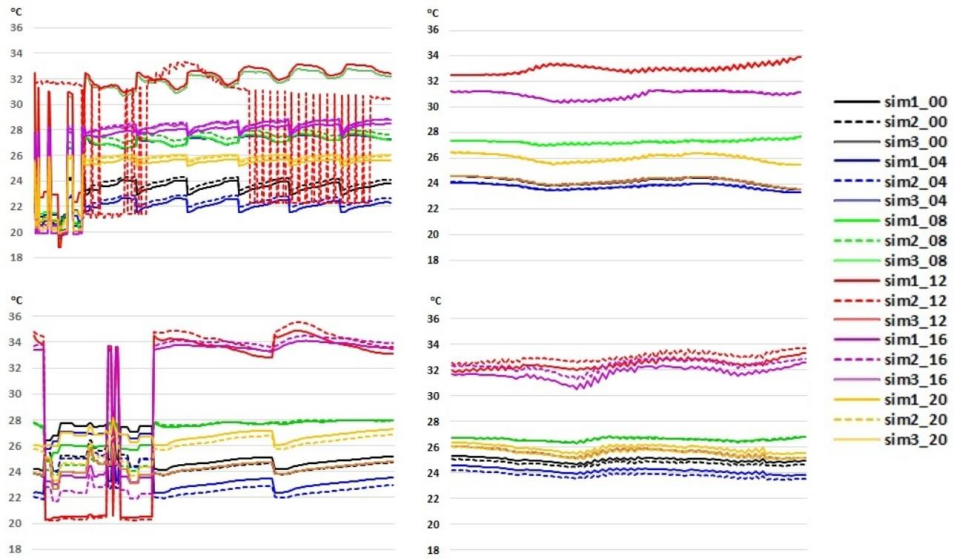


Fig. 5. Ta profiles at 00:00, 04:00, 08:00, 12:00, 16:00 and 20:00 of US canyon (left-above), PT canyon (right-above), AS canyon (left-bottom), and CS canyon (right-bottom)

5. CONCLUSIONS

Current microclimate models allow users to investigate the contribution of façade materials to CLHI. The validation study confirms the ENVI-met accuracy in predicting the Ta in the canopy layer when the initial wind speed at the boundary layer for input data is > 1.5 m/s. The analysis feature to compare two simulation scenarios offers a facility to conduct an experimental study with variation in façade material properties. Simulations of one-day Ta show that the effect of the thermal and radiative properties of façade materials on the canyon Ta depends on the street orientation, the presence of big trees along the street and the canyon aspect ratio or SVF. The comparison maps of simulation results between urban areas with existing façade material and the ones with 45 cm-thick, burned brick show a slight increase in the Ta in the daytime. Adding high α coating on the external surface walls can reduce the Ta in the daytime, but raise the Ta in the early morning and the night.

6. ACKNOWLEDGMENTS

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ASSOCIATION BETWEEN THERMAL COMFORT CONDITION AND WORSHIPPERS' SATISFACTION IN TIMBER AND CONCRETE OF SUBURBAN RELIGIOUS BUILDINGS

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ABSTRACT:
Human thermal comfort is the paramount target to achieve the satisfaction of the occupation and users of the building. The frequency of use in the Malaysian religious building, known as mosque, changes daily in different hours and intervals. The first objective of this study is to compare the thermal comfort condition between timber and concrete religious building. The second objective is to analyze the relationship between thermal comfort and worshippers' perception level in the religious building. A questionnaire survey and case study was conducted at various religious buildings in suburban area of Kelantan, Malaysia. The 476 closed structured questionnaires have been given out, and a total of 173 surveys have been achieved. The answers have statically analyzed by using SPSS Version 23.0: descriptive analysis (mean ranking) and multiple regression analysis. The result shows that majority of the respondents have chosen the concrete mosque as their preference to perform prayer instead of timber mosque. It is hoped that this study will give benefit for worshippers towards thermal comfort to achieve the thermally comfortable environment in mosques building.

Key-words: *Thermal Comfort, Religious Building, Concrete, Timber, Worshippers' Perception*

1. INTRODUCTION

According to Jamaludin et al. (2015), Malaysia is considered as a tropical country and characterized as a warm and humid zone located between the tropics of Cancer and Capricorn and at a latitude of 1° - 7°N and longitude 100° - 119°E. Due to its location and zone, Malaysia has high temperatures and humidity depending on the area and will experience warm and humid conditions every year. Qahtan et al. (2016) state that the average mean temperature in a day for this zone is 31.6 Celsius during the daytime and 24.6 Celsius during the night. In addition, the mean monthly relative humidity is 82% found in August and never falls below 75.79% in November. Besides, Malaysia is exposed to abundant sunshine as it is close to the equator. According to previous researches, the most climate impacts on Malaysia buildings are from the high intensity of solar radiation and air temperature with little wind movement and high relative humidity conditions which has greatly affected occupants' indoor thermal comfort in the building. This is supported by Qahtan et al. (2010) which describes Malaysia as a hot-humid tropical country that receives annual total radiation of above 4.31kwh/m² and 10 hours of sunshine per day which causes high indoor temperature that usually requires the installation of an air conditioner in the workspace. In March and May, Malaysia will have the most sunshine at over 200 hours

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each, and in November the sunshine will at least be at 150 hours. The high indoor temperature condition causes an increase in the demand for air conditioning in order to provide the necessary thermal comfort for the occupants. In most buildings, human's thermal comfort is the paramount target to achieve the satisfaction of the occupants and users. Inappropriate thermal comfort in mosques will lead to the unsuitable thermal environment for the worshippers and the functions held inside of the building. The mosque should provide an acceptable level of thermal comfort in order to seek serenity and focus during worship. In addition, a mosque should consider the importance of balancing an environmentally friendly surrounding, intelligent use of space, use of technology and modern materials to maximize the potential of the structure to be used in the best possible way (Asif et al., 2019). The variation in the building's design must consider the climate of the country, especially in the hot and humid areas to make sure the occupants are satisfied with the thermal comfort environment in the building. Hence, this study attempts to determine the influence of thermal comfort condition on worshippers' satisfaction in two different materials of the mosque, which are timber and concrete mosques.

2. OVERVIEW OF RELIGIOUS BUILDING IN MALAYSIA

The religious building in Malaysia is known as mosque, and in the Arabic language is known as 'masjid' which comes from the word 'sajd' which means 'sujud' (prostration) and 'sejadah' (prayer mat) (Nasir, 1984). The combination of these two words means an act of prostration by a person on a prayer mat. The mosque is an important physical symbol of Islam and the centre of Muslim activity. For Muslims, the mosque is a centre for learning about Islam, and it acts as a school, hence helping bind the community together. As a holy place, it functioned as a praying area to help to refine the souls and awaken their minds and hearts.

Mosques differ from other types of buildings. Mosques have an intermittent operation schedule which is wholly or partially yet periodically occupied due to five prayer times per day throughout the year. The five prayer times are known as Subuh (daybreak), Zohor (noon), Asar (midafternoon), Maghrib (sunset) and Isyak (evening) where it will start from early morning until night time with duration of approximately twenty minutes to an hour each to complete the prayer. Each of the prayers will be performed in a group and led by an Imam where the prayer has two to four cycles (rakah) containing a series of postures per rakah.

2.1. Timber and Concrete as the Material for Mosque

In the early period of Islam in Malaysia, mosque architecture was straightforward and did not possess clear features, such as large domes and decorated calligraphy from those in the Middle East. Zafrullah (2011) the typology of the mosque at the start of the design was built of wood and has pyramidal roof characters are layered in two or three floors and the roof using a screen stocking. Timber mosque architecture is very different from the modern mosque in aspects such as its small size, the use of timber as the primary building material, post and beam method of construction and decorated carved components. A distinctive difference is the carved ornamentation of the roof or within the building. The roofs were multi-tiered pyramidal formations and were prevalent throughout the Malay Peninsula, Sumatra, Java, Kalimantan, Brunei, the southern Philippines and the former kingdom of Champa in Cambodia.

In the Era of the British Colonialization (18th to 19th century), the drastic transformation in terms of architecture design in most buildings had led to the elimination

of timber as a construction material. As replacements, the new materials were introduced, which were bricks, stone, cast iron and steel. According to Omer (2010), "the British for geopolitical reasons helped to build mosques that looked monumental and more like palaces than places of worship, to keep up with their reputation as colonial masters but also for the satisfaction of a local sultan". Malaysian mosque architecture underwent a drastic revolution from the time when its independence in 1957. The transformation in the architecture style of mosques during the British Era has shown the transformations between the traditional mosques in terms of scale and proportion, form, features and building materials.

2.2. Thermal Comfort

ASHRAE Standard 55 (2013) stated that thermal comfort is the condition of mind that expresses satisfaction with the thermal environment. In general, comfort is attained when body temperature is held within a narrow range, skin moisture is low, and the physiological effort of regulation is minimized. The human body will be affected and will lead to discomfort in cold environments when the body loses more heat to the environment and in hot environments when their body will not exert enough heat.

The thermal comfort is influenced due to many factors. There are two major factors that affect the thermal comfort level of the human body, which is the environmental and personal factor. Under the environmental factor, there are four factors that define the surrounding environment condition, while the latter two represent personal factors. These factors may be independent of each other but together contribute to thermal comfort. The most dominant factor affecting the thermal comfort is the air temperature and has been considered the major influencing factor to the thermal comfort, and many of the indexes produced are mainly focused on the determination of the comfort temperature (Maarof, 2014). The six factors affecting thermal comfort are both environmental and personal.

2.2.1. Air Temperature

The most dominant factor affecting thermal comfort is air temperature. This supported by Maarof (2014) described that the air temperature had been considered the major influencing factor to the thermal comfort and many of the indexes produced are mainly focusing to the determination of the comfort temperature. Air temperature is measured on how hot or cold the air is it and most commonly measured weather parameter. Temperature describes the kinetic energy, energy of motion and of the gases that make up air. The air temperature will increase, as gas molecules move more quickly. The previous studies have shown that air temperature is considered as the main factor among other factors of thermal comfort that influences the occupants' thermal comfort level. However, some of the studied show that the air temperature has less significant in influence the thermal comfort level. Maarof (2014) result shows that a change in the air temperature does not affect the comfort condition based on the feedback were given by the respondents.

2.2.2. Air Velocity

Air velocities are the impact on the rate of heat transfer between air and adjacent surfaces. It happens where the higher the velocity of the air moving across a surface, the higher the heat transfer will be. Air velocities in an indoor building affect the thermal comfort of people within spaces. The greater air velocity in building spaces, the greater will be the heat exchange between people in a space and the air around of them. In other occasions, a higher air velocity may be necessary for example; a fan might be turned on

during hot climate/weather to increase the rate at where the body is able to lose heat to its surrounding areas. Under other circumstances, a fan may be undesirable, for example, in colder conditions when higher air velocities may be noticeable as a draught.

2.2.3. Humidity

Humidity is the mass of water vapours in a volume of air divided by the mass of dry air. For example, if the water is heated and it evaporates to the surrounding environment, it will result in the amount of water of the air will provide humidity. The high relative humidity is one of the biggest obstacles to tackle besides high air and mean radiant temperature for tropical countries, especially in the hot and humid regions (Maarof, 2014). High humidity environments have a lot of vapours in the air, which prevents the evaporation of sweat from the skin. In hot environments, humidity is important and necessary because less sweat evaporates it will be when humidity is high (80%+). The evaporation of sweat is the main method of heat reduction.

2.2.4. Radiant Temperature

The mean radiant temperature is defined in ASHRAE Standard 55b (2004) as "the uniform surface temperature of an imaginary black enclosure in which an occupant would exchange the same amount of radiant heat as in actual non-uniform space". The Mean Radiant Temperature is the weighted mean temperature of the temperatures of the surfaces that form the border of the room, including the effect of incident solar radiation and its effects will transfer by radiation. Together with air temperature, mean radiant temperature is the major factor that affects the sensation of warmth as the radiation that falls on the skin stimulates the skin's sensory organs.

2.3. Worshippers' Perception towards Thermal Comfort in Mosque

According to Hussin et al. (2014), inappropriate thermal comfort in mosque buildings leads to the unsuitable thermal environment for the worshippers and the function held inside. Soemardiono et al. (2019) elaborated that people participation is the key factor in sustainable development. In order to increase participation, the building design should be appealing and suitable to the condition of the area. The worshipper needs to feel comfortable and relax to achieve quietness, harmony and peacefulness during prayer. Sezer and Kaymaz (2016) mentioned that the users' physical performance and tranquillity are influenced by the comfort conditions of the indoor environment. The environmental variables such as air temperature, humidity, air movement and heat transfer affect thermal sensation and satisfaction of occupants. In Malaysia, the use of air conditioning has been a trend in order to achieve thermal comfort. However, if the improper operation or control of the air-conditioning systems, thermal comfort may not be achieved (Al Homoud et al., 2009).

3. METHODOLOGY

The research objectives are divided into two: firstly, to identify thermal comfort condition in timber and concrete mosque building and secondly, to determine the differences between worshippers' perception level on thermal comfort in timber and concrete mosque building. In this research, the questionnaires were used to collect the data in order to determine the differences between worshippers' perception level on thermal comfort in timber and concrete and to analyze the relationship between thermal comfort and

worshippers' satisfaction in mosque building. In obtaining this information, two approaches have been chosen: a survey (questionnaire) and observation (case study) method.

3.1 Questionnaire Survey

The survey was conducted to determine user expectations about comfortable thermal conditions in mosques and to what extent these expectations are met. The research aims to cover indoor temperature, humidity, air movement (ventilation), and heat transfer issues depending on the user responses. The survey is developed based on 5-point Likert scale ranging from strongly agree to strongly disagree. The survey questionnaires used in this research consists of two main sections: Background Information (Section 1) and Worshippers' Perception of Thermal Comfort in Mosque Building (Section 2). The second section of the questionnaire is divided into two parts where Part A emphasis on the independent variable (IV) of this research, which is Environmental Factors whilst Part B focuses on the worshippers' satisfaction as the indirect variable of the research. All items in Section 2 of the questionnaire survey were adapted and modified from previous research on indoor environmental quality (IEQ) (Tharim et al., 2018) and also taken from different literature on satisfaction research.

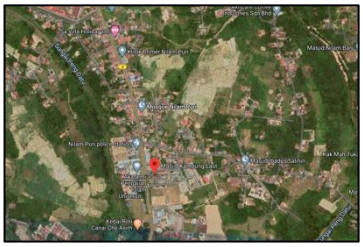
The scope of this study is limited to user comfort perception parameters of timber and concrete mosques. In ensuring the consistency, a survey was held in different material mosques that are naturally ventilated where the floor area range for these mosques are almost the same. They share a lot of similarities but mainly differ in the application of the material design, as discussed earlier. The 476 closed structured questionnaires have been given out, and a total of 173 surveys have been achieved, which is about 36% of the questionnaire have been received. The answers have statically analyzed by using SPSS version 23. The attained results are illustrated in graphs in the research result section.

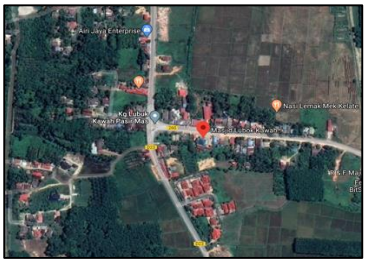
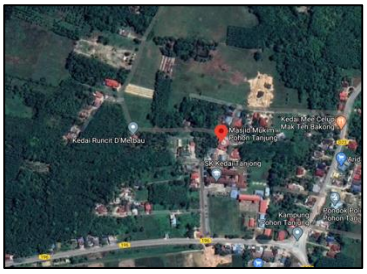
3.2 Case Study

The case study was used to achieve objective one, which is to identify thermal comfort condition in timber and concrete mosque building. The first process in data collection is to evaluate the factor affecting the changes in the thermal condition inside the prayer hall of the mosques. The common practice is to measure the common factors affecting the thermal comfort, which are building design and ventilation system. The researcher evaluated the number of opening and ventilation system at four selected religious buildings (Masjid) as shown in Table 1 below in Kelantan, Malaysia shown in Table 1.

Table 1.

The geographic information of selected religious buildings in suburban area of Kelantan, Malaysia

Timber Mosque		
	Mosque	Description
1	Masjid Kampung Laut	6.0273°N, 102.2411°E
		

2	Masjid Ar-Rahman 	5.9387°N, 102.1196 °E 
Concrete Mosque		
1	Masjid Lubuk Kawah 	6.0627°N, 102.0798°E 
2	Masjid Pohon Tanjung 	6.0716°N, 102.0775°E 

Out of available methods for collecting primary data, survey and case study have been found suitable for the topic study. These have fulfilled the requirements for the data collection properly. Meanwhile, **Fig. 1** below portrays the conceptual research model for this research. It is theorized that there are environmental factors which can be related to thermal comfort and worshippers' perception in the mosques as follows:

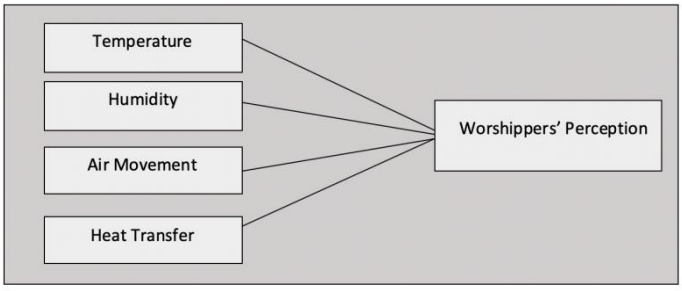


Fig. 1. Research Framework (adapted from Tharim, Samad & Ismail, 2018)

4. RESULTS AND DISCUSSION

The purpose of this chapter is to describe the result from the analysis and the finding obtained from the data collection process, which is a questionnaire survey. It is explained through the two objectives of the study.

4.1 Objective 1: To Compare the Thermal Comfort Condition between Timber and Concrete Mosque.

Table 2.

The analysis of the overall comparison of timber and concrete mosques in term of thermal comfort condition

Questions	Timber	Concrete	Rank
	Mean		
Temperature			
Satisfied with the temperature Condition	3.82	3.78	3
Comfortable with the ventilation system	3.68	3.89	2
Need more cool air	3.79	3.96	1
More warm air	2.89	1.87	2
Humidity			
Satisfied with the overall humidity	3.48	3.67	2
Comfortable when the window is opened	3.86	3.90	1
More humidity (air is too dry)	3.37	3.54	3
Less humidity (air is too wet)	3.00	2.43	4
Air Movement			
Air movement (ventilation) available.	3.61	3.63	3
I think that the window size is all right for me	3.49	3.71	1
I need more air movement	3.36	3.70	2
I need less air movement	2.78	2.29	4
Heat Transfer			
Incoming sun	3.37	3.34	2
Hot wall/ window surfaces	3.36	3.53	1
Heat sources from ventilation system (e.g. Fans)	3.17	3.03	3
Worshippers' Satisfaction			
The overall thermal comfort level	3.65	3.92	1
The overall quality of indoor ventilation	3.71	3.86	2
I'm greatly satisfied with this mosque building	3.72	3.92	1

The result from **Table 2** above indicated the thermal comfort condition in between timber and concrete mosque consists of four factors of thermal comfort and the satisfaction in mosque building has been analyzed.

4.1.1 Temperature

From the analysis, worshippers agreed that they needed more cold air (M = 3.96) in the concrete mosque than timber mosques (M = 3.79). In addition, the data recorded that the worshippers were more satisfied with the temperature (M = 3.82) in the timber mosque than the concrete mosque (M = 3.67). However, the data also shows that the ventilation system in the concrete mosque is more comfortable (M = 3.89) than timber mosques (M =

3.68). Finally, hot air does not need to be in the concrete mosque where mean values record the lowest value (M = 1.87) in concrete and (M = 2.89) in timber mosque.

4.1.2. Humidity

The concrete mosque recorded the highest value in the humidity factor is where the worshippers felt more comfortable when the window was opened (M = 3.90) and satisfied with the overall humidity (M = 3.67) also required more humidity (M = 3.54) instead of mosques by the score of the more comfortable when the window is opened (M = 3.86) and satisfied with the overall humidity (M = 3.48) also requires more moisture (M = 3.37). However, the highest value for timber mosque is the need for less humidity (M=3.00) other than concrete mosque (M=2.43).

4.1.3. Air Movement

The results show the window size of the concrete mosque (M=3.71) are more satisfied than timber mosque (M=3.49). In addition, the need more air movement (M=3.70) in the concrete mosque and (M=3.36) in timber concrete with the air movement ventilation available in the mosque (M=3.63) for concrete and (M=3.61) for timber mosque.

4.1.4. Heat Transfer

The Hot wall/ window surfaces are more affecting the thermal comfort of worshippers in timber mosque (M=3.53) other than concrete mosque (M=3.36). In addition, the incoming of the sun in timber mosque (M=3.37) and a concrete mosque (M=3.34) was recorded as the second higher in heat transfer followed by heat sources from ventilation system which is timber mosque (M=3.17) and a concrete mosque (M=3.03).

4.1.5. Worshippers' Satisfaction

The analysis found that the worshippers' perception level in concrete mosques is higher than timber mosques which has a mean score of M=3.92 in terms of their overall thermal comfort level and satisfaction with the mosque. The worshippers' also give the good result for the overall quality of indoor ventilation where the score of the mean is still high where the mean is 3.86 for concrete and the mean=3.71 for timber mosques.

4.2. Objective 2: To Analyze the Relationship Between Thermal Comfort and Worshippers' Perception Level in the Mosque Building

4.2.1. Multiple Regression Analysis

By using multiple regression analysis methods, this analysis indicates the direction of the relationship, which is positive or negative. The multiple regression analysis displays the coefficient table comprises significance values and beta value. The significance level (or p-value) is the probability of obtaining results as extreme as the one observed. If the significance level is very small (less than 0.05), the relationship is significant, and the two variables are linearly related. However, if the significance level of the coefficient table is relatively large (above 0.05), the relationship is not significant, and the two variables are not linearly related. In this study, multiple regression analysis was conducted to examine the relationship between worshippers' satisfaction and factor affecting thermal comfort in mosque building.

Table 3.

Descriptive statistics on the agreed factors

Hypothesis	t	Sig	Beta	Hypothesis Finding
Temperature	6.150	.000	.428	Supported
Humidity	0.613	.540	.058	Not Supported
Air movement	7.916	.000	.721	Supported
Heat Transfer	4.200	.000	.212	Supported

*R2 adjusted value 0.457 (model) *P value >0.05/t. >1.96

4.2.2. Hypothesis Testing

From **Table 3**, the result from multiple regression analysis has shown that the three variables were found to be consist of a significant level where p> 0.05. The first variable is air movement followed by temperature and finally, heat transfer. The humidity variables are not significant and not supported by the hypothesis. This is because the ρ value is more than 0.05. Thus, the hypothesis of temperature, air movement and heat transfer are accepted in this research.

4.2.3. Determining the model fits

The model summary table provides the R, R2, adjusted R2, and the standard error of the estimate, which can be used to determine how well a regression model fits the data:

Table 4.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.685a	.469	.457	.50629

The value of 0.469 is that independent variables explain 46.7.9% of the variability of the dependent variable is influenced by model variables. Furthermore, the result was interpreted into adjusted R square to get the accurate data of the analysis. Based on SPSS Version 23.0, the result showed that 45.7% (model) worshipper's satisfaction is influenced by model variables which are thermal comfort factor, and thus 54.3% is from an external factor.

4.2.3. Determined model coefficients

To get the result for the statistical significance of each of the independent variables whether the unstandardized (or standardized) coefficients are equal to 0 (zero) in the population. If $p < .05$, it can be concluded that the coefficients are statistically significantly different to 0 (zero). The t-value and corresponding p-value are located in the "t" and "Sig." columns. Table 4 shows the temperature, air movement and heat transfer were significant of each of the independent variables where the coefficients are equal to 0 (zero). The above table is a summary of descriptive statistics and analysis results. The temperature, air movement and heat transfer factor are positively and significantly correlated with the criterion, indicating that those worshipper's satisfaction. Humidity is negatively correlated with worshipper's satisfaction with a score of 0.540, where it exceeded $p < 0.05$. It can be concluded that temperature, air movement, heat transfer has a positive relationship with worshippers' satisfaction. However, the humidity variables are considered as having a

negative relationship with worshipper satisfaction. Furthermore, unstandardized coefficients indicate how much the dependent variable varies with an independent variable when other independent variables are held constant (considering the effect of temperature, humidity, air movement and heat transfer). From the beta value, the most dominant variable is air movement followed by temperature and heat transfer. Air movement result scored the highest value (0.721) followed by temperature (0.428) and heat transfer (0.212).

Table 5.

Coefficients Table

Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
	B	**Std. Error**	**Beta**		
Temperature	.428	.070	.397	6.150	.000
Humidity	.058	.095	.040	0.613	.540
Air movement	.721	.091	.499	7.916	.000
Heat Transfer	.212 .051		.257	4.200	.000

Majority of the respondents have chosen the concrete mosque as their preference to perform prayer instead of timber mosque. Referring to the data, the worshippers are satisfied with the humidity factors, comfortable with the ventilation system, air movement and satisfied in overall building condition and environment inside the concrete building. Based on the data analysis, timber and concrete mosque significantly effects on worshippers' perception level. The data has shown that temperature, humidity and satisfaction have a positively and significantly correlated with the different type of the mosque's building. The majority of the respondents have good perception level towards timber mosque rather than concrete mosque where the temperature, humidity, heat transfer is greater than the concrete mosque. In addition, the concrete mosque also scores a higher result compared to timber mosque in term of worshippers' satisfaction and air movement.

5. CONCLUSIONS

Based on the results of the survey and case study finding, the overall worshippers were satisfied with the thermal comfort level in timber and concrete mosques. However, the need for improving thermal comfort for the concrete mosque is higher than the timber mosque. Based on descriptive statistics, the data analysis has shown that the demand of the worshippers in improving thermal comfort condition in terms of temperature, humidity, air movement is more crucial in regards to the local climate (hot and humid). In addition, most of the respondents (worshipper) are satisfied with the ventilation and opening of both mosques where the size and types of the opening and ventilation are applicable and significant in providing the thermal comfort. This research can be referred to as a guideline to the Architects and developers in designing and constructing the building in regards to the satisfaction of the clients or people and according to the local climate which is hot and humid. The design and architecture of the building have significantly contributed to the overall satisfaction of occupants and users.

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ANALYSIS OF GROUNDWATER VULNERABILITY IN COAL MINING AT TANAH LAUT DISTRICT, SOUTH KALIMANTAN

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ABSTRACT:
A mining plan will affect the water catchment especially on the availability of groundwater. One effort to maintain the quantity and quality of groundwater is analyze the level of groundwater vulnerability. The aim of this research is finding areas that potentially have pollution of groundwater. The analytical method using DRASTIC method. DRASTIC have seven parameters: depth of groundwater (D), recharge (R), aquifer type (A), soil texture (S), topography (T), impact of the vadose zone (I), and hydraulic conductivity (C). DRASTIC divides each parameter into several classes according to rating, and weight based on their effect of groundwater vulnerability. The final results of this study are a map of groundwater vulnerability level using ArcGIS software. The study area has 2,5% area with very low vulnerability, 75% low, 20% moderate and 2,5% high. Groundwater vulnerability maps can be a guidance for area of mining plan, in order to minimize the negative effects of mining activities.

Key-words: *Vulnerability, DRASTIC, Groundwater, Coal mining, Kalimantan.*

1. INTRODUCTION

The term vulnerability began to be used intuitively in the world of hydrogeology in the 1970s in France and was more widely known in the 1980s (Foster, 1987). The model of groundwater vulnerability based the physical condition of the environment has a level of groundwater protection against pollution (Vrba & Zoporozec, 1994). Groundwater susceptibility is natural (intrinsic) and due to human activities (specific). Intrinsic vulnerability means the aquifer that is susceptible to contamination and attaches to the geological and hydrogeological features. Meanwhile specific susceptibility means the susceptibility of aquifers to a group of pollutants or to only one pollutant (Foster & Hirata, 1988). The intrinsic vulnerability relying on three elements: His fluid contaminant flow dynamics in the saturated zone; absorption process and fluid contaminant travel time; the residual concentration of the contaminant as it reaches the saturated zone (Maria, 2017).

The quality of groundwater depends on the presence or absence of contaminants entering the groundwater and the physical condition. This causes groundwater to be in the soil layer or subsurface, thus affecting the level of groundwater danger to a pollution. The level of groundwater hazard is a priority by groundwater level itself, as well as the level of contaminants or contaminants that exist. Coal mining activity changes morphology, geology,

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hydrogeology, and land use. It can impact on subsurface rock layers, topographic, and aquifers. The water catchment will have an effect on the availability of groundwater both in quality and quantity because the changed of land use (Vias et al., 2005). The decrease of watertable in the mining area is very possible because the elevation of the mine floor is far below the surface of the ground, especially the surface of deep groundwater. Decrease in groundwater potential affects the decrease in groundwater level, groundwater discharge, subsidence (surface or land subsidence), and groundwater quality (Haq et al., 2013). Activities of mining that can bring impact to be pollutions such as, overburden dumping, activities in workshops, the construction of haul road facilities and infrastructure, stockpiling activities, coal processing and disposal of domestic waste from employees. A model for measuring the level of groundwater vulnerability to pollution is important to do with protecting groundwater from pollution caused by mining activities. The aim of this study is determine zone of the groundwater level vulnerability against pollution. The novelty of this research is determining the level of groundwater vulnerability can be applied in the mining area and can be a reference for the government or mining company to manage the groundwater.

2. STUDY AREA AND DATA

The study area is located in Tanah Laut, South Kalimantan. It was a tropical climate and located between the latitude of 3˚18’25” S and longitude 114˚33’53” E. Its 4 hours from Syamsoedin Noor Airport, Banjarbaru. This location is one of coal mining concessions. The area is about 100km^2.

3. METHODOLOGY

Many methods to estimate groundwater vulnerability. There are DRASTIC, COP, GOD, SINTACS, EPIK, SI, MEDALUS, KHRERICI, etc (**Table 1**). Every method has parameters that relate in hydrogeological features. EPIK, GOD, COP, PI, RISKE, REKS, VURAS usually used for karst area. SI can be used in urban, plantation, or agriculture. MEDALUS can be used on an endoreic area or in the highlands (Bouhata & Kalla, 2014). KHERICI used in reservoir on groundwater (Attoui et al., 2012). Meanwhile DRASTIC and SINTACS have a similarity, but this research only using DRASTIC method because DRASTIC have many parameters than others and can be applied in coal mining area.

DRASTIC is the method most widely known in a variety of regional conditions (Foster & Hirata, 1988). DRASTIC is an acronym of the parameters within a hydrologic feature, which handle groundwater pollution: depth of groundwater (D), recharge (R), aquifer type (A), soil texture (S), topography (T), impact of vadose zone materials (I), and hydraulic conductivity (C). The DRASTIC model has a result, it’s a numerical index from weights and rating assigned the seven parameters. Every parameter has a weight, its about score 1–5 based on the important things, the greater weights means greater pollution probability. Rating of every parameters about 1 to 10 depends on relative effect of vulnerability, if rating 1 means the least pollutant potential and rating 10 means the highest pollutant (Piscopo, 2001). The DRASTIC index is shown in equation below.

$$\text{DRASTIC Index (Di)} = DrDw + RrRw + ArAw + SrSw + TrTw + IrIw + CrCw \quad (1)$$

Where, w is for weight and r is for rating.

Table 1.

Comparison vulnerability method (Linggasari et al., 2019)

No.	Method	By	Year	Parameter																							
				Depth	Recharge	Aquifer	Soils	Topography	Vadose Zone	Conductivity of	Overlaying protective	Concentration of flow	Precipitation	Infiltration	GW Occurance	Materials of vadose zone	Saturated aquifer	Epikarst	Karst network dev	Attenuation potencial	Land Use	Input	Exfiltration	Rock type	Evapotranspiration	Irigation	Temperature
1	DRASTIC	Aller, et. Al.,	1985	√	√	√	√	√	√	√																	
2	COP	Vias, et. al.	2006								√	√	√														
3	GOD	Foster dkk	1987	√		√									√												
4	SVV	Putra	2007		√				√							√											
5	PI	Goldscheider et al.	2000								√			√													
6	AVI	Van Stempvoort et al	1993							√							√										
7	EPIK	Doerfliger et al.	1999								√			√				√	√								
8	SINTAC	Civita	2004	√	√	√	√	√	√	√																	
9	SI	Ribeiro	2000	√	√	√		√													√						
10	SEEPAGE	Navulur & Engel BA	1999	√		√	√		√											√							
11	PRAST	Civita	1994		√	√	√	√			√																
12	APLIS	Andreo, et. Al.,	2008	√		√	√	√						√													
13	LOS	Aschonitis et al.,	2012				√	√		√															√	√	√
14	EPPNA	Inag	1998	√	√	√		√													√						
15	GLA	Holting et Al	1995																√	√							
16	RISKE	Petelet-Giraud,	2000				√							√				√	√					√			
17	REKS	Witkowski et al.	1997				√											√	√								
18	VURASS	Vrana	1999											√								√	√				
19	LEA	Otmar & Razaq	1996								√	√															
20	VULK	Jeannin et al.	2001								√								√								

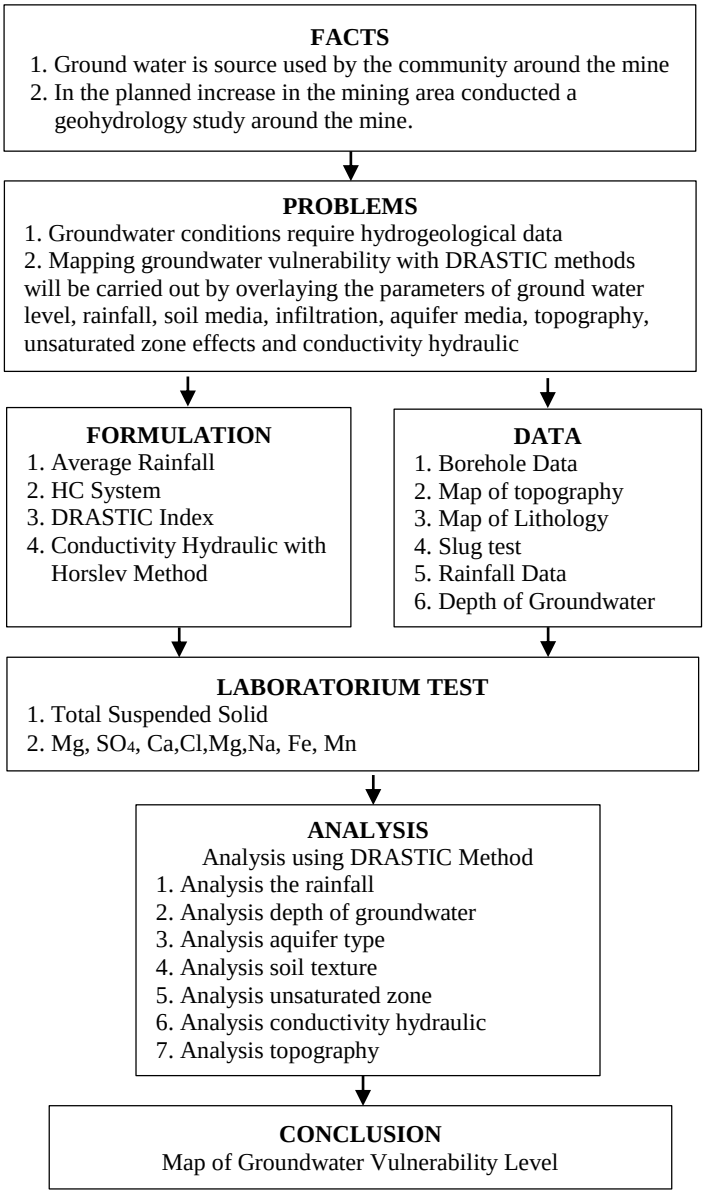

Fig.1. Methodology Flowchart

Increasing DRASTIC index will produce higher groundwater pollution possibility. The classification and rating of DRASTIC can be seen in **Table 2** to **Table 8**, while the assessment of the weight of each parameter is presented in **Table 9** and class of vulnerability in **Table 10**.

Table 2
Classification and Rating of Watertable depth (Aller et al., 1988).

Depth of GroundWatertable (m)		
Class	Range	Rating
1	0-1,5	10
2	1,5-4,5	9
3	4,5-9,0	7
4	9,0-15	5
5	15-22,5	3
6	22,5-30	3
7	>30	1

Table 3.
Classification and Rating of Recharge (Aller et al., 1988).

Recharge (mm/tahun)		
Class	Range	Rating
1	0-1500	2
2	1500-2000	4
3	2000-2500	6
4	2500-3000	8
5	>3000	10

Table 4.
Classification and Rating of Aquifer Type (Aller et al., 1988).

Aquifer Type		
Class	Aquifer Type	Rating
1	Massive Shale	2
2	Weathered metamorphic/ igneous	3
3	Metamorphic rock	4
4	Sand, shale, limestone	6
5	Massive sand	6
6	Massive limestone	6
7	Sand and gravel	8
8	Basalt	9
9	Limestone, karst	10

Table 5.
Classification and Rating of Soil Texture (Aller et al., 1988).

Soil Texture		
Class	Soil	Rating
1	Gravel	10
2	Sand	9
3	Shrinking clay	7
4	Sandy loam	6
5	Loam	5
6	Silty loam	4
7	No shrinking clay	1

Table 6.
Classification and Rating of Topography (Aller et al., 1988).

Topography(%)		
Class	Range	Rating
1	0-2	10
2	2-6	9
3	6-12	5
4	12-18	3
5	>18	1

Table 7.
Classification and Rating of Material In Vadose Zone (Aller et al., 1988).

Material in vadose zone		
Class	Media	Rating
1	Confining layer	1
2	Shale	3
3	Limestone	6
4	Sandstone	6
5	Bedded limestone, Sandstone and shale	6
6	Sand and gravel with silt and loam	6
7	Metamorphic/igneous	4
8	Sand and gravel	8
9	Basalt	9
10	Karst limestone	10

Table 8.
Classification and Rating of Conductivity Hydraulic (Aller et al., 1988).

Conductivity Hydraulic (m/year)		
Class	Range	Rating
1	1-100	1
2	100-300	2
3	300-700	4
4	700-1000	6
5	1000-2000	8
6	>2000	10

Table 9.
Weight of DRASTIC (Aller et al., 1988).

Parameter	Depth	Recharge	Aquifer	Soil	Topography	In vadose	Conductivity
Weight	5	4	3	2	1	5	3

Table 10.
Criteria of the vulnerability assessment using DRASTIC method.

Class of Vulnerability	Index DRASTIC
Very Low	<79
Low	80-119
Moderate	120-159
High	160-199
Very High	>199

4. RESULTS AND DISCUSSIONS

The parameters considered in weighting groundwater vulnerability include depth to ground watertable, recharge, aquifer type, soil texture, topography, impact of vadose zone, hydraulic conductivity. The level of groundwater vulnerability is created by overlapping the seven DRASTIC parameters in the study area.

Depth of Water

The depth of ground water in mining plan is around 3 to 50 meters. The depth is measured through exploration and geotechnical drill holes. The deeper groundwater surface, the potential for groundwater contamination will be smaller, and vice versa if the groundwater level is increasingly shallow, the potential for groundwater contamination will be even

greater. This is proven by the deeper groundwater level, the time the contaminant reaches the groundwater level, the longer the potential for contamination will also be smaller.

Recharge
Recharge calculated by rainfall data. Rainfall in this area is high category, which is around 4000 mm per year. High rainfall is likely to significantly influence groundwater pollution. High rainfall will affect the high pollutants because the high rainfall makes the infiltration rate higher, and pollutants easier to reach groundwater.

Aquifer Type
Aquifer type are determined based on rock formations in the study area. The results of interpretation of drill log data show that the aquifer type in the area are sandstone. Grain size of sand stone can affect groundwater vulnerability in mining plans, because sandstone aquifer type makes it possible to keep and pass groundwater in large quantities.

Soil Texture
Soil has a significant impact on water including dissolved contaminants infiltrated from the surface of the soil into the soil. In general, the finer the grain size, the smaller the potential for dissolved contaminants to enter the soil. Based on the borehole and field observations, the soil texture in the study area is dominated by sandy loam in the western part of the mining plan area. Whereas in the east, dominated by silt and clay. Silt and clays have a big grain size, which can reduce soil permeability and limit the movement of contaminants.

Slope (Topography)
Topographic maps in the mining plan area are prepared through a digital elevation model (DEM) obtained from USGS. Based on the slope map, the study area has a slope varies between 2 to 74%. Almost all areas is low slope. Area with lower slope causes water to have a chance to seep into the soil, whereas in areas with higher slope water tends to flow immediately.

Impact of Vadose Zone (Unsaturated Zone)
Material of vadose zone is located above the watertable which is discontinuously saturated or unsaturated. It determined based on the type of the material, including the characteristic or boundary of the soil and rocks below the groundwater level. The material will control the direction and travel time needed to reach groundwater. Based on exploration and geotechnical drilling holes, the unsaturated zone in the mining plan area is dominated by silty clay and a small amount of sand.

Conductivity of Aquifer
Hydraulic conductivity is defined as the ability of aquifer materials to transmit water, which in turn, controls the rate at which groundwater will flow under a given hydraulic gradient. Aquatic hydraulic conductivity is the ability of aquifers to escape water and affect the speed of the water flow. The greater the value of hydraulic conductivity, the potential for groundwater pollution will also be even greater. Hydraulic conductivity in the mining plan area is 0.17-1.99 m / day. This value is obtained based on the slug test that has been done.

Based on identification of the seven parameters above, the results of the field shown on the **Table 11**.

Table 11.

The result of DRASTIC Index.

Level of Vulnerability	Very Low			Low			Moderate			High		
	R	**W**	**Score**	***R***	**W**	**Score**	***R***	**W**	**Score**	***R***	**W**	**Score**
Depth of Watertable	1	5	5	1-7	5	5-35	3-9	5	15-45	10	5	50
Recharge	10	4	40	10	4	40	10	4	40	10	4	40
Aquifer Type	6	3	18	6	3	18	6	3	18	6	3	18
Soil Texture	4-6	2	8-12	4-6	2	8-12	4-6	2	8-12	6	2	12
Topography	1	1	1	1-9	1	1-9	1-10	1	1-10	10	1	10
Impact of vadose zone	1	5	5	1-6	5	5-30	1-6	5	5-30	6	5	30
Conductivity Hydraulic	1	3	3	1-2	3	3-6	1	3	3	2	3	6
DRASTIC Index	78			80-119			138-152			166		

Groundwater Vulnerability Map

Every parameters of the DRASTIC model have been determined as a part with ArcGIS 10 software. The Geostatistical Analyst with Inverse Distance Weighted (IDW) interpolation in ArcGIS was used to create the raster map and graph and interpolate the points. The map of groundwater vulnerability interpreted by score of DRASTIC indices. DRASTIC index of this study divided into 4 classes (**Fig.2**). A greater index DRASTIC indicates a higher level of vulnerability, while a smaller value indicates a lower level of vulnerability. After DRASTIC values in each drill hole are obtained, then interpolated using the Inverse Distance Weight method to obtain delineation between points, so that the zone in the study area is known. The results is the study area has a very low level of vulnerability, low, moderate, and high. Based on the DRASTIC classification, the distribution of groundwater vulnerability levels dominated in low range.

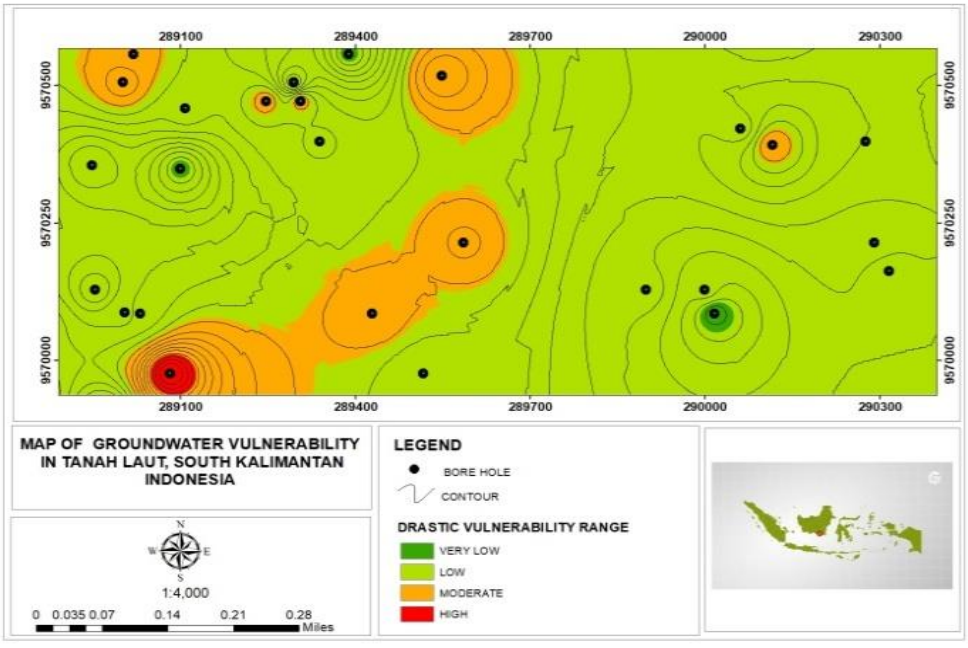

Fig. 2. Map of Groundwater Vulnerability.

Verification

Groundwater quality measurements were carried out both in the field and in the laboratory at seven drill holes (**Fig. 3**) to determine the physical and chemical character of groundwater. This measurement used as a verification of groundwater vulnerability analysis. The measured have eight parameters, Iron (Fe), Manganese (Mn), Chloride (Cl), Sulfate (SO_4), Calcium (Ca), Magnesium (Mg), Total Suspended Solid (TSS) and pH.

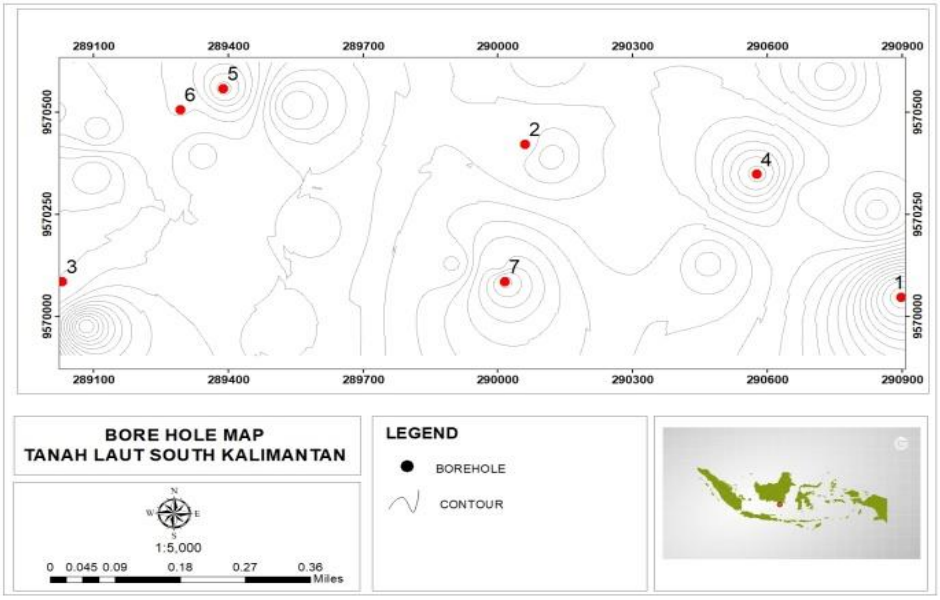

Fig. 3. Map of Borehole.

Based on the correlation coefficient of eight parameters above with DRASTIC index, concluded that the Fe parameter has the greatest correlation coefficient value (81%) than the other parameters. This is evidenced in the drill holes that have the highest DRASTIC index also contains the highest Fe metal.

5. CONCLUSIONS

The zoning results of groundwater vulnerability are divided into four categories: very low, low, medium and high. The level of groundwater vulnerability is very low located in the southeast around 2.5% of the total research area. Low groundwater vulnerability dominates the study area with 75% of the total area. The moderate level of vulnerability covers 10%. While the high level of vulnerability is located in the southern part of the study area, which is 2.5%. This area needs groundwater monitoring periodically covers the quality and quantity of groundwater and have a priority for groundwater management related to the location of planned facilities and infrastructure, so as to minimize the impact of coal mining on groundwater in the study area. The area with very low until low vulnerability can be used for

workshop, fuel station, settling pond. The area with moderate until high vulnerability is for parking vehicles and heavy unit. If a high vulnerability area will be mined, it must be carried out in an area that is less than the ground water level or make sure to prepare growing process.

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ASSESSMENT ON THE REUSE AND RECYCLING OF DOMESTIC SOLID WASTE IN MALAYSIA

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ABSTRACT:
The most preferred waste management practices are to prevent or minimize waste. Public participation in domestic waste separation for reuse and recycling is the key to reduce waste disposal or increase the amount of waste diverted from landfill. These practices are influenced by knowledge of the public on the concept of source separation, reuse, and recycle, varieties of recyclable goods and methods of disposal for domestic waste. This paper proposes an assessment to explore the reuse and recycling of domestic solid waste by local residents in Malaysia. The propose assessment will include field experiment at selected housing schemes in Malaysia. The experiment will become a platform to guide and educate the public to manage domestic waste. These hands-on practices will be closely monitored. Three interventions will be conducted to identify their current practices of domestic waste management. The interventions will be "information only", "information and norms" and "information and monetary incentives". The record of domestic waste collected by the local authorities, before and after these interventions will be checked and analysed. The findings of the experiment shall indicate the influencing factors for separation at source for domestic waste.

***Key-words**: Domestic Waste, Waste Management, Reduce, Reuse, Recycle*

1. INTRODUCTION

Greening the domestic solid waste management require "3R – Reduce, Reuse and Recycle" activities to minimize or prevent waste generation. The green solid waste management is indicated by the least practice of waste disposal (with reference to the waste management hierarchy). The participation of residents in domestic solid waste separation, reuse and recycling is the key to reduce waste disposal or increase the amount of waste diverted from landfill. These activities influenced by knowledge of the residents towards recycling concept. This concept covers the varieties in good recycling and disposal method of solid waste. Examination of the current trend and pattern of waste generation and identification of the green practices by the residents is vital in greening Malaysia. The estimation of the generation of solid waste in Malaysia shows an increase pattern for the year of 2012 to 2017 (**Fig.1**) (MAMPU 2018). This estimation was based on the generation rate of 1.17kg per capita per day. The population growth in Malaysia will directly increase the generation of solid waste. However, the actual collection of domestic solid waste by the local authority shows an up and down pattern (**Fig. 2**). The influencing factors and decision-making mechanism of the residents need to be strongly understood. This paper proposes an assessment on the reuse and recycling of domestic solid waste practiced in Malaysia. This assessment will focus on the identification of the generic stream of domestic waste recycling

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in Malaysia, identification of the green practices in reuse and recycling of solid waste adopted at household level and the determination of the influencing factor of green practices in reuse and recycling of domestic solid waste.

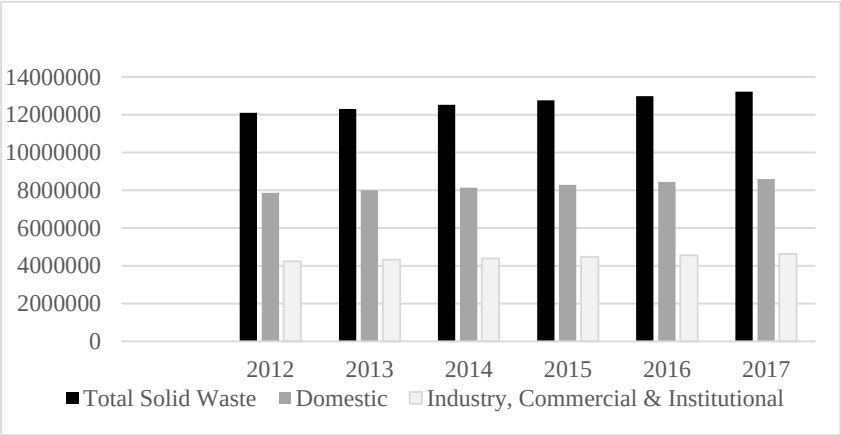

Fig. 1. Estimation of Solid Waste Generation in Malaysia (2012-2017)
Source: MAMPU (2018)

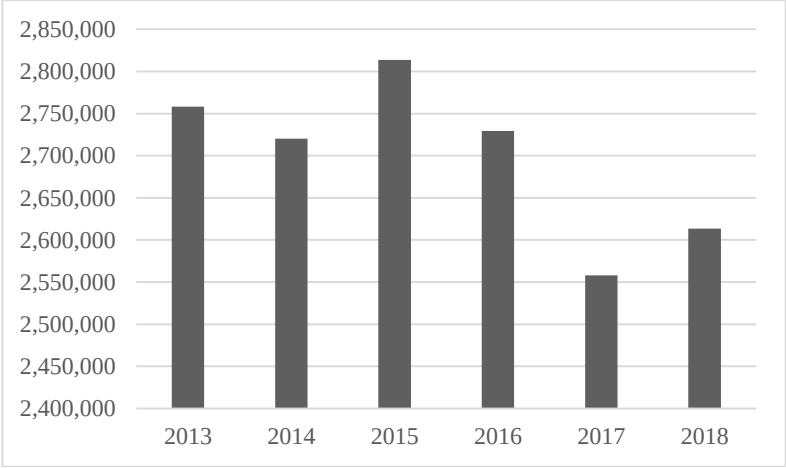

Fig. 2. Collection of Domestic Solid Waste (2013 – 2018)
Source: MAMPU (2019a)

2. REVIEW ON DOMESTIC SOLID WASTE MANAGEMENT

The solid waste management becomes a major concern among the policy makers and planners. The highest generator of solid waste in Malaysia is domestic waste as shown in **Fig. 1** above (MAMPU 2018; Ministry of Housing and Local Government, 2006). The adoption of an effective waste minimisation strategy by the government is expected to promote sustainable solid waste management. Greening the domestic solid waste management is a way to minimize and prevent waste generation through regular practice of

Reduce, Reuse and Recycle. A green solid waste management is indicated by the least practice of waste disposal (with reference to the waste management hierarchy). The participation of residents in domestic solid waste separation, reuse and recycling is the key to reduce waste disposal or increase the amount of waste diverted from landfill. The composition of recyclable solid waste sorting at source by residents in Kuala Lumpur, Putrajaya, Pahang, Perlis, Kedah, Negeri Sembilan, Melaka and Johor had been recorded as in **Fig. 3** (MAMPU 2019b). The participation of the residents in this activity could be improved and increased.

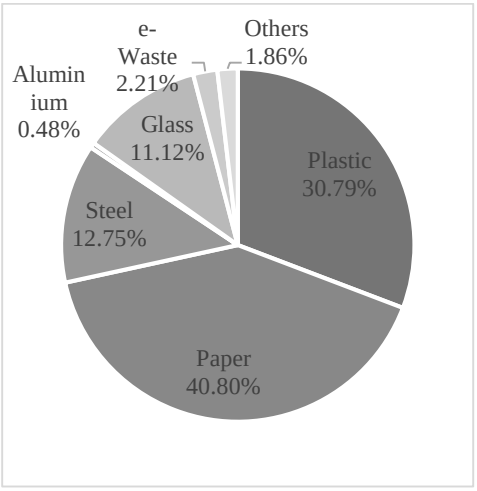

Fig. 3. Composition of recyclable solid waste sorting at source
Source: MAMPU (2019b).

In product recovery, the lowest hierarchy is recycling (Amelia, et al. 2009). Recycle is a simple method to reduce disposal problem. Recycling activities could expand the lifespan of the existing landfill. Therefore, seeking new landfill site could be delayed or avoided. The Suitability Index for Waste Landfills considers public health, minimal impact on the environment, and provide safe disposal of waste (Manoiu et al. 2013). In addition, the recycling program is more economical by substituting raw materials with used materials, conserves energy, and creates jobs. (Meen-Chee and Narayanan, 2006). The community must be knowledgeable on recycling techniques, methods and benefits. The process of recycling also must be appropriate, low-cost, and easy (Purcell and Magette. 2010). The daily percentage of recyclable materials disposed of at landfill is about 65% (Meen-Chee and Narayanan, 2006). In Malaysia, only few recycling industries are available despite the positive sign of recycling activities (Fig.3). The recycling industry need to be increased and enhanced (Saeed et al., 2009). Community Based Solid Waste Management (CBM) training course is one example of sharing and dissemination of knowledge to all parties (Tantanee and Hantrakul, 2016).

Examination of the current waste generation patterns and identification of the green practices of reuse and recycling by residents is vital in greening the country. Despite of that, a clear understanding of the main influencing factors and decision-making mechanism of the

residents are also required. Therefore, all parties should collaborate to improve the good practices and comprehensive solid waste management. The success of the implementation of solid waste management depends on the collective effort from all parties involved. This achievement is indicated by the inclusiveness, fully integration with the economic and social practices, and incorporation with all parties.

3. ASSESSMENT ON THE REUSE AND RECYCLING OF DOMESTIC SOLID WASTE

The proposed assessment in reuse and recycling of domestic solid waste in Malaysia comprise of three stages namely identification of the study area and sampling strategy, fieldwork setting and experiment design and intervention (**Fig. 4**).

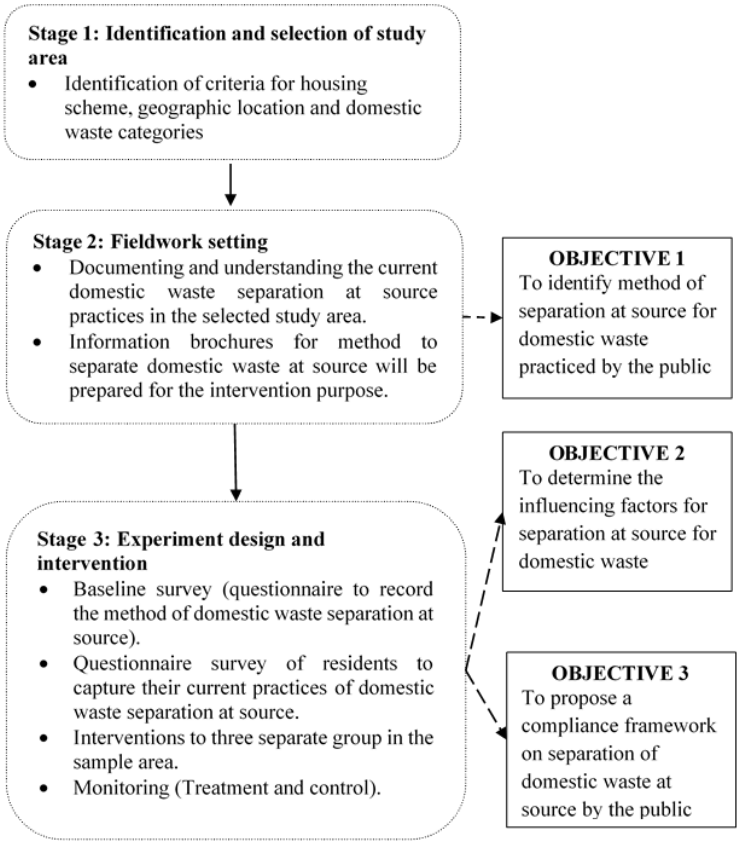

Fig. 4. Assessment Flow Chart.

3.1. Identification and selection of study area

The study area will be selected based on the population density and recorded data of household waste collected by the municipality or district in Malaysia. The sample will be drawn from the housing scheme area with a cluster randomization technique. The investigation on greening the domestic solid waste management will focus on the reuse and

recycling activities by residents in selected municipalities with high density of population in Malaysia.

Review on available data from reliable sources provides a baseline for the identification and selection of study area. The estimation of solid waste generation in for every state in Malaysia for the year 2020, 2025 and 2030 shows an increasing pattern (**Fig. 5**). The highest generation of solid waste will be in Selangor.

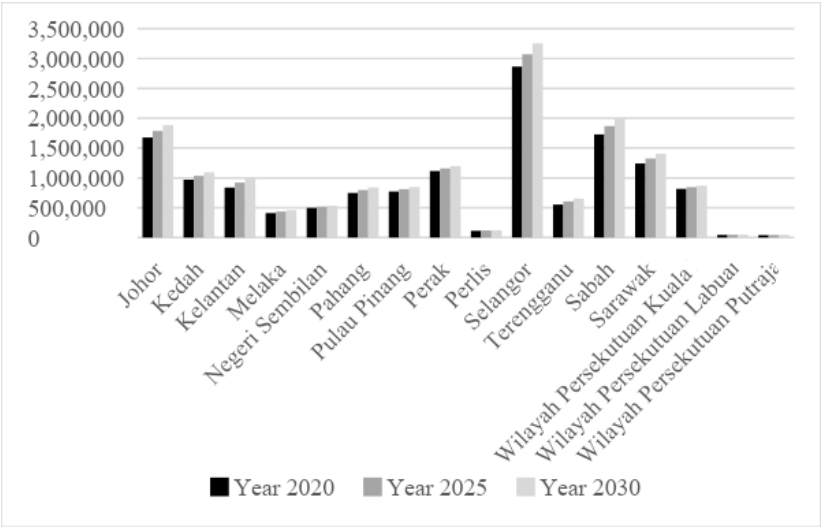

Fig. 5. Estimation of Solid Waste Generation by State in Malaysia (2020, 2025 & 2030)
Source: MAMPU (2019c).

The geographical areas of study will be pre-determined in accordance to zoning/under the management of Solid Waste Corporation Malaysia (SWCorp) as in **Fig.6**. In Peninsular Malaysia, only 7 areas are managed by this Corporation. This investigation will include recycling concept, recyclable materials and disposal method of domestic solid waste.

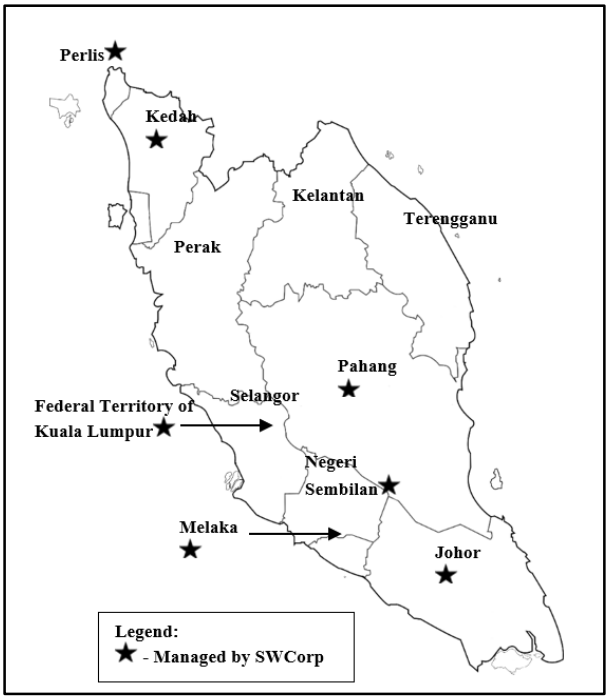

Fig. 6. Area under the Management of Solid Waste Corporation
Source: SWCorp (2020).

The investigation on greening the household solid waste management will focus on the reuse and recycling activities by residents in selected municipalities with high density of population in Malaysia. There are seven categories of recyclable waste in Malaysia namely plastic, paper, aluminium, glass, steel, battery (lead) and others. Plastic found to be the largest composition of recycled waste for the year 2014 to 2018 (**Fig 7**) (MAMPU 2019d). Second largest composition of recycled waste was paper and the least was battery (lead). Further investigation will be conducted as in the proposed methodology to promote recycling activities for domestic waste. This investigation will include concept of recycling, recyclable goods and methods of disposal for household solid waste.

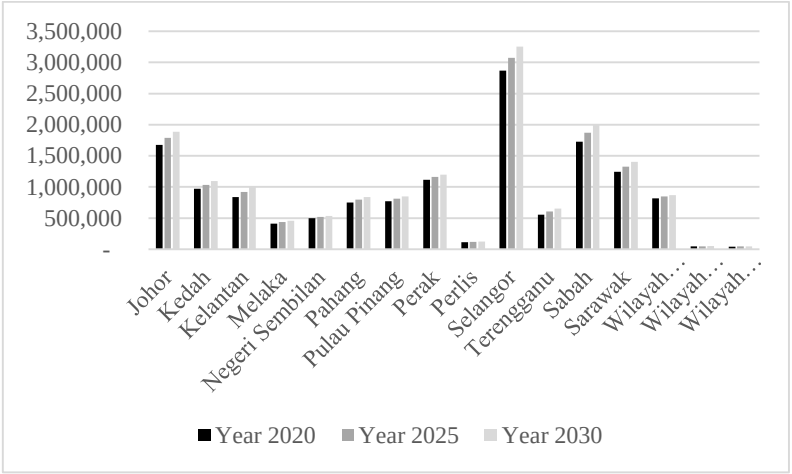

Fig. 7. Recycled Solid Waste Composition (Source: MAMPU, 2019d).

3.2 Fieldwork setting

The fieldwork setting will be divided into two categories. First is documenting and understanding the generic waste collection chain in the selected study area. The documentation will cover the recorded data of household waste for disposal and recyclable waste collected. Second is preparing the information brochures for green practices of domestic waste management for the intervention purpose. The information brochures will include waste management hierarchy and best practices of waste management. Therefore, this brochure becomes an additional guide to the public on how to sort domestic waste.

3.3 Experiment design and intervention

The experiment becomes a platform to guide and educate the residents on the green practices of managing household waste. This 'hands-on" practices will be closely monitored by the research team. The experiment involves baseline survey, interventions and monitoring.

a. Baseline survey (questionnaire to record the domestic waste disposal practices).

   Questionnaire survey on domestic waste management by the residents is to capture their current practices of reuse and recycling. The survey will inquire the waste generation frequency, waste disposal frequency, waste disposal method, types of domestic waste generated, and reuse or recycle methods applied at their home. The domestic waste generated will be weighed before "Interventions".

b. Interventions – There are three category of interventions will be conducted namely Information only; Information and norms; Information and monetary incentive. These interventions will be conducted to identify the current practices of households in managing their household waste. Different sample of housing scheme will be randomly chosen to receive any one of these interventions. The second weighing of household waste will be conducted to compare the effectiveness of the Interventions.

c. Monitoring (Treatment and control).
The monitoring will be conducted twice to evaluate the changes of behavioural of the household in managing waste. During the monitoring, the household waste will be weighed.

5. CONCLUSIONS

The expected findings from the proposed assesment will benefit the residents and local authorities. The residents will have a greener environment due to less pollution caused by household waste. Subsequently, the generation of employment and income due to recycling of household solid waste expected to rise. This initiative could positively enhance the economic distribution. The main potential benefit to local authorities will be easier to manage household solid waste when the reuse and recycling activities are increase. Cost saving for the collection and transportation of household waste disposed at landfill. The approach from this propose assessment can be directly shared with the potential beneficiaries through meetings, discussions, demonstration and any other dissemination of knowledge activities. The potential beneficiaries should be able to sustain the green practices in managing household solid waste after series of knowledge sharing. The identified green practices in reuse and recycling of domestic waste could indicate sustainable living in Malaysia. These good practices would minimize domestic waste generation. Thus, the Sustainable Development Goal could be achieved.

The examination of the existing waste generation patterns, and identification of the green practices applied at the domestic level is vital in greening the country. A strong understanding on the main influencing factors and decision-making mechanism of the residents is essential.

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DETERMINATION OF LANDSCAPE AESTHETIC VALUE IN DEVELOPING QUESTIONNAIRE SURVEY FOR CAMPUS PLANTING COMPOSITION

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ABSTRACT:
In landscape aesthetics, planting composition is significant in revitalizing the surrounding environment. Expert judgments are essential in landscape aesthetic decisions. This article examines the experts-based approach in assessing scenic beauty based on the objective paradigm. The objective paradigm has extensively used and recognized by the art and design-based professionals. The aim of this study is to determine the selected scene for landscape preference survey. The experts are selected from the landscape architecture field with knowledge in planting design, composition and other inherent physical features of the landscape. Those attributes are used to assess the physical quality of planting composition in the campus landscape. Using the Likert scale, 10 of the experts have rated the 95 photographs of campus planting area. The pictures were presented on a separate colour slide format as a mechanism to ascertain the visual preference of experts. The design of the questionnaire consists of the principles and elements of planting design. R programming was used as a method to analyze data. The findings show that the variety of plants based on the experts' choice with a high preference which equal to complexity. The results are useful in developing a questionnaire survey for campus planting design.

Key-words: *Planting composition, landscape aesthetic, expert, objective paradigm*

1. INTRODUCTION

In planting design practice, vegetation is an element that able to manipulate the varying level of landscape aesthetic quality in green spaces (Liu and Schroth, 2019; Soemardiono, Rachmawati, Ardianta and Nugroho, 2019). Planting is valuable to reduce carbon dioxide (Merry, Bettinger, Siry and Bowker, 2015). It can create a real modification in landscape aesthetic when the properties of plants are well accomplished with principles of planting design (Yilmaz, Özgüner and Mumcu, 2018). Thus, the designers able to guidance viewers' perception of aesthetic and increase satisfaction through planting design principles (Yilmaz et al., 2018). The judgment of the landscape aesthetic quality can be determined by using attributes and properties of vegetation such as shape and form, colour, scale, texture, composition, uniqueness, variety and unity (Lothian, 1999; Daniel, 2001; Jamilah and Nur Shazwani, 2014; Polat and Akay, 2015; Yilmaz et al., 2018). Based on these properties, one

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who is a highly skilled observer or expert can validate the impact of aesthetic for some landscapes area (Jamilah and Nur Shazwani, 2014). Besides, research that falls in this paradigm is mostly concerned with procedures for recognizing specific characteristics (Zube, Sell and Taylor, 1982) or objective measurement (Kuper, 2017).

1.1. The objective paradigm in perceiving landscape aesthetic

In this study, the objective measurement or also known as the objective paradigm, is concerned with the physical setting of planting design principles and elements within the context of the campus landscape. The principle of unity and variety may underlie all major principles in planting design (Robinson, 2004). Unity is similar to the design like coherence, which generates the harmony and balance in aesthetic, binds the overall elements into a unified design, and creates space with an orderly arrangement of planting (Robinson, 2004). While, variety is a related perception to complexity, and accomplished with a series of plants which comprises a diversity of planting design elements (Robinson, 2004). Principles and objectives that landscape designers and planners have been applying for the last several hundred years support the implication that coherence and complexity are essential to creating landscapes that people like (Kuper, 2017). Later, Liu and Schroth, (2019) conducted a survey where coherence, complexity and legibility are rated high for open landscape scene.

In the present paper, we propose to analyze the experts' determination of landscape aesthetic value in planting composition scene. Then, the findings will assist researchers in developing a survey for public perception based on experts' demand. In order to achieve the objective measures, the information processing theory by Kaplan and Kaplan (1989) is used in this study as a formal description with indicators like coherence, complexity, legibility and mystery. Thus we have chosen this theory as a preference factor concerning planting composition attributes. The methodical relevance of our study is related to measuring students' green spaces development on campus. This method should be the first step before developing a questionnaire survey to obtain a valid result and avoid misconception.

2. STUDY AREA

In recent years, there are numerous studies related to the campus landscape. Some of the scholars report campus landscape is able to improve health (Lau, Gou and Liu, 2014), learning ecosystem (Scholl and Gulwadi, 2018), academic performance (Kweon, Ellis, Lee and Jacobs, 2017), stress and mental fatigue (Li and Sullivan, 2016). The placement of vegetation throughout the campus has an incredible impact on how students psychologically relate to their university (Stepan, Schuster, Cole, Davision and McKay, 2014; Hipp, Gulwadi, Alves, and Sequeira, 2015). Therefore, the pattern of planting arrangement should include an emphasis on enhancing visual aesthetic quality within the campus landscape. However, the component of landscape properties such as planting composition has rarely discussed in campus landscape studies. Lipscomb and Rollings (2017) found that planting is a component in the workplace setting and is an important predictor for task performance as well as improving the well-being of workers.

In conjunction with previous studies, this research observed a campus with a large green space area. According to UI GreenMetric World University Ranking, Universiti Putra Malaysia (UPM) has been listed as one of the highest-ranking universities in Malaysia. The main campus of UPM is located in Serdang, Selangor Darul Ehsan (**Fig. 1**). UPM has a strategic location and can be categorized as a suburban area which is around 12 KM to

Putrajaya and 25 KM to Kuala Lumpur city centre. The boundary land covers an area of 1245.056 hectares (which covers from the north campus to the south campus). The north campus (**Fig. 2**) consists of academic and administrative buildings while the south campus comprises of college and sports centre area.

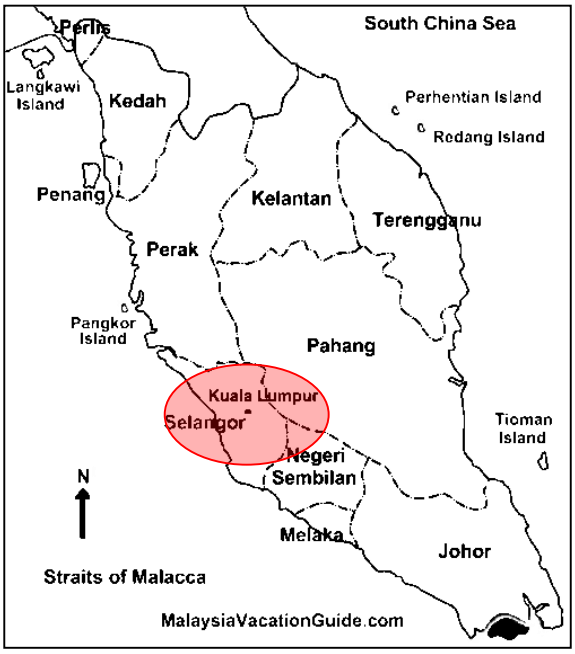

Fig. 1. UPM is situated in a suburban area in Selangor, Malaysia
(Source: MalaysiaVacationGuide.com)

Fig. 2. North campus is the main survey area in UPM which consists of academic and administrative buildings *(Source: https://akademik.upm.edu.my/dokumen/BGAKA1_NORTH_CAMPUS)*

UPM has 15 faculties offering a variety of academic programmes at its main campus. North campus is selected as the main study area in UPM because the students ultimately utilize the faculties. According to Hanan (2013), students are bound with places that they live in, study, play and move around from one activity to another on a daily basis. Each student has a home base around which his or her daily campus activities circulate (Hanan, 2013). She added, the home base is usually the students' major department, where they take most of their classes, meet their adviser, and attend departmental events. On that note, this survey has been conducted around all faculties in UPM Serdang.

3. METHODOLOGY

3.1. Photograph collection

This research used the photograph-based sampling (Daniel and Boster, 1976) as an evaluation method in the campus green spaces. The photographs were taken around the faculties green spaces that represent the vibrant spaces in the study area. The time control during the photo-shoot was between 9.00 a.m. to 11.00 a.m. and 2.00 p.m. to 4.00 p.m. The photos ideally taken in bright conditions with lots of sun (ideally sunny conditions), if in cloudy sky conditions, it must convince that the scene still gets enough sunlight (Lothian, 2000). Lothian (2000) also suggests avoiding taking photos too early in the morning or the late afternoon. The panoramic photograph (Polat and Akay, 2015; Hoyle, Hitchmough and Jorgensen, 2017; Yilmaz et al., 2018) employed in obtaining the planting scenes. Dupont, Antrop and Eetvelde (2014) reveal that people generate more fixations in panoramic photographs. A larger amount of fixations in the same observation time will increase the observer's capacity to recognize and memorise the scene Duchowski (2007).

The authors took a pool of 95 photographs. Photographs were shot more than one sceneries in a wide-ranging style that able captured the planting composition scenes. Pictures with similar planting compositions criteria should be excluded. Before that, the original photographs were stitched together to create panoramic view images using PhotoStitcher software. All the photographs taken used the Nikon DSLR camera with 18-105mm lens. Moreover, a mechanism to control all pictures taken was used tripod-based to balance the quality of images and angles. The tripod also assists the researcher to manage the view of planting on human eye-level. Then, the selection of images done through a discussion among experts that were invited by the researcher.

3.2. Planting composition survey

This article examines the contribution of an expert in assessing landscape planting based on the objective paradigm, which consists of elements and principles of planting design and concurrent with a preference matrix based on Kaplans' theory. The purpose of the expert assessment is to determine the selected planting scene before conducting a perception-based survey. This process is significant in understanding the content in each landscape scene via expert, coupled with people's perception. Indeed, this method was used to avoid bias in selecting the images for the survey. The relationship between principles of planting design and Kaplans' theory was used to develop the matrix. The matrix was developed to assess expert judgment on the visual properties of plants with design principles and Kaplans' preference matrix (**Table 1**).

Table 1.

The matrix relationship between planting design properties and information processing theory

Visual properties of plants (Robinson, 2004; Leszczynski, 1999)	Visual composition principles (Robinson, 2004; Bell, 2004)	Information processing theory (preference matrix) – (Kaplans, 1989)
Form **Texture**	Balance Order	→ Coherence
Colour **Line**	Harmony Contrast	→ Complexity
	Emphasis Scale	→ Legibility
	Rhythm Sequence	→ Mystery

Kaplan (1975) has recommended the aesthetic judgment of the landscape should embrace the pure evaluations by individuals with the required skills and value judgments, which are typically experts comprising landscape architects (Daniel and Vining, 1983). Evaluations made by ten experts who randomly selected from landscape architecture departments. Five of them are corporate members of landscape architect and the other five experts possess more than five years of teaching experience in planting design courses. They also have a PhD degree in landscape architecture.

In the expert-based method, the structures of plants usually assessed according to form, line, scale, emphasis, contrast and other formal attributes in planting design which regarded to be indicators of landscape quality (Daniel, 2001; Yilmaz et al., 2017). In this research, a similar scheme has applied to evaluate planting composition. **Fig. 3** shows an example of the form used in this survey. The experts were asked to assess each planting photographs based on the Likert scale. The assessment was conducted using a five-point Likert scale ranging from 1 = 'very poor' to 5 = 'excellent' (Gerstenberg and Hofmann, 2016; Polat & Akay, 2015; Raskovic and Decker, 2015). The five-point scale can provide immediate response and eliminate any lengthy decision by respondents (Noriah, 2004). Typically, a scale which exceeds five points would be too complex for the respondents to make fine judgment towards particular questions.

All photographs were provided on a separated colour slides format and shown on an LCD screen. The experts were briefed to choose the best pictures to be selected or removed. The selection is useful in assisting the researcher in developing a questionnaire for a real survey later. From the 95 photographs taken, experts have voted 51 images which are considered appropriate for perception-based assessment. Experts have selected the 51 pictures due to the content of planting composition, quality of photographs, better angles of panoramic views and less redundancy or similar criteria of planting design. The collected data analyzed with the R Programming Software because of the ability of this software to analyze big data. The frequency value of rating evaluation has been calculated. Following the expert evaluations, the results visualized on photo analysis. As a result, planting composition attributes determined as contributors in the assessment of landscape aesthetic quality for campus green spaces.

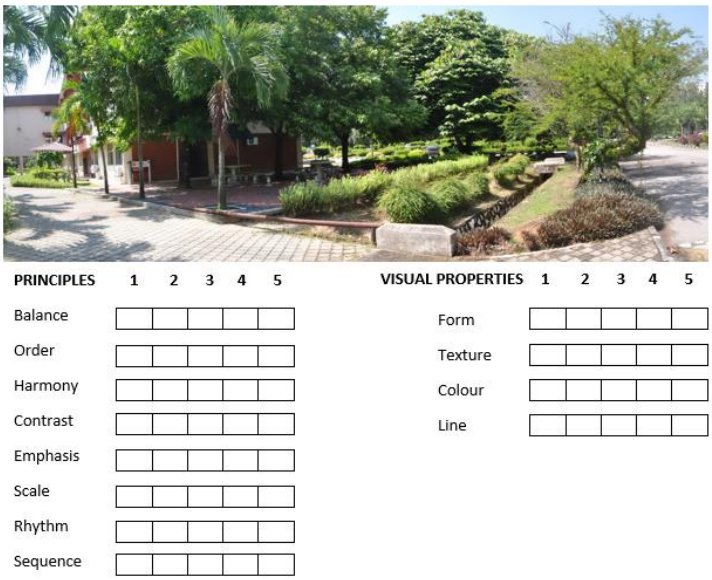

Fig. 3. The example of assessment form for campus planting composition scene

4. RESULTS AND DISCUSSIONS

There were 51 photographs chosen by ten experts. The experts have a similar opinion on 16 images. Albeit some experts have rated different scale for different principles, but all of them have selected these 16 images. The images shown here are some examples of the images which all experts agreed to be included in the real questionnaire later. The characteristics of these examples reflect the coherence and complexity design as the dominant selection. The variety of forms and textures clearly demonstrated in the images (**Fig. 4**). As supported by Robinson (2004), variety is the principle that is related to complexity, which can be succeeded with a series of plants species and cultivars, as shown in **Fig. 5**. While coherence is the theory that extends from the repetition element and the presence of balance and order arrangement (**Fig. 6**).

Fig. 4. The example of campus planting composition scene with a variety of forms and textures

Fig. 5. The example of campus green space with a different range of plant species and cultivars

Fig. 6. The campus planting design with coherence setting which extends from the repetition element and the presence of balance and order arrangement

Concerning Kaplan and Kaplan (1989) definition on the variables of aesthetic preference, the viewers′ evaluate coherence as the pleasantness of the views, complexity as the functional setting, and legibility as the orientation able to assist at the planting design stage. These three examples reflect the experts' evaluation towards landscape aesthetic in planting composition for campus landscape design. Open spaces like **Fig. 6** or enclosed spaces create different effects on visual and encourage diverse aesthetic experiences (Liu and Schroth, 2019). This planting scene is the highest rating because it is highly visible, well-structured and provides a pleasant view (Liu and Schroth, 2019).

Fig. 7 shows the distribution principles of planting composition attributes for mostly agreeable photographs by all experts. The figure shows that 16 images have been highly rated with balance and harmony, and moderately rated with emphasis and scale. Balance and harmony have been discussed earlier as having similar criteria with coherence and complexity design. The findings show that most of the characteristics of planting composition in this context exhibited that complexity and coherence are the major contributors to visual aesthetic quality.

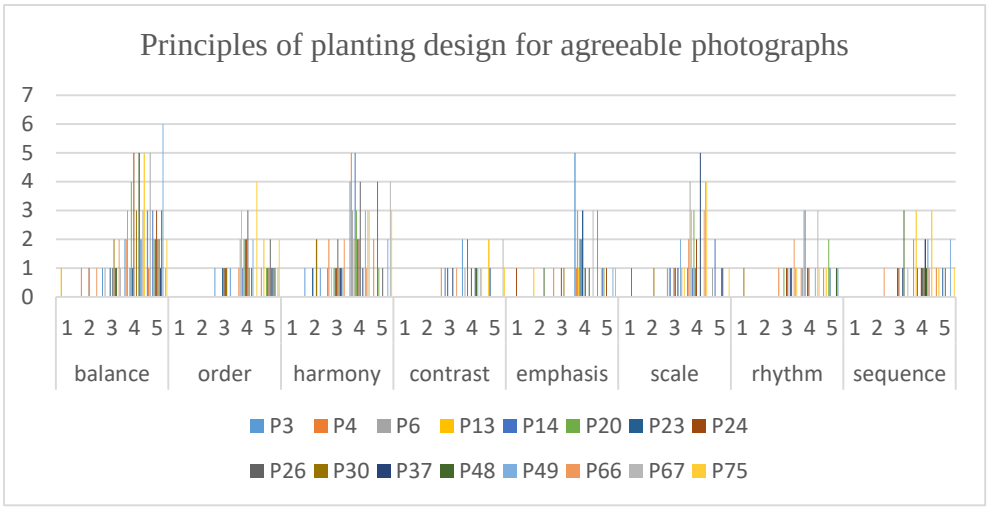

Fig. 7. The 16 photographs with all experts voted for campus planting composition scene

Based on these results, we can determine that planting composition attributes such as balance and variety of planting elements couple with order arrangement are the visual predictor towards landscape aesthetic rating by skills judgments.

5. CONCLUSION

Landscape aesthetic studies have identified a variety of ways in which they can be classified by the objectivist and subjectivist paradigms. This paper presented an objective paradigm which should be used to classify the perception studies at a fundamental level. Basically, this paradigm contrasts in viewing landscape quality as an inherent physical attribute. The physical attribute involves formal aesthetic values such as form, texture, colour, balance, order, rhythm, harmony, and complexity. These attributes can be viewed in objectivist terms by experts. The findings show the objective characteristics of planting scene achieve a high rating, which includes coherence and complexity that are related to the principles of balance and harmony and have found to be a major contributor in the planting composition in the campus green spaces. Along with preference rating, complexity and variety of plants are the experts' choice. The results are useful in developing another research to compare the public response in identifying the most preferred planting composition which is able to influence the well-being of people and society in general.

Acknowledgement

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USING GIS TO MAPPING DISSEMINATION AND PREDICTION OF POPULATION IN BANDUNG CITY

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ABSTRACT :
Bandung, the capital of West Java, is the province with the largest population in Indonesia.Urban development is then interrelated with the number, structure, dynamics of the population, also the size of the area. The pattern of population distribution is an important point for the government in determining a City's Spatial Plan. Thus, this study aims to build a mapping system for population distribution and prediction in Bandung City, Indonesia. It will be very beneficial for the government, especially in making decisions for planning an area. The system implemented using the Google Maps platform APIs and the method of calculating Geometric models and processed data is data obtained from the Central Bureau of Statistics of the city of Bandung in the form of a sub-district catalogue in the reprocessed numbers. The results of the data processing are visualized into the Geographic Information System Web with information features in the form of population mapping, density, and prediction of the future population for each sub-district in the city of Bandung. Based on the results of testing the implementation of the Geometry model with the Black box method, the system's functionality has shown the appropriate results.

Key-words: *GIS, population prediction, Bandung, Geometric Method*

1. INTRODUCTION

Bandung is the capital city of West Java Province, the most populous province in Indonesia. The population growth rate in Bandung hits 1.06% a year. By carrying out the Smart City concept, the City of Bandung continues to strive to develop information and communication technology infrastructure in various fields, including government, transportation, environment, finance, education, health, security, community development, trade, and business, also known as e-government. Those concept as a model of government service by utilizing information and communication technology resources to serve the needs of the community (Howard, 2001). In addition to carrying the Smart City concept, the city of Bandung itself has a lot of attraction which is the cause of the movement of people from the villages and from outside the area to the city so that it is difficult to control and resulted in an increase in the population of each sub-district in the city. Population density often causes problems in spatial arrangement due to the large population pressure on land (Malik, Suparta, & Dewancker, 2019). In areas with dense population and uneven distribution, it will face problems such as housing problems, employment problems, education problems, food problems, security problems and can have an impact on environmental damage. Previous study about compact city in Bandung shows that Sub-district of Cibeunying becomes the

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center of public facilities. It led the concentration of density and activity, which finally raising the slum and overcrowded settlement (Paramita, 2016). This is also inline with the study in Namibia, South Africa that the complex spatial structures constructed by density, urban development and a mixture of human activity as well as high population mobility has successfully developed (Zee and Jong, 1999).

These problems can be more easily solved by the existence of a system, for example making a site or web based on the Geographic information system (GIS) where population data, population density, and prediction are made in the form of web-based mapping that can facilitate access to data and information. Observation of patterns of population distribution in an area is used so that the government can make the right decision to carry out development in the area in accordance with the existing population. The importance of population distribution in the form of mapping can be useful to demonstrate changes in the human population (Chen *et al.*, 2018). An information system in the form of an urban hazard information infrastructure (UHII) as data management for spatial decision-making, controlling urban development, and emergency response planning in the city of Windhoek

Data and information about population conditions such as population and projections in an area are needed in the framework of development planning in all fields. By knowing the number of needs in the future, the government can take policies or plan in providing land for settlements so that the development of settlements and other aspects in the future does not violate their designation and in accordance with the city's spatial plan. The use of GIS and Database Management System (DBMS) later created to gain an easier management, storage and review of data (Costantino et al., 2016). It is able to give information in different ways by represent a useful basis and an operative support. For example, a GIS called the Douglas County Emergency Management Agency (DCEMA) was developed to maintain and implement an integrated emergency management system where GIS act as decision-makers to develop a flood impact assessment and project the possibilities (Gunes & Kovel, 2000).

GIS stores georeferenced historical maps and it is able for assessing its development changes due both to natural or catastrophic events such as earthquakes (Baiocchi et al., 2013; Brigante & Radicioni, 2014). The study in the city of Cardiff as the capital city of the state of Wales, UK examines the effect of alternative population distribution models on the analysis of the spatial accessibility of GIS. It shows variation inaccessibility of the number of public services in the city where the results of these tests are used to inform city planning, provision of public facilities, and allocation of spatial financial resources (Langford et al., 2008). Mapping the quality of education through the education facilities location with GIS in order to make improvements and to increase public awareness of the importance of education (Shah & Nerurkar, 2012; Harison & Syarif, 2016). Mapping of distribution and analysis was also carried out for agricultural land. The results in the form of web-based, geographic information can display information on agricultural results, rainfall, and land height from sea level. This information is beneficial to analyze the soil types then to recommend the agricultural products (Rahmawati, Saputra & Sugiharto, 2014; Susanto, Kharis & Khotimah, 2016). The population projection is carried out aimed at assessing the level of population density and its distribution and reviewing population projections and housing needs. The level of population density is calculated based on the population per settlement area and the calculation of population projections is done using geometric methods. This method is used because the data on fertility (birth) and mortality is limited so that it is assumed that the factors that influence the growth of the permanent population are the same growth rates for each year.

2. METHODS

The research design is a depiction of the steps taken in conducting a research, the design in this study can be seen in **Fig. 1**. Starting from a literature study on previous research, continued with quantitative data collection and spatial data in Bandung city, then system requirements analysis to support research, system design includes the design process in the system and system interfaces, implementation of system design results with map digitization, database, and coding program, enter the stage of testing and analysis of test results to determine the system's functionality.

For the data obtained from the catalog such as sub-districts in the numbers derived from the city Central Statistics Agency and also some data obtained from the website of each sub-district in the city of Bandung for the past five years from 2013-2017 with a total of 150 reprocessed data and spatial data of Bandung city and its sub-districts in the form of coordinate points. The following population data numbers 2017 are used as a reference to project the population that will come to **Table 1**.

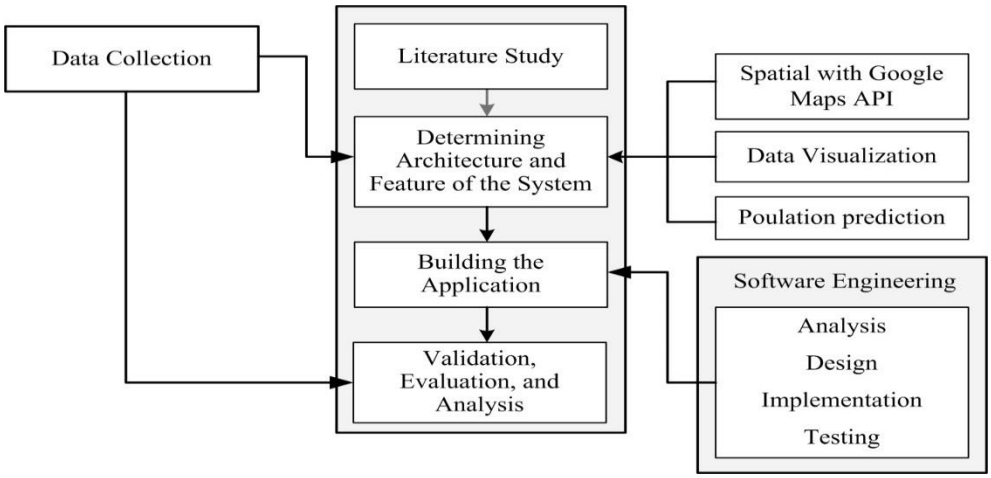

Fig. 1. The framework of dissemination and pediction of population using GIS.

To present the results of calculations in the form of mapping, it is necessary to configure the spatial data in the form of layers in the local database with the Google maps API server so that the results can be seen in the browser. Google maps API is used because Google maps have an API that can be easily used for web-based GIS applications or webgis as a base map or base map so that applications can be easily developed again and Google maps feature that is always updated every time.

Before configuring the layer, it is necessary to have a class identification which is then used to determine the interval of data that has been obtained so that it can be displayed in the form of statistics that are interpreted in the form of coloring so that the user can easily read information about the situation from the amount of population distribution. In determining the class must be known the amount of data to be processed, and then turned into Sturges formula as follows:

$$class = 1 + 3.3 \log(n) \tag{1}$$

Table 1.

Population on Bandung in 2017.

Names of districts	Population	Names of districts	Population
Andir	104.962	Cicendo	98.324
Antapani	74.557	Cidadap	49.931
Arcamanik	46.774	Cinambo	23.376
Astanaanyar	70.205	Coblong	113.89
Babakan Ciparay	114.265	Gedebage	33.198
Bandung Kidul	47.956	Kiaracondong	142.342
Bandung Kulon	143.313	Lengkong	71.333
Bandung Wetan	38.066	Mandalajati	63.147
Batununggal	114.330	Panyileukan	35.040
Bojongloa Kaler	119.025	Rancasari	67.483
Bojongloa Kidul	47.956	Regol	83.404
Buahbatu	89.555	Sukajadi	108.892
Cibeunying Kaler	87.068	Sukasari	80.971
Cibeunying Kidul	87.068	Sumur Bandung	34.411
Cibiru	61.707	Ujung Berung	75.477

Source: Bandung in Figure 2017

For example, the number of classes obtained based on formula (1) with the number of data (n) of 30 districts in the city of Bandung is obtained $5.78 \cong 6$ classes. Then determine the interval for each class to be easier in classifying each region to be interpreted in color. So that the user can read information related to population density according to the interval interpreted into the color. Intervals are determined by the following formula:

$$Intervals = \frac{Max - Min}{Number\ of\ Class} \tag{2}$$

The minimum value is obtained from the minimum population in 2017, while the maximum data is obtained from the prediction of the largest population in the projection period of the next 30 years. There are several ways to project the future population including using mathematical methods and component methods. In this study using mathematical methods in calculating population projections using geometric methods, geometric methods are used because of the assumption that the population will increase geometrically using the basis of compound interest calculations. In other words, the gradual growth takes into account population growth only at the end of the year from a period. The following formula is used in calculating geometric methods:

$$P_t = P_0(1 + r)^{\,t} \tag{3}$$

where P_t is population in year t, P_0 is population in the base year, r is population growth rate, and t is the time period between base year and year t (in year).

If the minimum and maximum value has been determined and has determined the interval for each class then it will be entered into the frequency distribution table for the distribution of population obtained based on the calculation results with the number of classes (K) 6 and the number of population intervals in each class totaling 33,619.05.

3. RESULT AND DISCUSSION

3.1. The Architecture of System

In web-based geographic information to be able to communicate with different components in the web environment, a web server is needed. Because the standard of geo data is different and very specific, the development of the system architecture follows the Client Server architecture. **Fig. 2** shows the geographic information system architecture. The application is on the client side that communicates with the server as a data provider through web protocols such as Hyper Text Transfer Protocol (HTTP). The Web Server is responsible for the request process from the client and sends a response to the response. In web architecture, a web server also manages communication with server-side GIS Components. In this case, the GoogleMaps API server is responsible for connections to spatial databases such as translating queries and making representations passed to the server. To manage geographic data, a DBMS is needed by using a database server such as xampp. In this case, object-oriented modeling is also needed because relational database modeling is not able to store geospatial object data consisting of spatial data information and non-spatial data. Spatial information can be visualized by converting it to Virtual Reality Modeling Language (VRML) and non-spatial data is displayed dynamically in the Hypertext Markup Language (HTML).

When the client requests, the connection is made to the DBMS, then the spatial information selected from DBMS is converted into VRML and the Plug-In Browser on the client side displays VRML output as output become a map.

3.2. Implementation

In this study, the end result was in the form of a GIS mapping the distribution and prediction of the population in the web-based city of Bandung as follows:

a. Homepage interface

When the system is first accessed, the system raises the main page, the page is displayed in **Fig. 3.** Basically it shows the name of the system, the navigation bar, Bandung's view along with a short description of Bandung, and an icon about system information.

b. Modeling page interface

The next page is the modeling page, which is shown in **Fig. 4**, and this page contains a line chart of information on population growth in each sub-district in the city of Bandung by presenting information every two years. So, it is a part of visualization data used in the modeling and prediction for the population growth. It can be seen that we can choose the visualization types based on district or year.

c. Prediction page interface

This page contains information about the prediction of the sub-district population in the city of Bandung which is presented with information in the form of mapping (**Fig. 5**). There is also a comparison year button and the year of prediction, which is the comparison year button to display information on the population in each sub-district in Bandung in the previous year and the predictive button to display prediction information on population numbers in sub-districts in Bandung City based on the number of years of prediction chosen. As well as a popup that displays information about the population in the sub-district by clicking on the map of the sub-district selected.

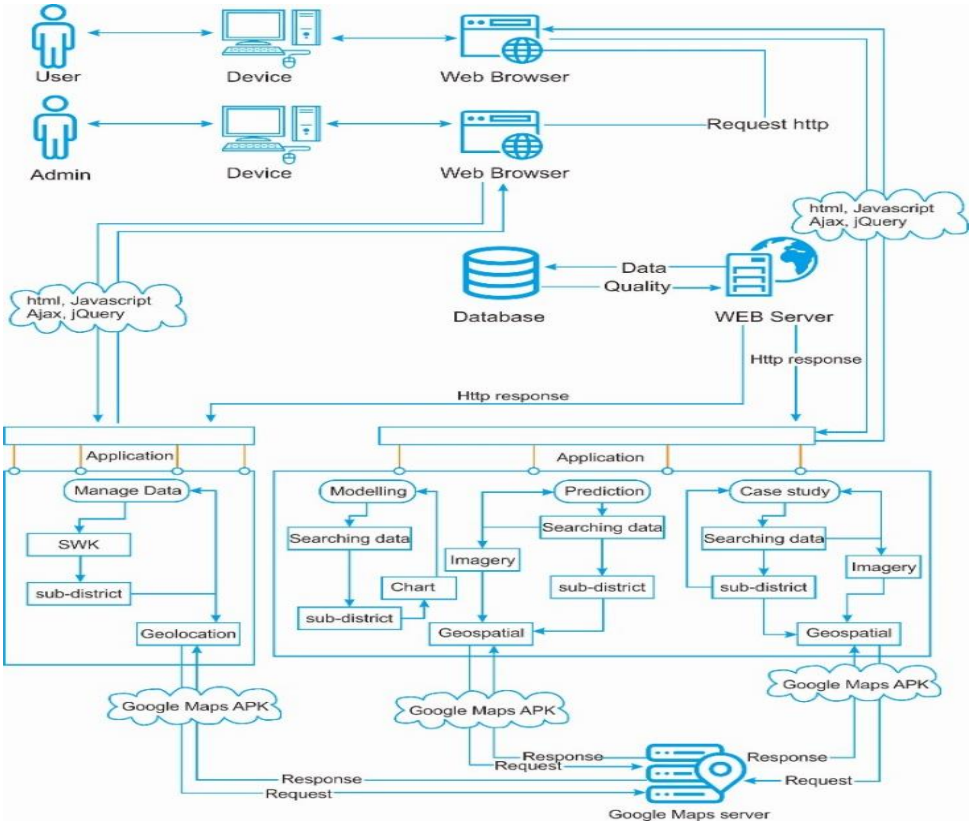

Fig. 2. The architecture of GIS for dissemination and prediction of population in Bandung.

Fig. 3. Implementation of the homepage interface of the system.

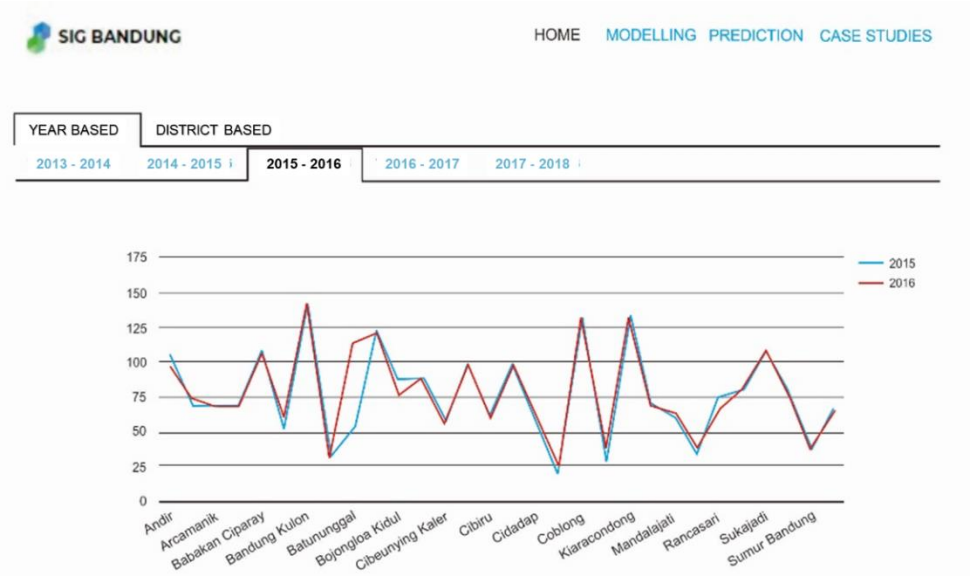

Fig. 4. The population growth in some sub-district in Bandung in 2015 and 2016.

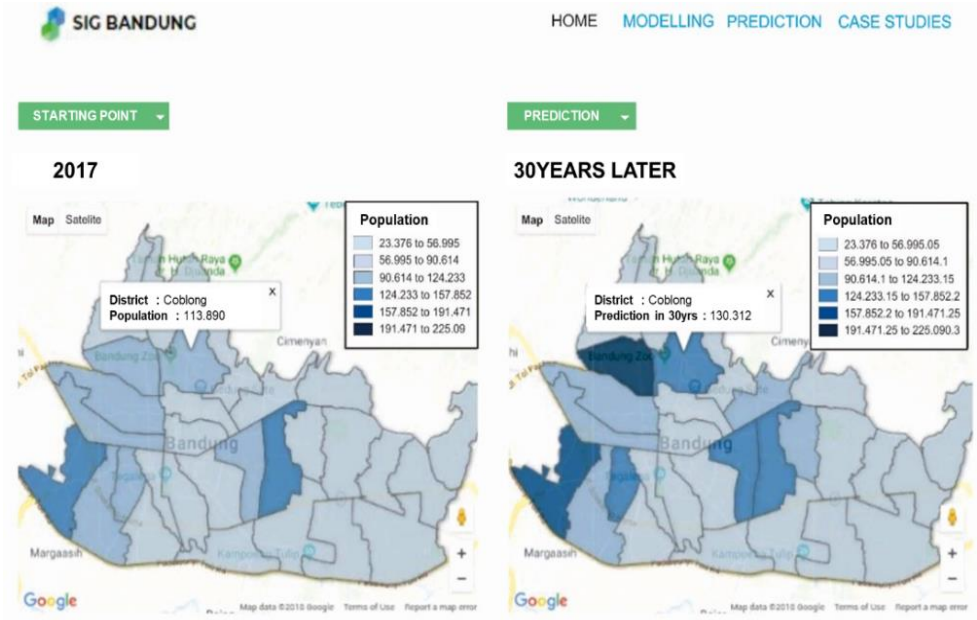

Fig. 5. Implementation of the Prediction page interface.

It can be seen that there are two following maps built in the spatial mode: population on a specific year (e.g., in 2017) and longterm prediction of the population growth (e.g., next 30 years). On the left map users can click on a particular district to visualize its chosen population while on the right one we show the prediction map. We can see on Fig. 5 that population growth is represented by changing color, which is darker color.

d. Interface page for case studies

Next is the case study page as shown in **Fig. 6**. This page contains information about density in each sub-district in Bandung City, as well as sub-district information based on the year presented in **Table 1**. Basically, **Fig. 6** presents a comparison between the population and the area. Then, we represent the density on spatial map with different colors. The detailed data can also be seen in the table below on the map.

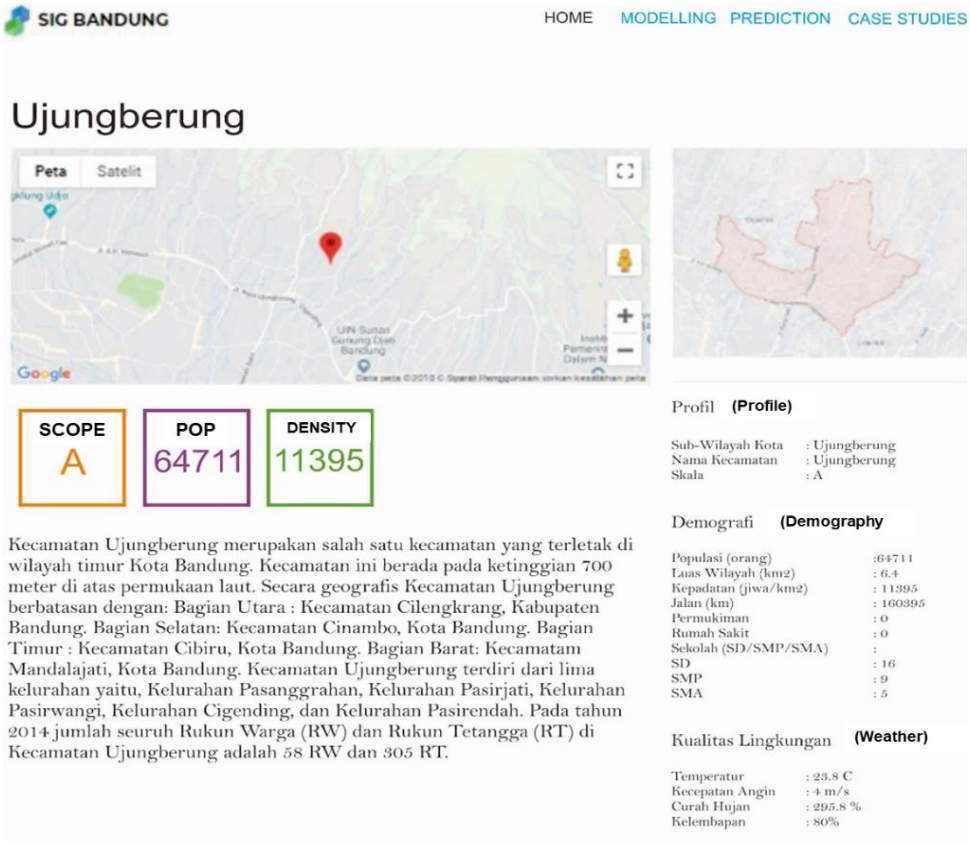

Fig. 6. Visualization of the density on some district in Bandung.

e. Interface the detail page of Case Studies

Detail page for a case study is presented in **Fig. 7** which contains detailed information in each sub-district in the city of Bandung, i.e. a map of sub-district locations, sub-district boundaries, sub-district scale, sub-district population, sub-district density, sub-district description, sub-district profile, sub-district demography, and environmental quality in the selected sub-district as shown above. It can be seen for this case, the sub-district "Ujungberung" has the scale A, 64,711 for the population, and round 11,396 for the density (i.e., calculating from people/km^2). Moreover, other relevant information is presented as well in this page, such as the numbers of facilities, environment quality, etc.

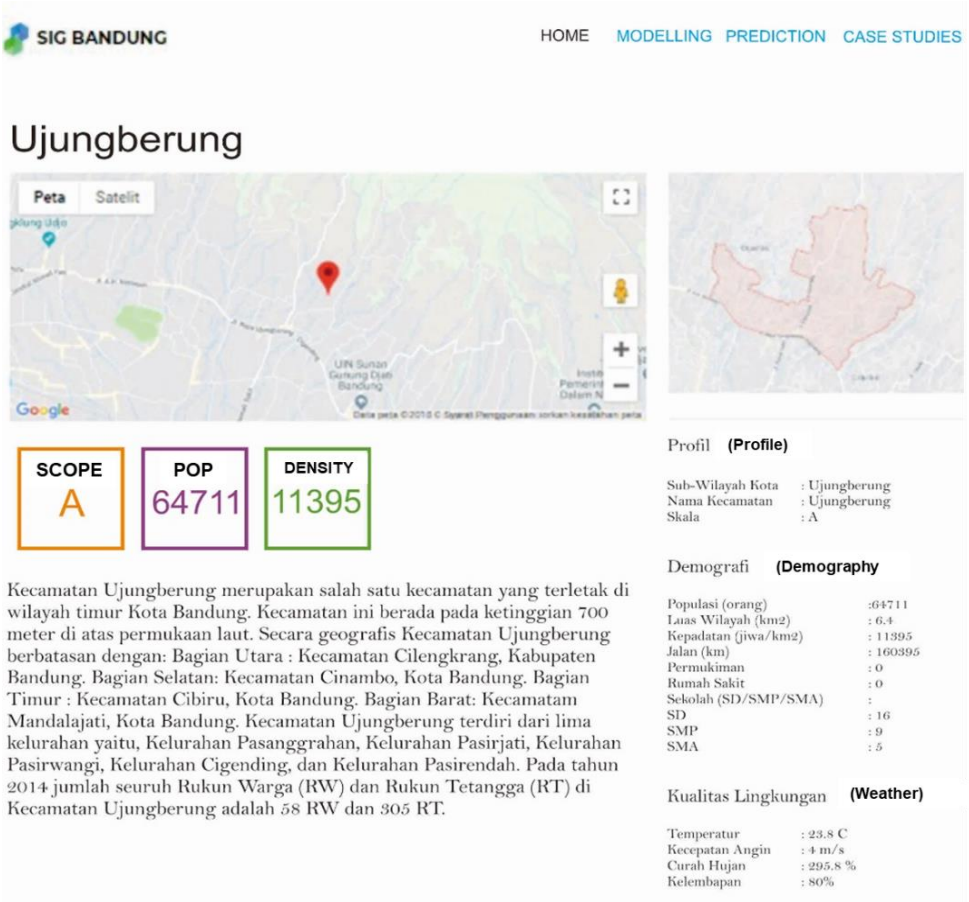

Fig. 7. The resume page about population, density, and other information for the sub-district "Ujungberung" in Bandung.

4. CONCLUSION

A GIS mapping the distribution and prediction of the population in the city of Bandung using a web-based biometric model has been made in accordance with the analysis and design. Application specifications that are built consisting of a prediction feature of the population in all districts in the city of Bandung automatically using Geometric methods. A webgis technology is used to visualize the distribution map of population results, population density, and a comparison map between existing population distribution maps. The application can also predictive maps that show changes in the distribution of population distribution in the city of Bandung. In the future, the application will be enhanced to facilitate the process of observing the population distribution and prediction in Bandung city area. Those application will be useful as the spatial decision that outlined in the spatial planning and territory (RTRW) of Bandung.

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THE JAKARTA TOD MODEL APPLICATION FOR TYPOLOGY OF MIDDLE CITIES (APPLIED RESEARCH DESIGN IN KUPANG CITY)

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ABSTRACT:
Realizing the vision of sustainable cities in Indonesia is a necessity. The Indonesian government continues to encourage all parties making various approaches to solving the urban problems to create a livable city in 2045. The TOD is widely recognized by researchers as one of the most feasible and comprehensive sustainable planning approaches. In Indonesia, only Jakarta has begun implementing TOD since 2017. This study aims to obtain respondents' perceptions (government, business actors, and experts) to assess the alignment of the Jakarta TOD Model compared with the key success factor of TOD best practice, also in line with the principles of urban transportation sustainable development. This analysis is quantitative descriptive for hypothesis testing uses non-parametric statistical tests: Independent and Bayesian One-Sample T-Test. The results of the analysis show us that the Jakarta TOD Application Model is not in line yet with the principles of urban and transportation sustainable development. This is caused by several factors of Bayes interpretation. Refers to the result of variable Large Bayes effect analysis (based on Cohen's value d), its need to be re-arrangement some regulations and/or policies by considering: an institutional improvement, integrated planning, definition of TOD, partnership patterns, development strategy, sustainable and inclusive development goals.

Key-words: *Urban Sustainable, Sustainable Transportation, TOD, Independent and Bayesian One-Sample T-Test*

1. INTRODUCTION

The Government of the Republic of Indonesia, through the Ministry of National Development Planning/NDPA, had been formulated a National Urban Policy Framework and disseminated in October 2018, establishing the Indonesian Urban Vision is "Sustainable Cities 2045: Inclusive, Prosperous, Green and Resilient" (Ministry of National Development Planning, 2018). Various results of the literature review from the perspective of transportation, the experts stated that almost all major cities around the world currently are developing urban transportation systems through the Transit-Oriented Development (TOD) concept approach, as a part of the implementation of sustainable cities. The main issue is a compact city, by prioritizing the public transportation and walking or cycling transportation systems as the backbone.

The rapid rate of uncontrolled urbanization has caused cities to continue to develop dynamically and sometimes develop uncontrollably (sprawl), especially urban areas in

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developing countries. Besides urbanization, urban sprawl has positive and negative impacts for a citizen, as well as the economy, culture, and environment, clean water, transportation needs, food security, energy, etc. This gives the impression of a city that is chaotic (slum) and not livable (Giduthuri, 2015). Urbanism raises issues of land use, transportation, and the urban environment (Motieyan and Mesgari, 2017). In developing countries, the population density of urban areas will increase if it's close to the location of economic activity, which is the city center and will decrease when it's far from the city center (Malik, Suparta and Dewancker, 2019).

To overcome this problem, urban planners apply a planning approach in an integrated and integrated manner and are more compatible with the goals of sustainable development. Urban planners agree that the challenges of urban development are an urgent need to achieve sustainable development goals. The most basic thing is that it requires the active participation and involvement of the local urban population. However, the approach is complex and multidimensional. Intensive collaborative research between urban planners, architects, designers and infrastructure managers is needed to produce a concept and outcome of sustainable urban development comprehensively (Kabisch, 2019). One proof that active community participation is a key success factor in creating and developing dense urban areas that are when developing a dense old city through sustainable urban landscape approaches such as Kembang Jepun in Surabaya (Soemardiono *et al.*, 2019)

Discussing urban development, the national and regional levels of governments must be directed to improve the quality of public transportation services due to the high use of private vehicles in urban areas (Wei and Ewing, 2018). The development of transportation infrastructure cannot be separated from the consumption of land use, impacts on environmental damage, and social dislocation (Bagheri and Tousi, 2018). The process should be starting from re-evaluating the factors and sustainability key performance of each transport infrastructure project and reviewing the framework of the relationship between sustainable development factors and the performance of infrastructure projects (Amiril *et al.*, 2014). Therefore, the government needs to make serious efforts in applying the concept of sustainable transportation development as an important factor, and also serious for promoting the implementation of sustainable development strategies in the field of transportation, especially in urban areas.

The Transit-Oriented Development (TOD) approach is widely recognized by researchers as one of the most feasible and comprehensive sustainable planning approaches (Motieyan and Mesgari, 2017). The results of a review of several kinds of literatures are known that most modern and developed cities in the world today are starting to apply the TOD Model as one of the appropriate transportation management approaches in implementing traffic demand management. In the context of sustainable cities, TOD approaches were able to increase mobility and expedite traffic (Guerra *et al.*, 2018), but must be supported by structuring the city structure and the pattern of the use of urban and/or regional spatial layout properly (Liu *et al.*, 2018). The application of TOD in various regions still has many very striking gaps because each region has different natural characteristics, social, economic, cultural, and environmental factors. However, all experts agree that the principle of sustainable transportation intervened through the TOD approach can reduce private car dependency (Akbari *et al.*, 2018).

Some research result show that the application of TOD still reaps various challenge factors in various countries, including (1) factors of socio-cultural characteristics of the community of urban areas; (2) political and local government policies, especially non-compliance in implementing regulations, including the potential for high personal and group

interests and policies that tend to be ego-sectorial, other than because of political conflicts therein; (3) land ownership is also potentially hamper the application of TOD due to multiple-choice, disputed land, land brokerage, uncontrolled selling prices; (4) the distance of settlements and transit points in high-temperature coastal areas results in people reluctant to walk; (5) the availability of on-line transportation modes is increasingly prevalent in door-to-door service, caused people just wait to be picked up and/or delivered (Thomas *et al.*, 2018 ; Thomas, Rao and Sohoni, 2017 ; Pan *et al.*, 2017), etc. Based on this, it's necessary to consider implementing TOD Model in other cities in Indonesia.

2. STUDY AREA AND DATA

In Indonesia, only one Regional Government that already has Regulations on the application of TOD, it is the Provincial Government of DKI Jakarta. This is stated in DKI Jakarta Governor Regulation Number 44 the Year 2017 about Development of Transit Oriented Development Areas and then revised through the DKI Jakarta Governor Regulation Number 67 the Year 2019 about the Implementation of Transit-Oriented Areas. The Jakarta TOD Model had been applied in Palembang City but is not optimal yet. Some questions arise, why has the Jakarta TOD Model failed to be implemented in Palembang City? Did the Jakarta TOD Model in line with TOD best practices and relevant to the concept of sustainable city development? This is the driving force for this research.

Jakarta, as the capital of the Republic of Indonesia, is developing very rapidly. The number of private transportations in Jakarta is more than 18.6 million vehicles. Public transport users in Jakarta only reach 24%. The number of movements in Jabodetabek is around 47.5 million. The Jakarta Central Bureau of Statistics (BPS) data Year 2015 shows that every day there are around 1.4 million commuters from the area around the Capital City. The rapid and uncontrolled trend of expansion in the Jakarta-Bodetabek area has significantly increased transportation costs, reduced the level of mobility, and reduced the quality of life of its residents.

The rapid and uncontrolled development of the cities of Jakarta and Bodetabek is largely due to the construction of low-floor settlements (almost 64% of the total Jakarta area) and low-rise buildings cause high land consumption in Jakarta. As a result, Jakarta currently does not have enough space for future development. Now, it's time for Jakarta to change its development paradigm, no longer oriented to the use of private vehicles (especially cars), but rather to pedestrians and mass public vehicles. These changes not only stop at providing an adequate mass transportation system but also the concept of urban development which must provide convenience and comfort for its inhabitants, including regional staging, passenger flow, and intermodal integration.

TOD is an urban area that is designed to integrate transit functions with humans, activities, buildings, and public spaces that aim to optimize access to public transportation so that it can support the carrying capacity of the passenger. The issue of the city of Jakarta is what drives PT MRT Jakarta to develop the concept of transit-oriented or transit-oriented development (TOD) in several stations, for phase 1 is the South-North corridor of 13 TOD Areas (**Fig.1**).

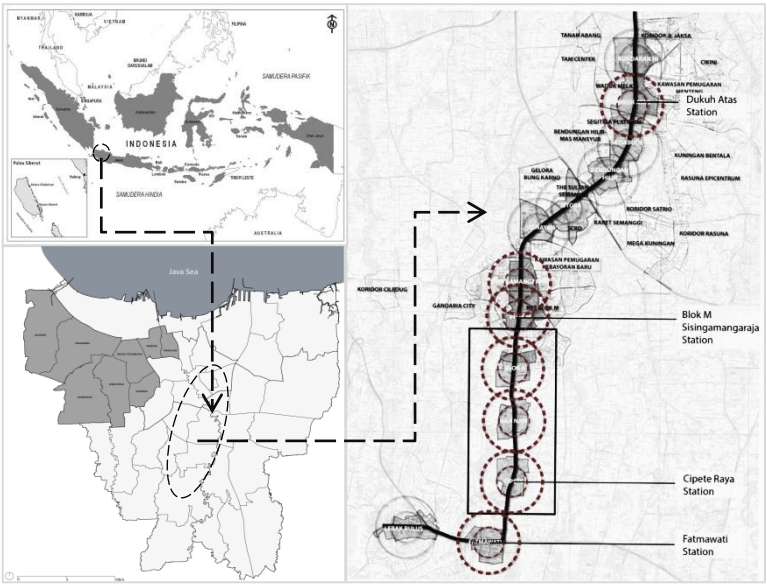

Fig.1. Indonesian countries and Jakarta City (left) and Jakarta TOD Model (right). (*Source: https://www.jakartamrt.co.id/konektivitas/transit-oriented-development-tod/).*

As additional information, the existing condition of most cities in Indonesia indicates the low standard of urban services. The indicators are many urban slums, drinking water, and poor sanitation services, high urbanization, increased use of private vehicles, low urban public transport services, the environmental carrying capacity of urban areas are decreasing. This is profaning that the development of cities in Indonesia has not pointed yet to the concept of sustainable cities. Studied from the Jakarta TOD Model, the authors are interested to conduct an applied research TOD model for a typology of medium cities that has the potential to develop into a large city or metropolitan city. This is important because the analysis of NDPA in 2018 predicts that in 2050 a total number of 13 cities in Indonesia will change from the typology of medium cities to metropolitan cities, one of them is Kupang City. Also, cities in Indonesia will be dominated by cities with the typology of the medium city as much as 62%.

3. METHODOLOGY

First of all, it needs to be understood that this study aims to obtain respondents' perceptions (by the government, business actors, and experts) to assess the alignment of the Jakarta TOD Model Application compared by the key success variables or best practice of TOD implementation. Based on the results of literature reviews, seminars, and forum group discussion, we summarized there are have 8 key variables (latent variables) of the best practice of TOD principle's that are: (1) definition of TOD, (2) location suitability, (3) development strategy, (4) integrated plans, (5) institutional, (6) partnerships, (7) inclusive goals, and (8) sustainable development.

Perceptual assessment for the Jakarta TOD Model application is done through hypothesis testing uses non-parametric statistical tests, which is:

H_0 = if the Jakarta TOD Model Application is in line with the principle of urban and transportation sustainable development

H_1 = if the Jakarta TOD Model Application is not in line yet with the principle of urban and transportation sustainable development

given that amount of data N < 30, the hypothesis formula, used are:

$$H_0 = \text{accepted if } -t_{a/2} \leq t_o \leq t_{a/2}$$

$$H_1 = \text{accepted if } -t_0 < -t_{a/2} \text{ or } t_0 > t_{a/2}$$

for conditions where H_0: $\mu_1 = \mu_2$ and H_1: $\mu_1 \neq \mu_2$

Furthermore, for measuring variables empirically (observed variables) or indicators using discrete variables as a result of respondents' perceptions of the questions outlined in the questioner then given a value based on a Likert scale of 1 to 5 for each question. Respondents' answers are chosen number 5 if the respondent considers that the Jakarta TOD implementation model is very compatible with the key to success or best practice of TOD implementation. Respectively, the respondents choose number 4 if it regards appropriate, number 3 if it is not appropriate, number 2 if not suitable, and number 1 is considered very incompatible with the key variables for successful TOD implementation. This research method is explained briefly through the scheme as shown in **Fig.2.**

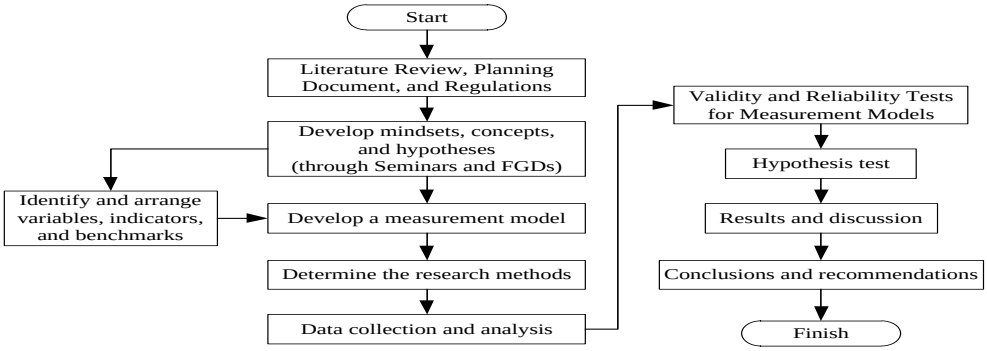

Fig. 2. Flowchart of Research Methodology.

The data collection process is done through the distribution of questionnaires to three parties where they are considered to have direct interests and understanding of the application of TOD. The respondents participating parties are elements of government (10 persons), business actors (10 persons), and experts (10 persons). Here, expert judgment is considered because it is a neutral party (counterweight) in providing perception. Therefore, at the end of the perception assessment need to see also the dynamic force flow between the respondent variables through the inferential analysis presented by form of descriptive plots. The data obtained were then analyzed to answer the research objectives. As for some of the tests conducted, that is: (1) Descriptive statistical tests to obtain temporary answers to research hypotheses; (2) Test the validity and reliability using the values of McDonald's ω, Guttmann's λi, and Cronbach's α; (3) Test classic assumptions using the Test of Normality using Shapiro-Wilk based on W and P-value; (4) Hypothesis testing using Independent One-Sample T-Test given by t value, p-value, effect size Cohen's d; and (5) To interpret how far the degree of subjective trust must change rationally when new guidelines or policies are using Bayesian One-Sample T-Test Log (BF), Density f ($x \mid \theta$), Prior π (θ), and Posterior π ($\theta \mid \underline{X}$) analysis. Software used for statistical data analysis using JASP Computer software by JASP Team (2018) with JASP Version 0.9.2.

4. RESULT AND DISCUSSION

The initial stage of data analysis in this study starts from the reliability test to see the consistency of responses to the perception of variables. The reliability test result using parameter value uses the Guttmann's scale value λ6 = 0.847; McDonald's ω based on Structural Equation Model (SEM) = 0.809, and Cronbach's α = 0.795 shows that overall scales value > 0.6. This meaning that the respondents' answers are consistent (**Table 1**).

Table 1.

Data reliability test results.

Descriptive Statistics				
Latent Variable	**N**	**Mean**	**Standard Dev.**	**Standard Error**
Definition of TOD	29	2.759	0.636	0.118
Location Suitability	29	2.138	0.581	0.108
Development Strategy	29	2.724	0.702	0.130
Integrated Plans	29	2.897	0.673	0.125
Institutional	29	3.414	0.983	0.182
Partnership	29	3.000	0.964	0.179
Inclusive Goals	29	2.690	1.105	0.205
Sustainable Development	29	2.621	0.903	0.168
Reliability Statistics				
Basis SEM	**Mean**	**SD**	**McDonald's ω**	**Cronbach's α**
Scale	2.78	0.361	0.809	0.795
Note: Of the observations, 29 were used, 0 were excluded list wise, and 29 were provided consistency respondent if value reliability scale > 0.6; Guttmann's λ6 = 0.847				

Next, the normality test was done using The Shapiro-Wilks test. The Shapiro-Wilks test for normality is one of three general normality tests designed to detect all departures from normality. It is comparable in power to the other two tests. The test rejects the hypothesis of normality when the p-value ≤ 0.05, and sig-value (significance value or P-value) > 0.05, then the data are declared normal distribution. Normality test results **(Table 2)** show that the data are not normally distributed because of the P-value < 0.05, the distribution is skew. For this reason, further data testing uses non-parametric statistics.

Table 2.

Test of Normality (Shapiro-Wilk) result.

Latent Variable	**W**	**p**
Definition of TOD	0.776	< .001
Location Suitability	0.748	< .001
Development Strategy	0.786	< .001
Integrated Plans	0.798	< .001
Institutional	0.874	0.002
Partnership	0.830	< .001
Inclusive Goals	0.852	< .001
Sustainable Development	0.882	0.004
Note: Significant results suggest a deviation from normality.		

The next step is to test the hypothesis. This research uses non-parametric hypothesis testing. Since the scale of ordinal data and the nature of the distribution are skewed, some hypothetical testing options that can be done are: for example, replacing the T-Test with

Man-Whitney or Kruskal, Anova with Kruskal, Paired T-Test with One-Sample Sign Test, and other non-parametric tests. This study chose to use the Independent One-Simple Sign Test, and the results are presented in **Table 3**.

Table 3.

Independent One Sample T-Test result.

Latent Variable	t	df	p	Cohen's d	95% CI for Cohen's d	
					Lower	Upper
Definition of TOD	6.021	28	< .001	1.118	0.646	1.578
Location Suitability	0.834	28	0.412	0.155	-0.213	0.520
Development Strategy	5.188	28	< .001	0.963	0.515	1.400
Integrated Plans	6.788	28	< .001	1.260	0.764	1.744
Institutional	7.485	28	< .001	1.390	0.870	1.897
Partnership	5.320	28	< .001	0.988	0.536	1.428
Inclusive Goals	3.126	28	0.004	0.581	0.182	0.970
Sustainable Development	3.416	28	0.002	0.634	0.230	1.029

Note: Student's t-test; For the Student t-test, the effect size is given by Cohen's d. For all tests, the alternative hypothesis specifies that the population means is different from 2.048 ($t_{a/2}$) with a significance level of two-way test for df=28, $\alpha = 0.05$.

To conclude the results of hypothesis test, the interpretation of the test results is done by comparing results of t arithmetic with t table ($t_{a/2}$) and the value of probability (p value). The assessment parameter used is:

1. Based on t value:
   H_0 = accepted if $-t_{a/2} \leq t_o \leq t_{a/2}$ or in this case is $-2.048 \leq t \leq 2.048$
   H_1 = accepted if $-t_0 < -t_{a/2}$ or $t_0 > t_{a/2}$ or in this case is $- t < -2.048$ or $t > 2.048$
2. Based on probability using p-value:
   H_0 = accepted if p-value > 0.05
   H_0 = rejected if p-value < 0.05

Whereas, to find out the level of confidence of the Bayes effect (small < 0.2, medium = 0.5, large > 0.8) using the parameter value is Cohen d.

For this case, the test result show that t value of 7 variables is > 2.048 (it means that H0 is rejected), except 1 variable i.e. Location Suitability with t value = 0.834 > -2.048 and 0.843 < 2.048 (it means that H0 is accepted). Likewise, based on probability parameters, all test results P-value < 0.05 (it means H0 is rejected), except for variable Location Suitability with P-value = 0.412 > 0.05 (it means H0 is accepted). Hence, it can generally state that the Jakarta TOD Model Application is not in line yet with the principle of urban and transportation sustainable development. Bayes effect level refers to the results of the analysis by Cohen's d value showing that the value of Cohen's d is 7 variables > 0.8 or it can be said that the effect of Bayes is large, except for 1 variable namely Location Suitability with Cohen's d value of 0.155 < 0.2 (level of Bayes effect small). From these results, it can be stated that the determination of TOD location is not a major effect variable in the application of TOD in Jakarta. Not yet in line with the Jakarta TOD Implementation Model with the best practice of TOD and Urban Principles and transportation sustainability caused by several factors Bayes interpretation.

Some variable Large Bayes effect (based on Cohen's value d > 0.8) is the institutional variable (1,390), integrated planning (1,269), Definition of TOD (1,118), Partnership (0.988), and Development strategy (0.963). There are two variables categories in the moderate Bayes effect are sustainable development (0.634) and inclusive goals (0.581).

Table 4.
Bayesian Independent One-Sample T-Test result.

Latent Variable	Log (BF)	error %
Definition of TOD	9.275	3.394e -7
Location Suitability	-1.304	0.005
Development Strategy	7.197	2.564e -6
Integrated Plans	11.161	9.604e -8
Institutional	12.838	2.980e -9
Partnership	7.527	2.098e -6
Inclusive Goals	2.278	3.855e -6
Sustainable Development	2.918	5.840e -4
Note: For all tests, the alternative hypothesis specifies that the population means is different from 2.048.		

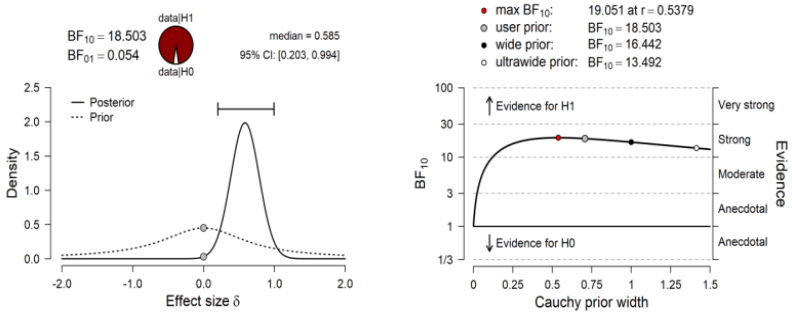

Fig. 3. Prior and posterior Bayes Factor Robustness Check.

One mathematical tool and philosophical approach for modeling uncertainty through prior or model or loss classes, as well as measuring uncertainty and its effects, to avoid arbitrary assumptions, can be done through the Bayesian approach, for example, Bayesian Robustness analysis. The results of the analysis show that psychologically the level of subjective trustworthiness of the respondents towards the current application of the Jakarta TOD Model, refers to result of Bayesian One-Sample T-Test Log (BF_{10}), Density f ($x \mid \theta$), Prior π (θ), and Posterior π ($\theta \mid \underline{X}$) analysis (**Table 4** and **Fig.2.**) tends to be strong towards H1 or H0 is rejected. These results also prove that there is a strong suspicion that Jakarta is currently the Jakarta TOD Application Model is not in line yet with the principles of urban and transportation sustainable development.

Learning from the experience of the TOD Model in Jakarta, at this time, the research will be continued by developed a TOD model application to be applied for a typology city, which has the opportunity to develop, to become a typology of a large city and or metropolitan city (even as a megapolitan city). Kupang city was chosen as the object of research because this city is one of the cities that are projected to potentially develop into a big city between 2025, 2035 and 2045 to become a Metropolitan City. The weakness of implementation in Jakarta will be an important lesson when creating models for implementation in Kupang. The research framework will be arranged in the form of the Structural Equation Model that can be collected can be seen in **Fig. 4**.

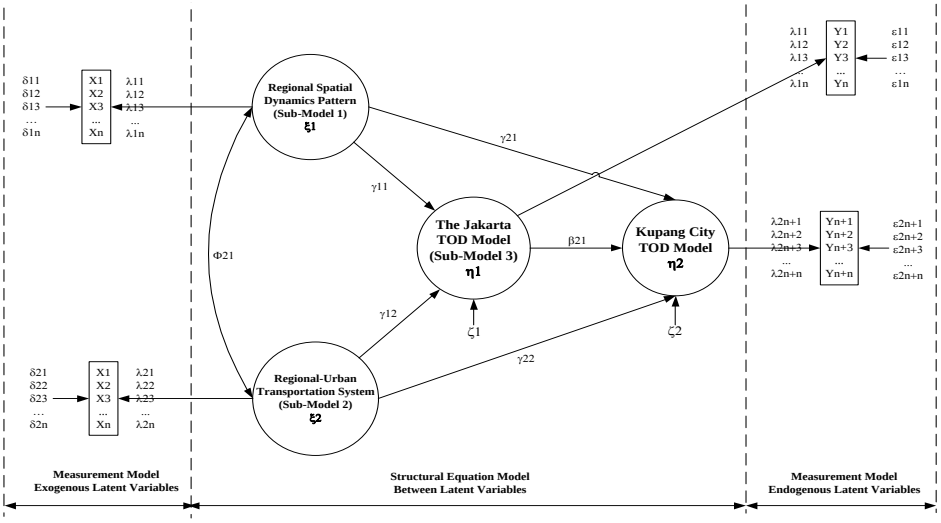

Fig. 4. Causal Relations Diagram of Research Variables.

The structural equation based on the Structure Model Specifications in **Fig. 5** is written in the form of an equation for analysis as follows:

$$\eta = B * (\eta + \Gamma) (\xi + \zeta)$$
$$x = \Lambda x * (\xi + \delta)$$
$$y = \Lambda y * (\eta + \varepsilon)$$

Furthermore, the estimation of the structure model above is done through the choice of estimation method in the SEM domain, namely the Maximum Likelihood (MLE) estimation procedure. Mathematically, the Covariance Model Matrix can be written as follows:

$$\Sigma\,\theta = V * \begin{bmatrix} x \\ y \end{bmatrix} = V * \begin{bmatrix} \Lambda x\,\Phi\Lambda'x + \Theta\delta & \Lambda x\,\Phi M'\Gamma' \\ M\Gamma\Phi\Lambda'x & M\Gamma\Phi\Gamma'M' + M\psi M' + \Phi\varepsilon \end{bmatrix}$$

Where, $M = \Lambda y * ((I - B)^{-1})$ and testing the null hypothesis (goodness of fit) measured by H_0:Cov $(z) = \Sigma\,\theta$ and H_1:Cov $(z) \neq \Sigma\,\theta$.

5. CONCLUSIONS

The results of the analysis show us that the Jakarta TOD Application Model is not in line yet with the principles of urban and transportation sustainable development caused by several factors Bayes interpretation when correlated with the principles of the Jakarta TOD Model application. Refers to result of some variable Large Bayes effect analysis (based on Cohen's value d), its need to be re-arrangement some regulations and/or policies by considering some important variables, that is: institutional improvement, integrated planning, definition of TOD, strong partnership patterns (government, business entities, and communities), and future development strategy. Also, important to consider two variables categories in the moderate Bayes effect are sustainable and inclusive development and goals.

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AUTOMATION OF DRINKING WATER TREATMENT SYSTEMS IN RURAL AREA

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ABSTRACT:
All living things need water to live. The increasing population in the world results the increased demand of water, include in Indonesia. Water scarcity is also a big issue in Indonesia, especially in rural area like Gunung Kidul. In Gunung Kidul people difficult to get clean water. Clean water can be obtained with drinking water system. The drinking water system that now exist in Temuireng Village, Girisuko, Panggang, Gunung Kidul could meet the water need of the people, but there is a problem with the design of the water treatment system. The drinking water treatment system still use semimanual mechanism that less effective and efficient. The purpose of this research is to design the automatic drinking water treatment system that now exist in Temuireng Village to improve the quality of the water in that area and to reduce the operating cost of the systems. With considering the need, technology and some other aspects, this research obtained the new prototype design of the drinking water treatment systems that be equipped with automation.

Key-words: *Automation, Design, Prototype, Rural area, Water treatment system*

1. INTRODUCTION

Water is one of the most important resources for life. All living things need water to live and develop. Safe water is important for humans, plants, and animals (Abu Hasan, Muhammad, & Ismail, 2020). In Indonesia, the increasing population results the increased demand of water but the water resource availability was limited (Kardono, 2007). Many water sources that are commonly used are not as good as they used to be (Wiyono, Faturrahman, & Syauqiah, 2017). Once the water has been contaminated by toxic compounds, it must be treated before can be consumed by people (Abu Hasan et al., 2020). The water contaminations occur because of a few key factors, i.e. industrial and sewage effluent discharge, agricultural industry, illegal garbage disposal and leakage of leachate from landfills (Hasan, Abdullah, Kofli, & Yeoh, 2016).

Nowadays, clean water supply becomes one of the big issues in the world, especially in developing country (Nandiyanto & Haristiani, 2016). Unlike urban areas where water pollution is usually caused by poor wastewater treatment, in rural areas water sources are still good but the problem is the difficulty of accessing good water source (Apip, Sagala, & Pingping, 2015) (Luo et al., 2019). This scarcity of water can cause the disruption of life. This water scarcity is main issue in Gunung Kidul, includes in Temuireng, Girisuko, Panggang, Gunung Kidul, Yogyakarta (Sugiarto & Suharwanto, 2017). Water stress can caused by lack of awareness of tree planting, the use of water for households is increasing, exploration and use of water for industrial, especially manufacturing (Dwianika, Murwaningsari, & Suparta, 2020). (Haryadi & Sudarmadji, 2014). Gunung Kidul as an area

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with water scarcity and dryness, one of the reasons is because of the morphology of the area (Haryadi & Sudarmadji, 2014). Gunung Kidul as a mountain area, like in other natural places indicate a low degree of urbanization, but at the same time, these regions are facing global natural changes (Nistor et al., 2018).

The consequence from drought was a lack of consumable water to be used in various activities (Rotjanakusol & Laosuwan, 2019), especially in agriculture which is the main career of the people in Gunung Kidul. In Gunung Kidul, the ground water conditions is also influenced by climate like the other semi-arid region (Chamchati & Bahir, 2011). Gunung Kidul area is a karst topography region formed from limestone dissolution. In areas with karst topography, rain water that falls on the surface will immediately soak into the ground and form underground rivers. This makes it difficult to get clean water on the surface, especially in the dry season. However, the availability of ground water is very abundant with good water quality in the area. Technology is needed with the main goal of helping to provide clean water and ensure healthy lives (Kabisch, 2016). Ground water can be raised with appropriate (Sugiarto & Suharwanto, 2017).

One of the technology that can be used to raise the ground water is water treatment system. Water treatment systems have been researched, developed and used in various regions. This water treatment system can be done by various methods according to the needs and conditions of the water source. One of the water treatment systems is conducted by Wiyono, Faturrahman, and Syauqiah (2017) carried out by aeration, filtration, adsorption, and disinfection. However, in this system the design of tools is less effective because the quality of the water produced does not meet the established quality standards (Sugiarto & Suharwanto, 2017). The other drinking water systems has been develop by Sugiarto and Suharwanto (2017) in Gunung Kidul. This drinking water treatment system was developed to reduce E-coli bacteria, organic matter (coliform parameters) and inorganic materials (TDS parameters) by the process of deposition, slow sand filter, and splash distortion of solar power (Sugiarto & Suharwanto, 2017). This treatment system can reduces TDS from 400 ppm to below 160 ppm.

Public service availability and quality remain relatively low in the rural areas, particularly in developing country (Yang, Liu, Phang, & Wei, 2020), including water treatment systems in Temuireng. In that area, the mechanisme of drinking water treatment systems still uses semi-manual work (Sugiarto & Suharwanto, 2017)**.**The role of labor was still dominant to running the systems. In recent times, to ensure the continuous supply of good quality and safe of water, the water treatment system is equipped with automation controls (Dubey, Agarwal, Gupta, Dohare, & Upadhyaya, 2016). The development of drinking water treatment system with integrated automation is expected to help the community in fulfilling water, safer, cheaper and easier. With the automation, the quality of the water from water treatment systems can be improved (Handayani, Kusnayat, Sukma, & Atmaja, 2017). In addition, water distribution systems can also become more efficient through automation (Gowtham, Varunkumar, & Tulsiram, 2017).This paper wants to explain the continuation of research from Sugiarto et al. in the form of a prototype design of an automated drinking water treatment system.

2. METHODOLOGY

Object of this research is drinking water treatment system that located in Temuireng village, Girisuko, Panggang, Gunung Kidul, Yogyakarta, Indonesia. This drinking water

treatment was used to fulfill the water demand approximately 269 families in that area. The steps of this research can be seen in **Fig. 1**.

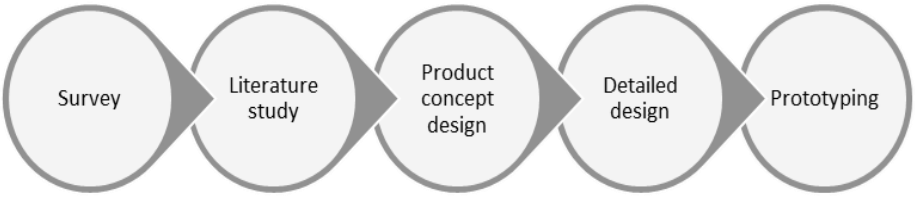

Fig.1. Steps of the research

1. Survey
   The first step of this research was survey in the location of the drinking water treatment system in Temuireng village, Girisuko, Panggang, Gunung Kidul. The survey was conducted to determine the needs of the current drinking water treatment system.
2. Literature Study
   Literature study is conducted to find out the current drinking water treatment system in other places. This study was also conducted to add information in product design.
3. Product Concept Design
   Product concept design is done by considering the needs, technology and SHE IS FATER (Tontowi, 2016). SHE IS FATER is the concept of product design that considering (1) SHE (Safety, Health, Environment), (2) Innovation and intellectual property rights, (3) Standard of the product, (4) Function, (5) Aesthetics, (6) Trends of the product, (7) Ergonomics, (8) Regulation.
4. Detailed Design
   After the product concept is obtained, the next is the detailed design of the product.
5. Prototyping
   After the detailed design of the product is obtained, the next step is to make a prototype. Prototype is made on a laboratory scale.

3. RESULT AND DISCUSSION

3.1. Overview of Society and Needs

Gunung Kidul is known as arid regions and droughts in the dry season. The drinking water treatment system is located in Temuireng village, Girisuko, Panggang, Gunung Kidul. **Fig. 2** is map of the location of a drinking water treatment system.

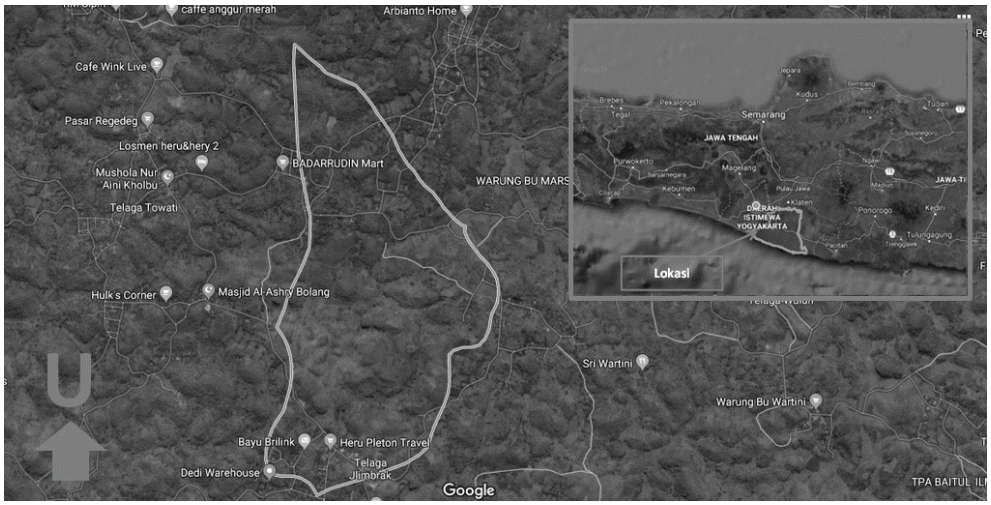

Fig. 2. Location of drinking water treatment systems in Temuireng, Girisuko, Panggang, Gunung Kidul, Yogyakarta.

In Temuireng village, there were approximately 269 families living with more than 1000 person who need clean water. Before the water treatment system existed, people used rainwater with a shelter like **Fig. 3**. Water quality in the rainy season before people use a drinking water treatment system containing E-coli 9000 per 100 ml and total Coliform bacteria 28000 per 100 ml. In the moderate rainy season, total coliform 4000 per 100 and in dry season total Coliform 400 per 100 ml with the maximum regulation 50 per 100 ml (Sugiarto & Suharwanto, 2017)

Fig. 3. The shelter of rainwater.

From survey activities and identification of community needs, there are several needs for clean water that can be seen in **Tab. 1**.

Table 1.

Needs of People in Temuireng.

Community needs		
Clean water	Automatic water treatment	Enough water
Healthy water	Continuous water availability	Cheap and affordable water
Easy to get water	Easy maintenance the tools/ systems	Easy operate the systems

3.2. Product Concept Design

Product concept design is the most important stage in product development. In this research the product concept design is considering the needs, technology and SHE IS FATER. **Fig. 4** explains the product concept design in this research.

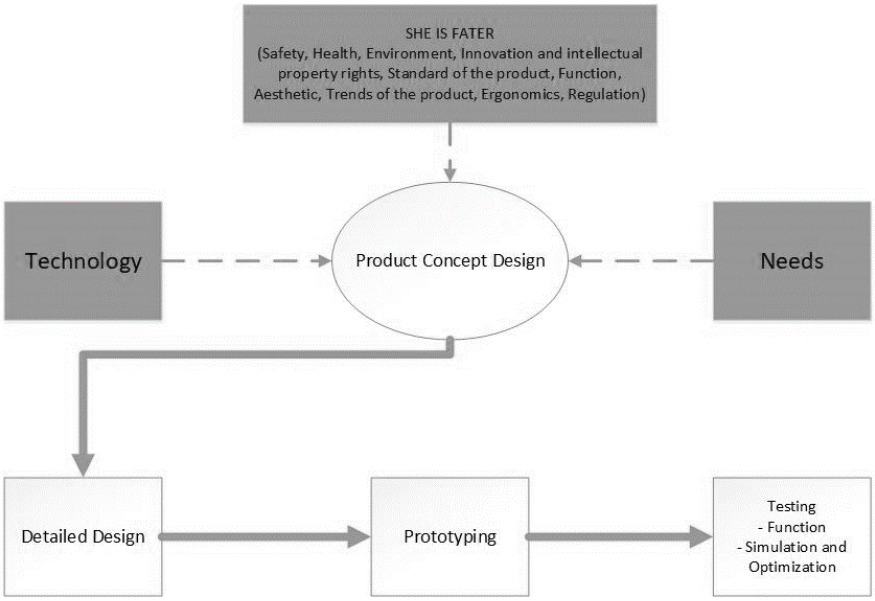

Fig. 4. Product concept design and process in this study.

The needs of people in Temuireng village can be seen in **Tab. 1**. From the needs that have been obtained, the next step is to design an automatic drinking water treatment system. The needs of these people are then combined with technology (automated systems) and other elements such as SHE IS FATER. Nowadays, automation is a technology that can be applied in almost everything. Automation can help people to manage productivity, improve quality, reduce downtimes, and also reduce operating cost. This technology can apply in water treatment system. The design of the product considering aspect SHE IS FATER besides the two factor technology and needs. After the design concept is reached, the next step is to make a detailed design.

3.2. Product Design

Product design in this research improves the design from Sugiarto et al. (2017). In this automation drinking water treatment system, the automation control will be installed in three areas. The automation will be installed mainly before the tanks because the main function of this automation is to control the volume of the water in each tank. The selenoid will be installed in output of mixer, output of alum and alum tube. **Fig. 5** shows the process design concept for this water treatment system.

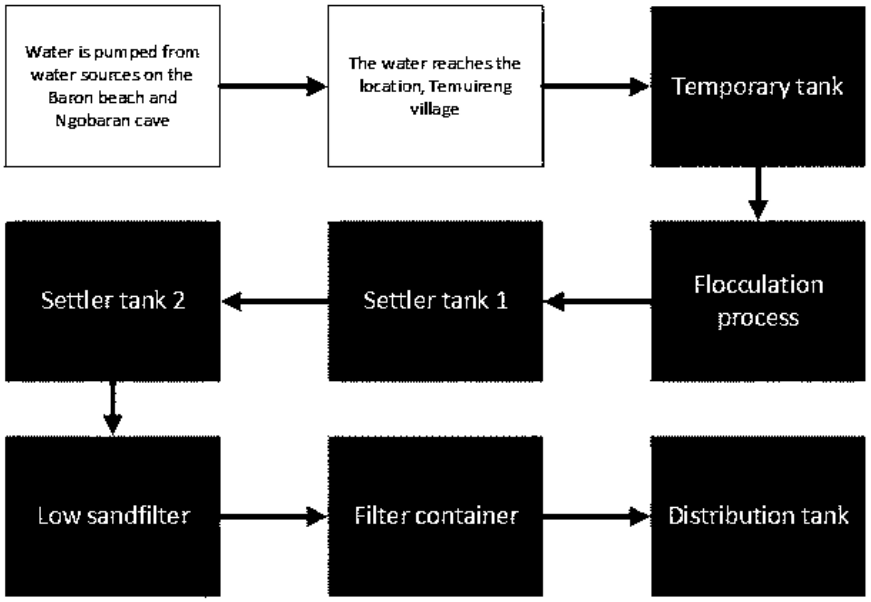

Fig. 5. Process concept design of this water treatment system.

First, water is pumped from the water source in Baron beach area and Ngobaran cave. Then after the water reaches the Temuireng village, Girisuko, Panggang, Gunung Kidul, the water is pumped to reach in temporary tank that located in higher area. The water in the temporary tank then was streamed to flocculation process to reduce the E-coli and total coliform. This process used natural clot like moringa.

In the next process, water that has been processed in flocculation then was streamed to settler tank 1 and settler tank 2. The settler tank was designed twice to optimize the sedimentation process. The result of this sedimentation process then was streamed to low sand filter process. This process used zeolite and charcoal. Then the next process was test the quality of the water in the filter container, if the water still contained high e-coli and coliform then chlorination should be done. If the quality of the water has been achieved then the next process water was streamed to distribution tank and the water ready to be distributed.

3.3. Prototyping

Prototyping in this research is made in laboratory scale. After a detailed design has been obtained, the next step is to make a prototype. Before the automation system be applied in real system, it needs a simulation and optimization. One of the way to running the simulation

and optimization is making a prototype. Prototype in this research will be made in laboratory scale, with the same process, function, and material (water) as a real system.

The equipment used in this prototype is coagulant shelter, mixer shelter, sedimentation shelter, filtration shelter, product shelter, pump, solenoid valve pneumatic, and control panel. After the prototype has been made, the next step is testing the prototype and then evaluate. In the prototype testing step, the prototype function will be checked and then the simulation and optimization will be run. **Fig. 6** is the sample of the prototype in a laboratory scale.

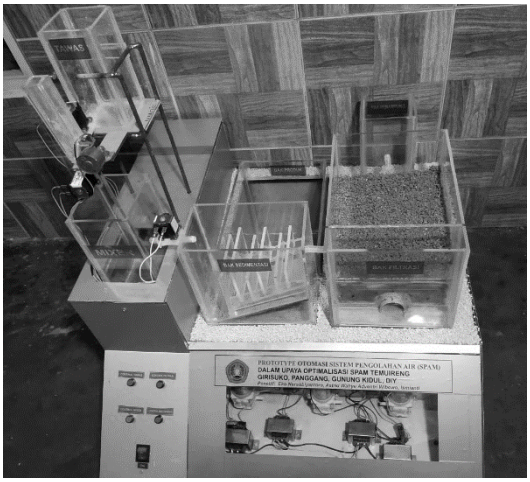

Fig. 6. Prototype in laboratory scale

In this prototype the automation were installed with solenoid. With this solenoid, the water will automatically come out when the engine is started and water will automatically stop when the tank is full. This applies to all tanks so that no manpower is needed to turn on and turn off the water tap.

3.4. Data Analysis

From the prototype test results, the TDS of water can be reduced from 400 ppm to below 160 ppm. The results of this TDS are in the category of excellent based on WHO (World Health Organization, 1993). Reduction of TDS in each process can be seen in **Fig. 7**.

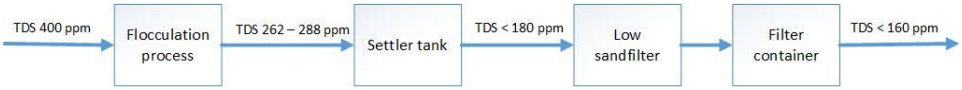

Fig. 7. Reduction of TDS in each process.

Tab. 2 shows the results of laboratory tests of water source (raw material) from PDAM Gunung Kidul Regency and water products from drinking water treatment system in Temuireng.

Table 2.

Laboratory test from water source and drinking water treatment system.

No.	Parameter	unit	Maximum content	Result of test	
				I*	II**
1	Total Suspended Solid (TSS)	mg/l	(-)	13	12
2	Total Dissolve Solid (TDS)	mg/l	500	402	251,5
3	Hardness	mg/l	500	178	162
4	Dissolved Oxygen	mg/l	(-)	7,58	7,78
5	Turbidity	NTU	5	0,94	0,24
6	Number of coliform	JPT/100 ml	0	None	None

**I : Test content from water source in PDAM Temuireng*

***II : Test content from water products of drinking water treatment systems*

Tab. 3 shows the results of laboratory tests for the prototype of an automated drinking water treatment system.

Table 3.

Laboratory tests for the prototype of automated drinking water treatment system.

No	Parameter	Unit	Maximum content	Result of test		
				I	II	III
1	Total Suspended Solid (TSS)	mg/l	(-)	10	7	9
2	Total Dissolve Solid (TDS)	mg/l	500	159	160,5	162
3	Hardness	mg/l	500	78	54	60
4	Dissolved Oxygen	mg/l	(-)	7,58	7,19	7,78
5	Turbidity	NTU	5	0,39	0,42	0,27
6	Number of coliform	JPT/100 ml	0	Nihil	Nihil	Nihil

I, II, III: test content from prototype of automated drinking water treatment systems in Temuireng.

According to Permenkes 492 / Menkes / Per / IV / 2010 the maximum allowable level for TSS is zero. The processed product from the Temuireng drinking water treatment system is 12 mg / l which means it still does not meet the required standards. Based on Table 3 laboratory test results for TSS parameters in the water product automation drinking water treatment system that is replicated 3 times is 10 mg / l, 7 mg / l and 9 mg / l shows there is an increase in the quality standard of drinking water, although it still does not meet drinking water quality standards in accordance with the Regulation of the Minister of Health.

Hardness is the nature of water caused by the presence of valence metal ions, for example Mg2 +, Ca2 +, Fe + and Mn +. Total hardness is hardness caused by the presence of Ca2 + and Mg2 + ions together. The results of the measurement of hardness levels (table 2) for source water is 178 mg / l and hardness levels after processing with drinking water treatment system is 162 mg / l. According to Permenkes 492 / Menkes / Per / IV / 2010 these results are still below the required threshold, so it is suitable as drinking water. Table 2 shows

the results of the water test for drinking water treatment system automation products, the hardness content is quite low when compared to the results of the SPAM treated water test. The hardness content of processed automated drinking water treatment system products is 78 mg / l, 54 mg / l and 60 mg / l which qualify as a source of drinking water and clean water.

4. CONCLUSIONS

The existing drinking water treatment system in Temuireng village, Girisuko, Panggang, Gunung Kidul need an improve design to optimize the function of the water treatment. Automation is one of the main needs of the water treatment system. From this research, the new design of automation drinking water treatment system has been obtained. The design considering the need of people, technology, and SHE IS FATER (1) SHE (Safety, Health, Environment), (2) Innovation and intellectual property rights, (3) Standard of the product, (4) Function, (5) Aesthetics, (6) Trends of the product, (7) Ergonomics, (8) Regulation. With the new design of the drinking water treatment system, the operating cost will be reduced and the quality of the water be improved. From the results of laboratory tests, the quality of source water and treated water in the drinking water treatment system increases in quality.

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PREVENTING CLIMATE DISASTERS IN PEAT ECOSYSTEM USING BIO-WASTE MATERIALS FOR CANAL BLOCK MODULES

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DOI: 10.21163/GT_2020.151.29

ABSTRACT:
Peat ecosystems play a very important role in controlling global climate stability. Massive channel development in the peatland ecosystem can have an impact on excessive drying of peatland, which is caused by increased water flow rate and decreased water-saving power in the peat region and implicates the increased oxidation, and the vulnerability of fire hazards which contribute to the disaster of climate change. Recovery of degraded and drained peat can be done by building peat rewetting infrastructure, one of which is canal blocking. This study aims to utilize bio-waste material namely coconut fiber waste (CFW) for composite panels for canal block modules. This research was carried out using the hand lay-up method, with composite compositions in the form of polyester, fiberglass, wire mesh, and coconut fiber. The results showed that the composition of the type C composite panel samples had a density value of 0.0853 gr/cm^3, the moisture content value was only 0.16%, thickness swelling was only 0.11%, and the length swelling was only 0.01%, better than other samples. Besides, the type C composite panel sample is also better, with a modulus of rupture (MoR) of 21.845 kgf/ mm^2, modulus of elasticity (MoE) value of 78.057 kgf/mm^2, and impact energy 79.66 Joules. It is expected that coconut fiber waste can be processed and used optimally as a bio-waste for canal block in preventing fire hazards (disaster climate change).

Key-words: *Climate change, Bio-waste, Coconut fiber, Canal block, Peat ecosystem.*

1. INTRODUCTION

Indonesia is a developing country and is one of the world's emerging economies that has one of the fastest economic growth rates. One of the driving forces of this growth has been the large-scale exploitation of its extensive natural resources, including its peat swamp forests, in recent decades, especially in Borneo Island (Miettinen et al., 2012).

Indonesia ranks eighth of the world's largest forest and has the largest peatland in Southeast Asia. Total forest area covers 50% of Indonesia land (~940,000km^2) and approximately 12% of the land is peatland ecosystem (~200,000km^2). A part from that, Kalimantan is the third largest island in the world, which has the second biggest tropical peat swamp forest with a higher amount of carbon storage in Indonesia.

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Given that surrounding land-use change affects the function of protected areas, it is crucial to identify the driving forces that influence them and modelling future changes to prevent further decline of natural resources (Rafaai et al., 2020), Based on study in Nigeria, the results showed that the drivers of land use changes in Nigeria were the gross regional product, average temperature, migration and population density, in which the gross regional product and migration had the highest impacts on land use change (Ighile & Shirakawa, 2020). Awareness of the preservation of natural resources for the next generation has become an international concern, especially highlighting water exploration for the manufacturing sector in the production process (Dwianika et al., 2020). Since 1950s, legal and illegal logging contributed on 30% of tropical forests loss in Indonesia (Hayasaka, 2012). The change of ecology after forest loss result such uncontrolled forest and peat fire in lasts century. Peatlands provide an important sink of carbon in their near natural state but potentially act as a source of gaseous and dissolved carbon emission if not in good condition (Rebekka et al., 2019). One of the worst eco-disasters on the planet is currently unfolding in Indonesia. Over the past two months in 2015, thousands of forest and peatland fires have been raging out of control, choking the entire region in a thick and toxic haze.

Besides, peat ecosystems play a very important role, both as a supporter of economic activity and as an element of sustainability diverse local life. Besides, the peat ecosystem also serves as controlling global climate stability, which is due to its ability to absorb and store carbon (C), (Ministry of Env., 2012). Scientific studies have shown that the massive channel development in the peatland ecosystem associated with logging activities can have an impact on excessive drying of peatland, which is caused by increased water flow rate and decreased water-saving power in the peat region and implicates the increased oxidation, and the vulnerability of fire hazards. The recovery of peat degraded and drainage can be done by building a peat wetting infrastructure, one of which is through the existing trench/conduit (canal blocking) activities with the block/dam system. So it is expected that high water advance and water retention in peat can be increased, to minimize the occurrence of fire hazards in the dry season and facilitate the rehabilitation of the surrounding areas. In the activity of the channel insulation, the partition material used is influenced by the size of the channel, easily obtained around the location, strong and durable (not easily weathered), not easily damaged (either by water flow, animal or human). But with the many uses of boards/wooden beams as a channel material from the local location, it will be increasingly damaging the environment itself. This study aims to examine the utilization of coconut fiber waste into composite material as a substitute material from the board/wood beam, to be applied as canal blocking. This study resulted in a product of canal block module made from raw coconut waste composite to be applied on a 3-meter wide water channel and 1-metre depth. The results of this study are expected to support government policy in the implementation of peat restoration in Indonesia.

2. METHODOLOGY

This research uses survey methods, laboratory testing and field testing with the steps of research implementation as shown in **Fig. 1**. A more detailed explanation of the research steps as ilustrated in Figure 1 is as follows:

STEP 1: Identification and analysis canal site

In this initial step, identification and analysis canal site done with a field survey was carried out including measuring cross section, lengthwise, depth of the canal and measuring

the flow of water flow on the canal to be installed in the canal block construction. As known, peat soil is a land that is formed from the accumulation of organic materials such as remnants of plant tissues that take place in a long period and generally always submerged throughout the year. Known as peatland when the thickness of peat is more than 50 cm, (Najiyati et al., 2005). Further, hydrological cycles are the basic concepts of equilibrium and water movement on the Earth, as shown in **Fig. 2**.

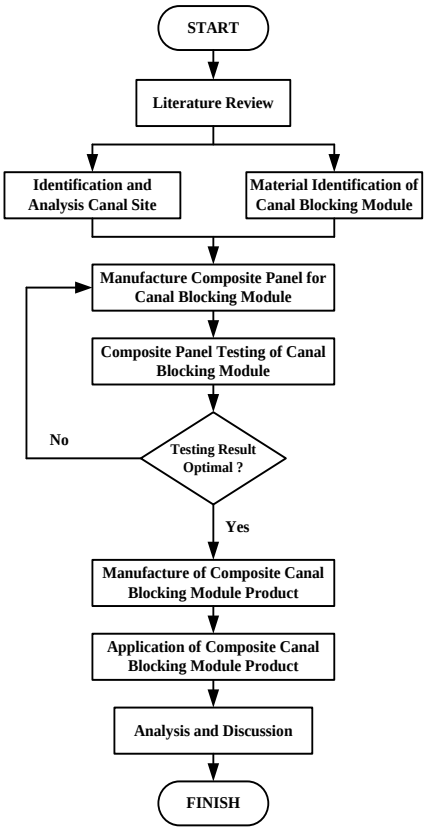

Fig. 1. Flowchart of research.

To examine the drought affected area is highly challenging because the drought is a natural disaster that starts and expands slowly. The severity of the drought is different when the rainfall is imbalance in the area (Rotjanakusol & Laosuwan, 2019). Based on the hydrological cycle, to prevent the reduction of groundwater face as a result of forest immaterial and the presence of trenches and open channels, control is required. One way to control the decline of groundwater in peatland is through canal blocking. It is expected that the groundwater advance in peatland will increase and peat does not suffer from drought.

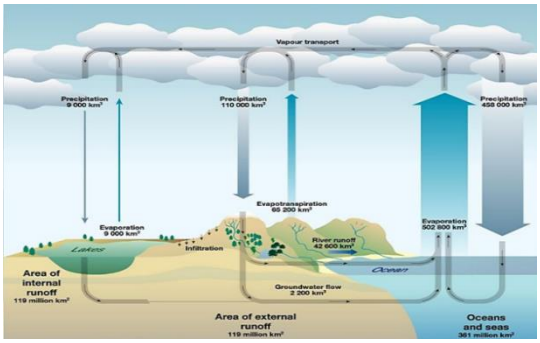

Fig. 2. Hydrological Cycle
(Source: Max Planck Institute for Meteorology, 1999)

STEP 2: Material identification of Canal Blocking Module

In the next step, the process of identifying the main types of material needed to make the canal block composite module as a substitute for wood which has been used to block the canals. One of potential bio-waste material can be used in canal blocking system is coconut coir. Coconut coir is one of the by-products of the coconut fruit that is in the form of coarse fibers. Coconut coir composes about 35% of total fruit weight. Coconut Coir has some properties such as durable, resistant to friction and not easily broken, resistant to water (not easy to decay), resistant to fungi and pests. Excess of coconut fiber is, 1) anti-moths, resistant to fungi, 2) provide excellent insulation against temperature and sound, 3) non-flammable, 4) flame-retardant, 5) unaffected by moisture and humidity, 6) durable, and 7) static (Satyanarayana et al.,1982).

STEP 3: Manufacture Composite Panel for Canal Blocking Module

After coconut fiber has been determined as the main material for making composite canal block module, then the next step is to identify and determine the composition of materials that form the composite panel for canal block module and how the process is made. Composite materials are formed from a combination of two or more materials that have different mechanical properties through non-homogeneous mixing. Its mechanical properties and characteristics differ from the constituent material properties. So it will be easier to plan its strength by arranging the composition of the constituent material because composite is a combination of matrix material or fastener with amplifier (Matthews & Rawlings, 1993). In general, composite materials consist of two elements, namely fiber, and binder called Matric. Composites can also be formed from a combination of two or more materials, either metal, organic or inorganic. Manufacturing of bio-waste material such as coconut fiber composite is included in the classification of randomly oriented discontinuous fiber (Schwartz, 1984). In the manufacturing of composites, three methods can be used, namely the Hand Lay-Up Method, Spray-Up Method, Vacuum Bag Method and Injection Mold Method. In this research, the method used for making composite canal bocking module is the Hand Lay-Up method, which is done by layer by layer method until the desired thickness is obtained, where each layer contains the matrix and filler, as shown in **Fig. 3**.

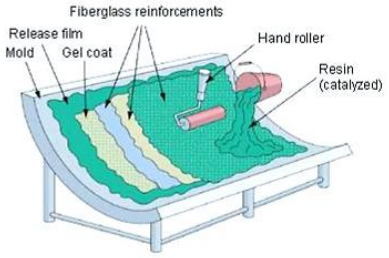

Fig. 3. Hand Lay-Up Methode (Source : *http://wacker.com*)

STEP 4: Composite Panel Testing of Canal Block Module

The next step is to test the composite panel for the canal block module based on SNI 01-4449-2006. Composite materials have several properties that are physical properties, the behavior of material properties that are not caused by the loading but rather lead to material structures such as density, water absorption, thickness swelling and lenght swelling.

Density is one of the physical properties of a composite board defined as the mass per unit of material volume, increasing regularly with increasing atomic numbers in each subgroup. Density depends on the atomic mass, size and way of its passenger. The magnitude of composite board density can be calculated using the following equation (Andriyansyah, 2014):

$$\rho = m/v \quad (1)$$

where ρ is the composite board density (gr/cm^3), m is the composite board mass (gr), and v is the particle board volume (p × l × t) (cm^3). Water Absorption is a percentage of water weight that is absorbed by the composite board in an equilibrium state with its surrounding environment. The amount of moisture content can be calculated using the following equation (Andriyansyah, 2014) :

$$KA = \frac{m_a - m_k}{m_k} 100\% \quad (2)$$

where KA is the composite material moisture content (%), m_a and m_k are the initial mass composite material and absolute mass dry composite material, respectively. Both are in **gr**.

Thickness swelling is a magnitude that represents a thick increase in test samples. To know the thickness swelling, the samples were soaked in water for 24 hours. Determination of the value of thick development can be calculated using the following equation, (Andriyansyah, 2014):

$$PT = \frac{t_2 - t_1}{t_1} 100\% \quad (3)$$

where PT is the thickness swelling of composite materials (%), and t_1 and t_2 are thickness of material before marinated (cm) and thickness of material after soaked (cm), respectively.

Length swelling is a magnitude that expresses the length of a test sample. For that, samples were soaked in water for 24 hours. Determination of long change values can be calculated using the following equation (Andriyansyah, 2014):

$$PT = \frac{P_2 - P_1}{P_1} 100\% \quad (4)$$

where PT is the length development of composite material (%),P_1 and P_2 are length of material before marinated (cm) and length of material after soaked (cm), respectively.

While mechanical properties are the behavior of material caused by loading such as modulus of elasticity (MoE), modulus of rupture (MoR), impact load and impact value. Modulus of elasticity is a value that demonstrates the nature of stiffness, is a measure of the ability of a material to withstand a change of shape or bending that occurs due to the liberation of the proportions. The modulus of elasticity is expressed as a comparison between stress and strain (Misrawati, 2015) where:

$$E = \frac{\sigma}{\varepsilon} \quad (5)$$

where E is the modulus of elasticity ((N/cm^2), σ is the stress (N/cm^2), and ε is the strain.

Forces that work on objects attempt to stretch objects so that modulus of elasticity can be calculated using the equation:

$$\text{MoE} = \frac{\Delta P L^3}{4 \Delta Y b d^3} \quad (6)$$

where MoE is the modulus of elasticity (kgf/cm^2), ΔP is the load difference (kgf), L is the buffer distance (cm), ΔY is the bending load (cm), b is the test sample width (cm), d is the test sample thickness (cm).

Modulus of Rupture is the fracture strength of a material expressed in the magnitude of the tension per unit area, which can be calculated using the magnitude of the stress on the top surface and the bottom of the material at maximum load (Misrawati, 2015). The modulus of composite boards can be calculated using the following formula:

$$MoR = \frac{3PL}{2bd^2} \quad (7)$$

where MoR is the modulus of rupture (kgf/cm^2), P is the maximum load (kgf).

Impact testing aims to measure how much energy a material can absorb to its breaking point. Impact testing is a response to shock or sudden loads.

$$Esrp = m\ g\ R\ (\cos\beta - \cos\alpha) \quad (8)$$

where Esrp is the energy absorbent (J), R is the arm length (m), m is the pendulum weight (kg), g is the acceleration of gravity (m/s^2), α is the pendulum angle before swing, β is the pendulum swing angle after breaking specimen.

Impact value can be calculated by

$$Hi = Esrp / Ao \quad (9)$$

where Hi is the impact value (J/mm^2), and Ao is the specimen area (mm^2).

STEP 5: Manufacture of Composite Canal Blocking Module Product

Based on the result of the analysis and identification of the canal site that have carried out in the previous initial step, then the next step is to make a design for the canal blocking module. The design that has been produced will subsequently serve as the basis for manufacturing composite canal blocking module product. The composite canal module product designed and made is a type of plank dam for canal size with canal width 3 meters and canal depth 1 meters, according the result of the analysis and identification of canal that have been previously surveyed.

STEP 6: Application of Composite Canal Blocking Module Product

The composite canal blocking that has been made is then applied to the canal that has been analyzed and identified in the intial stages of this research activity, which is on the plantation area owned by PT. Muara Sungai Landak, in Mempawah Regency.

STEP 7: Analysis and Discussion

The final stage, the analysis and discussion is based on observations and tests on real conditions in the field of composite canal blocking module product that have been installed on the plantation area owned by PT. Muara Sungai Landak.

3. RESULTS AND DISCUSSIONS

3.1. Physical and Mechanical Properties Analysis

In this research, physical and mechanical properties analysis was performed on a composite panel of canal blocking modules. The composite panel is made up of 4 types, based on the composition type of the composite panel, as shown in **Table 1**.

Tabel 1.

Composite Panel Composition with thickness 15 mm.

Panel ype	Matrix	Layer Composition
A	Resin Polyester	Mat Fiberglass – Mat Cocofiber – Wiremesh – Mat Cocofiber- Mat Fiberglass
B	Resin Polyester	Mat Fiberglass – Mat Cocofiber – Mat Fiberglass – Mat Cocofiber – Mat Fiberglass
C	Resin Polyester	Mat Fiberglass – Wiremesh – Mat Cocofiber – Wiremesh – Mat Fiberglass – Mat Cocofiber – Wiremesh – Mat Fiberglass
D	Resin Polyester	Mat Fiberglass – Wiremesh – Mat Cocofiber – Mat Fiberglass – Mat Cocofiber – Wiremesh – Mat Fiberglass

The results of the physical properties (density, moisture content, thickness swelling, and length swelling) of the 4 types of canal blocking can be seen in **Table 2** to **Table 3**.

Tabel 2.

Density Test and Moisture Content Result with Volume of 150 cm^3

No	Name of Test Sample	Weight (gr)	Density (gr/cm3)	Average of Density (gr/cm3)
1	A1	12,17	0,0811	
2	A2	11,94	0,0796	0,0808
3	A3	12,25	0,0817	
4	B1	12,38	0,0825	
5	B2	12,47	0,0831	0,0828
6	B3	12,41	0,0827	
7	C1	12,75	0,0850	
8	C2	12,83	0,0855	**0,0853**
9	C3	12,81	0,0854	
10	D1	12,57	0,0838	
11	D2	12,62	0,0841	0,0838
12	D3	12,53	0,0835	

No	Name of Test Sample	Initial Weight (gr)	Final Weight (gr)	Average Moisture Content (%)
1	A1	12,17	12,21	
2	A2	11,94	11,98	0,33
3	A3	12,25	12,29	
4	B1	12,38	12,41	
5	B2	12,47	12,51	0,30
6	B3	12,41	12,45	
7	C1	12,75	12,77	
8	C2	12,83	12,85	**0,16**
9	C3	12,81	12,83	
10	D1	12,57	12,60	
11	D2	12,62	12,64	0,21
12	D3	12,53	12,56	

Tabel 3.

Thickness and Length Swelling Result

No	Name of Test Sample	Thickness Before Soak (mm)	Thickness After Soak (mm)	Average of Thickness Swelling (%)
1	A1	15,14	15,17	
2	A2	15,12	15,16	0,29
3	A3	15,08	15,14	
4	B1	15,11	15,15	
5	B2	15,13	15,16	0,24
6	B3	15,14	15,18	
7	C1	15,09	15,11	
8	C2	15,12	15,14	**0,11**
9	C3	15,12	15,13	
10	D1	15,13	15,15	
11	D2	15,15	15,18	0,18
12	D3	15,11	15,14	

No	Name of Test Sample	Lenght Before Soak (mm)	Lenght After Soak (mm)	Average of Lenght Swelling (%)
1	A1	200,08	200,15	
2	A2	200,11	200,15	0,03
3	A3	200,07	200,12	
4	B1	200,09	200,11	
5	B2	200,08	200,13	0,02
6	B3	200,12	200,16	
7	C1	200,09	200,10	
8	C2	200,10	200,12	**0,01**
9	C3	200,07	200,09	
10	D1	200,11	200,13	
11	D2	200,08	200,11	0,01
12	D3	200,10	200,14	

Based on the test results of physical properties of 4 different types of coconut fiber canal block, the optimum results were obtained on type C composite panels, with a density value of 0.0853 gr/cm^3, moisture content value 0.16%, the thickness swelling value 0.11% and the length swelling value 0.01%, and meet SNI 01-4449-2006 requirements for fiber board quality standards, particularly high-density fiberboard categories. Furthermore, the properties testing (MoE and MoR) for 4 types of canal block module, can be seen in **Table 4** to **Table 5**.

Tabel 4.

Modulus of Rupture (MoR) with space of 200 mm, thickness of 15 mm and area of 50 mm

No	Name of test Sample	Maximum Force (kg)	MoR (kgf/mm2)	Average of MoR (kgf/mm2)
1	A1	784,73	20,926	
2	A2	786,68	20,978	20,994
3	A3	790,36	21,076	
4	B1	798,74	21,300	
5	B2	802,68	21,405	21,387
6	B3	804,59	21,456	
7	C1	820,36	21,876	
8	C2	817,74	21,806	**21,845**
9	C3	819,47	21,853	
10	D1	810,64	21,617	
11	D2	809,85	21,596	21,605
12	D3	809,63	21,590	

Tabel 5.
Modulus Elastisitas (MoE) with space of 200 mm, thickness of 15 mm and length of 50 mm

No	Sample name	Load Diff (mm)	Def mm)	MoE (kgf/mm^2)	MoE (kgf/mm^2)
1	A1	284.73	50	67.492	
2	A2	288.62	50	68.414	67.974
3	A3	286.95	50	68.018	
4	B1	292.78	50	69.400	
5	B2	294.53	50	69.815	69.699
6	B3	294.82	50	69.883	
7	C1	329.62	50	78.132	
8	C2	331.46	50	78.568	**78.057**
9	C3	326.83	50	77.471	
10	D1	310.86	50	73.685	
11	D2	309.47	50	73.356	73.606
12	D3	311.25	50	73.778	

Further, the test results regarding the impact test on the 4 types of canal blocking, can be seen in **Table 6**.

Table 6.
Result of Impact Test with specimen area of 196 mm and pendulum weight of 30.4 mm

No	Name of test Sample	Impact Energy (joule)	Average of Impact energy (joule)	Average Impact Value (joule/mm^2)
1	A1	58.75		
2	A2	59.27	58.99	0.301
3	A3	58.96		
4	B1	66.87		
5	B2	67.36	67.17	0.343
6	B3	67.28		
7	C1	75.59		
8	C2	79.74	79.66	**0.406**
9	C3	79.66		
10	D1	66.77		
11	D2	66.83	66.82	0.341
12	D3	66.85		

Based on the impact test of 4 types of canal blocking is made from coconut fiber, obtained the optimum value in the composite panel of type C, with impact energy value 79.66 joule and impact price of 0.406 joule/mm^2. Based on all test results on physical properties and mechanical properties in 4 types of composite panel samples, it obtained one of the most optimal type C. Composition for type C composite panel can be seen as in **Fig. 4**.

Fig. 4. Type C Composite Panel

3.2. Product of Composite Canal Block Module

Based on the results of the analysis and identification of the canals that have been carried out in the previous survey stage, then the type of canal block module that will be made is the Plank Dam type for canals with a width of 3 meters and a depth of 1 meter. The product of composite canal block modules can be seen in **Fig. 4**.

Fig. 4. Composite Canal Block Modules for Plank Dam Structure Type

3.3. Application of Composite Canal Block Module Product

In this research, a product of composite canal blocking module with a length of 400 cm, a width of 150 cm and thickness 12 cm were applied in the test area on plantation area owned by PT. Muara Sungai Landak, as seen in **Fig. 5**. Based on the result of observation and evaluation, the time taken to install of composite canal block module structure only takes 7 days. The construction materials used also not too much, requiring only 15 bags of cement, $3m^3$ sand, 1 m^3 of stone size 5/7", and 8 PVC pipe rods 2.5" with the inside using reinforced concrete instead of wooden beams to strengthen the foundation pillars of the struktur composite canal block modules product.

Fig. 5. Implementation Process of Composite Canal Blocking Module

4. CONCLUSION

Based on the results of density test, moisture content test, thickness swelling test and length swelling test on the 4 types of composite panel canal block module, obtained the most optimal result is type C composite panel, with a density value of 0.0853 gr/cm^3, the value of moisture content by 0.16%, thickness swelling value of 0.11% and 0.01 length swelling value, so sample type C composite panel met the SNI 01-4449-2006 standard about fibre board and entered in high density fibre board category. The sample type C composite panel also obtained the most optimal result, with MoR value of 21.845 kgf/mm^2 and MoE value of 78.075 kgf/mm^2. This shows a sample of type C composite panels above the minimum threshold for the category of high density fibre board type T1-20 based on SNI 01-4449-2006. Based on implementation of the composite canal blocking module product, indicated that the application process of composite canal block modules product is very effective and

efficient, both in terms of time and materials usage for its construction. In addition, the composite canal block modules product also works optimally in controlling the flow rate of the surface run off on the aqueducts of the peatland. Wood-based material used for the frame of the composit canal blocking module should also be made from composite materials made from coconut-fiber waste, so that utilization of coconut-fiber waste as raw material for the composite canal blocking module products can be maximized.

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PHYSICAL PROPERTIES ANALYSIS OF ENVIRONMENTALLY FRIENDLY REFRIGERANT ON THE CONVECTIVE HEAT TRANSFER COEFFICIENT

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ABSTRACT:
The negative impacts of synthetic refrigerant on the environment are ozone depletion and global warming. In spite of all the new refrigerants has no ozone depletion potential (ODP), only the existing refrigerant R22 has ODP as 0.055, however, the global warming potential of the new refrigerants are high. Therefore the use of environmentally friendly refrigerants is a must. Propane (R290) and isobutene (R600a) are environmentally friendly refrigerants as the refrigerants have no ODP and negligible GWP. R290 is more efficiently than R22 because R290 has higher COP. One should be noted of two refrigerants, R290 and R600a is their flammability. Therefore, the amount of R290 or R600a should be minimized in refrigeration or air conditioning system. This research is conducted experimentally and theoretically comparing the effect of physical properties on the heat transfer process of the low mass of R290 and R290 – R600a blends. An increase in vapor quality decreases the convective heat transfer coefficient. This is due to the decrease in thermal conductivity and specific heat of the refrigerant with an increase in the vapor quality. R290 has the highest convective heat transfer coefficient while 60%R290 – 40%R600a blend has the lowest convective heat transfer coefficient.

Key-words: *Synthetic refrigerant, environmentally friendly refrigerant, QDP, GWP.*

1. RESEARCH BACKGROUND

The use of synthetic refrigerants which have negative impacts on the environment has been decreased. The significant step is there is no production on ozone depletion refrigerant. However, the used of this kind of refrigerant still can be found to utilize the air conditioning system. R22 is the ozone depletion refrigerant with ozone depletion potential (ODP) index as 0.055 which is still in the R22 air conditioning system. The common synthetic refrigerant such as R134a, R410A, R32 and R407C are free of ODP but still have global warming potential (GWP). Global warming potential is the potential of a substance in trapping greenhouse heat compare to CO2. The GWP of R134a, R410A, R32, and R407C refrigerants are 1432, 2100, 650 and 1980 respectively (Padmanabhan and Palanisamy, 2013; Padalkar et al., 2014; Bolaji and Huan, 2013). Refrigerant life in the atmosphere is also an important thing. When the refrigerant remains exist in the atmosphere, the negative impact of the refrigerant is also with the refrigerant. One of negative impacts of global warming is heat wave (Suparta and Yatim, 2019; Bocancea, 2018; Esmailnejad, 2016). Suparta and Yatim, 2019 found that the heat wave has negative impact on plantation and human being healthy. Bocancea (2018) analyzes the heat wave in

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Romania and found that the duration of heat wave in Romania increases in a period of 1961 – 2017. Esmailnejad (2016) found that heat wave occurs in part of Iran several days in a year. Global warming also contributes to extreme rainfalls in Indonesia. Even though there is much water in the rainy season, but the quality of the water is at a low level due to waterflood. Dwianika et al (2020 stated that it is important to manage the water resources to avoid the conflicts which are from water source problems. Therefore, the researchers need to find the way to reduce the global warming potential.

As the synthetic refrigerants used in the refrigeration and air conditioning system still have the GWP, the research on the environmentally friendly refrigerant continuous to carry out. The environmentally friendly refrigerant substantively known a long time ago, however, as the synthetic refrigerants proposed the better performance, the use of environmentally friendly refrigerants are not used. Ammoniac is an environmentally friendly refrigerant. The drawback of the ammoniac is corrosively, therefore ammoniac needs a specific un-corrosive design system. The next environmentally friendly refrigerant is CO_2. This type of refrigerant is not familiar in refrigeration because CO_2 needs high-pressure air conditioning design. Another environmentally friendly refrigerant is the hydrocarbon. Hydrocarbon has an advantage among other environmentally friendly refrigerants. Propane (R290) and isobutene (R600a) are hydrocarbons which commonly used in the refrigeration system. Hydrocarbon (propane/R290) has similar operational pressure with R22. This advantage brings the R290 into the research to be the future refrigerant. The only drawback of the R290 is its flammability. Hydrocarbon has no ODP and negligible GWP (3). The lifetime of hydrocarbon in the atmosphere is one of its advantages. Hydrocarbon lifetime is 3 years, therefore the effect of hydrocarbon on the environment only in 3 years. Another hydrocarbon that already used in the refrigeration system is isobutene (R600a). R600a is popular in the refrigeration area. Refrigerator with R600a as its refrigerant is already in the market. R600a and R290 have the same ODP, GWP and atmosphere lifetime.

As the hydrocarbons are environmentally friendly refrigerant, these refrigerants become popular today. It is easy to find research on hydrocarbon. Previous researches show that R290 has a better COP compared to R22. The cooling capacity of R290 is slightly lower than its R22 (Park et al., 2007). Siang and Sharifian, 2017 found that the cooling capacity of R290 increases gradually from -20% undercharged - +30% overcharged.

As R290 is a flammable substance, the safety should be noted. Previous researches indicated that comparing to R22, the mass of R290 in the same system with R22 is about 40% - 50% mass for the COP and cooling capacity as explained previously (Gartshore et al., 1995). The use of R290 as refrigerant is in the small air condition system. This is due to the regulation of safety. When the mass of R290 lower than 40% of R22 mass in the system, the evaporator pipe easily covered by an ice layer. This is caused by the low pressure in the evaporator. The ice layer appears at the evaporator pipe because the temperature of R290 at that pressure is below the frosting temperature of the water. Siang and Sharifian, 2018 stated that increasing airspeed over the evaporator decreases the risk of frosting development around the evaporator pipe.

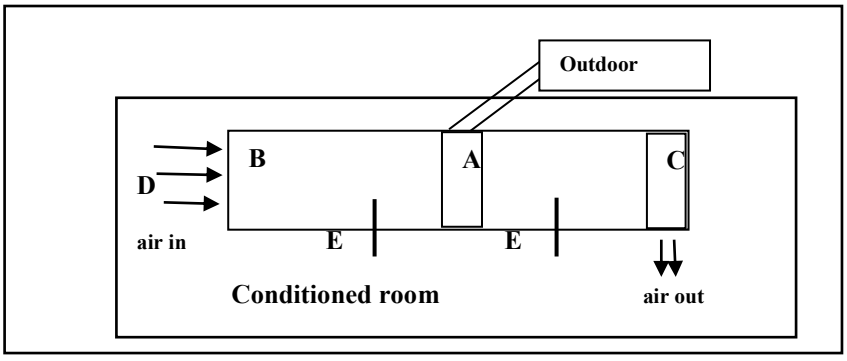
The research of comparison of the performance of R22 at normal charge with R290 at low charge 32% of R22 mass has been carried out with the result: COP of R290 is lower than the COP of R22. The cooling capacity of R290 is lower than the cooling capacity of

R22 at low and moderate speed of air over the evaporator, at 2.0 m/s, the cooling capacity of R290 is slightly lower than the cooling capacity of R22 (Siang et al., 2019a). The low pressure of R290 at a low charge has been studied in previous research. COP of R290 – R600a blend is slightly higher than R290 but the cooling capacity of this mixture is slightly lower than R290 (Siang et al., 2019b).

The present research aims to analyze the effect of the physical properties of R290 – R600a blend on the evaporation convective heat transfer coefficient compared to R290. Most of the previous researches on evaporation and condensation heat transfer coefficient found that the convective heat transfer coefficient increases with increasing the vapor quality (Park et al., 2008; Lee at al., 2005; Lee at al., 2006). However, Wang et al., 2013 have a different result. In their research, they found that the convective heat transfer coefficient may increase, remain constant or decreases. It depends on the boiling number and liquid and vapor density ratio of the refrigerant (Kandlikar and Steinke, 2002).

2. METHODOLOGY OF THE RESEARCH

The first step of the present research is experimentally collecting data of 120 g R290 mass in ¾ PK window air conditioning. The air conditioning has been modified to be an experiment apparatus can be seen in **Fig. 1**. Data collecting rom the experiment work are inlet and outlet temperature of evaporator and condenser, inlet and outlet pressure of evaporator and condenser, wind speed at inlet of the evaporator, temperature of the room and electrical power. After collecting data experiment, the COP and cooling capacity are calculated. Thermal conductivity, specific heat and viscosity are based on the saturation temperature of the evaporator. The last step of the present research is theoretically calculated the performance of R290 – R600a blend, physical properties and evaporation heat transfer coefficient of R290 – R600a blend.



A : Evaporator B : Wind tunnel C : Blower
D : Anemometer E : Bar thermometer

Fig. 1. Schematic diagram of experimental apparatus.

The speed of air over the evaporator was at 0.5 m/s, 1.0 m/s, 1.5 m/s and 2.0 m/s. Speed of air was recorded by fan anemometer with accuracy ±5%.

The evaporator pressure was assumed constant as well as condenser pressure and was recorded using bourdon pressure gauge with least count of 1ºC. Inlet temperature of evaporator was not recorded as it was the saturation temperature. Outlet temperature of evaporator, inlet and outlet temperature of condenser was recorded by thermocouple with least count of 1ºC. Inlet and outlet air temperature over the evaporator, room temperature were recorded by 1ºC least count bar thermometer. Electric current was measured using power clamp with ±2.0%. The properties of the refrigerant was found by using REFPROP 6.02

Reynolds number, Nusselt number, Prandtl number and convective heat transfer coefficient were calculated with the formula:

$$Re = \frac{4\, m_r}{\pi\, d\, \mu_r} \tag{1}$$

$$Pr = \frac{\mu\, C_p}{k} \tag{2}$$

$$Nu_D = 0.023\, {Re_D}^{4/5}\, Pr^{0.4} \tag{3}$$

$$h = \frac{k\, Nu_D}{d} \tag{4}$$

Convective heat transfer coefficient can be expressed as Equation (5) when Eq. (1) and (2) is put into Eq. (3)

$$h = 0.0697 \left(\frac{m_r}{\pi}\right)^{0.8} \left(\frac{Cp}{\mu_r}\right)^{0.4} \left(\frac{k}{d^3}\right)^{0.6} \tag{5}$$

3. RESULTS AND DISCUSSION

Table 1 shows that the highest cooling capacity is R290, and the lowest cooling capacity is 60%R290 – 40%R600a. The highest COP of the system is with 60%R290 – 40%R600a blend as 5.019 while the lowest COP is R290 as 4.544 Physical properties of the refrigerant at the condition shown in table 1 are presented in the next Figures.

Table 1.

Performance of the refrigerants in the present research.

Ref	P_{evap} (MPa)	P_{cond} (MPa)	T_1 (º C)	T_2 (º C)	T_3 (º C)	T_4 (º C)	Cooling (Kw)	COP
A	0,339	1,239	4,971	56.000	34.000	-10,522	0,966	4,544
B	0,339	1,239	5,652	56.000	34.000	-8,336	0,963	4,663
C	0,339	1,239	6,295	56.000	34.000	-5,962	0,959	4,789
D	0,339	1,239	6,894	56.000	34.000	-3,378	0,954	4,924
E	0,339	1,239	7,085	56.000	34.000	-0,566	0,948	5,019

Fig. 2 shows that the specific heat of the refrigerant decreases as the vapor quality decreases. The most decrease in specific heat is R290 as 17.6% and the least decrease is 60%R290 – 40%R600a blend as 15.8%.

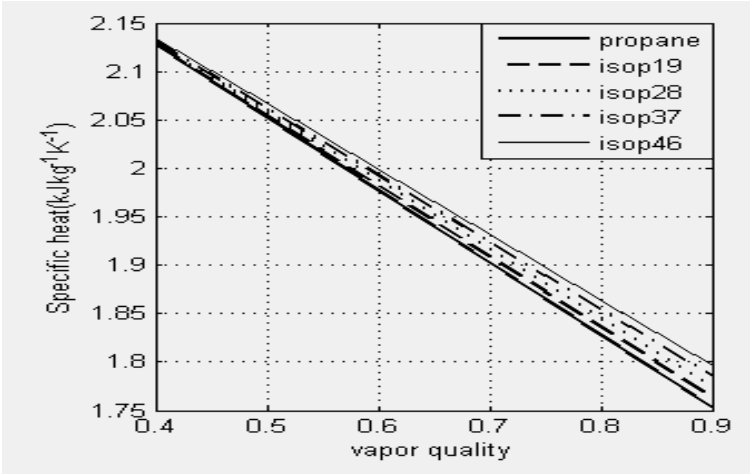


Fig. 2. Specific heat.

Figure 3 shows the change in the thermal conductivity of the refrigerant versus vapor quality. 60%R290 – 40%R600a has the highest thermal conductivity while R290 has the lowest thermal conductivity. On the other hand, the thermal conductivity of R290 decreases most 66.6% compared to other refrigerants. The refrigerant with the least decrease in thermal conductivity is 60%R290 – 40%R600a blend as 65.0%.

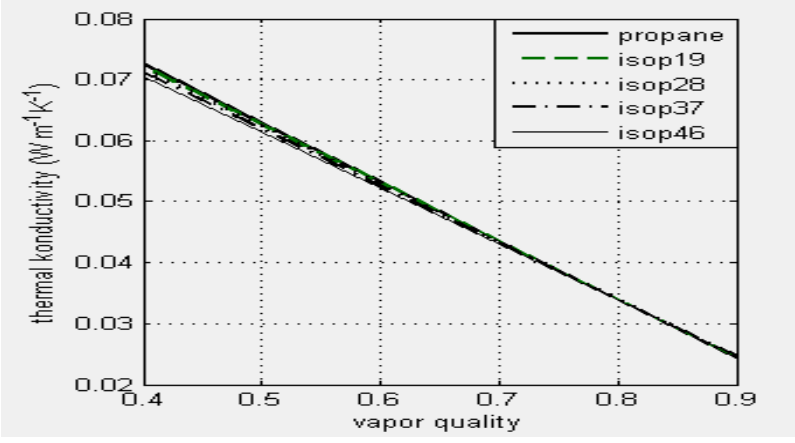


Fig. 3. Thermal conductivity.

The change of viscosity of the refrigerant with vapor quality is shown in **Fig. 4**. The figure shows the 60%R290 – 40%R600a blend has the highest among the refrigerants in this research and also decreases most in 76.9% as the vapor quality increases. Even though R290 has the lowest viscosity but decreases the least in 76.2% compared to other

refrigerants. As a result, the viscosities of all refrigerants in this research have nearly similar at vapor quality of 0.9.

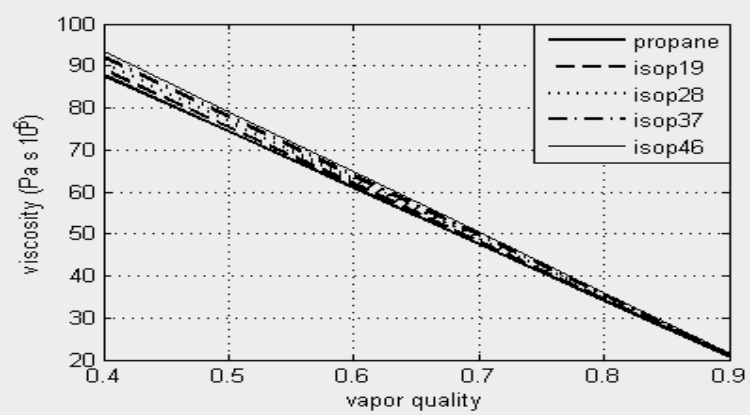


Fig. 4. Viscosity.

The comparison of Reynolds number of R290 and the variation of R290 – R600a blend is presented in **Fig. 5**. The figure shows the change of Reynolds number (Re) in the range of 0.4 – 0.9 vapor quality. There is a similar trend of Re number increases with R290 has the highest Re number, 60%R290 – 40%R600a blend has the lowest Re number. All the refrigerants increase by around 300% when the vapor quality increases from 0.4 to 0.9. The viscosity of the refrigerant has an important role in the change of the value of Re number. Re value increases with decreases in viscosity.

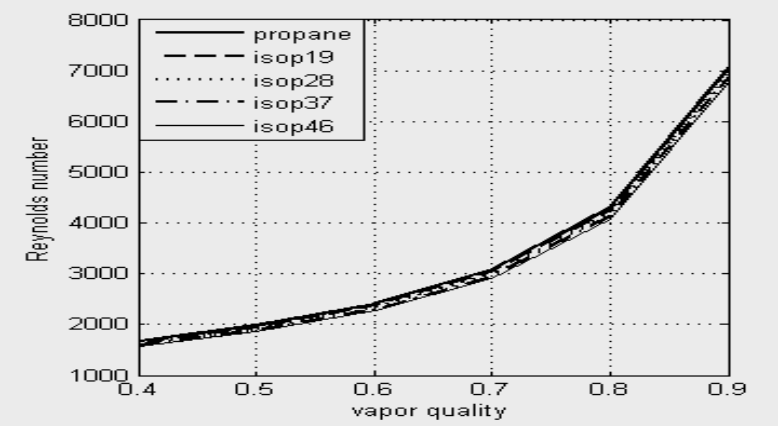


Fig. 5. Reynolds number.

Fig. 6 shows the change of Pr number along the 0.4 – 0.9 vapor quality. The Figure shows that 60%R290 – 40%R600a blend has the highest value while R290 has the lowest Pr number. The highest percentage of Pr decreasing is R290 as 44.5% while the lowest decrease in Pr number is 60%R290 – 40%R600a blend as 41.3%. Thermal conductivity,

viscosity and specific heat influence the value of Pr number. Thermal conductivity and viscosity are directly proportional to Pr number, while specific heat is inversely proportional to Pr number.

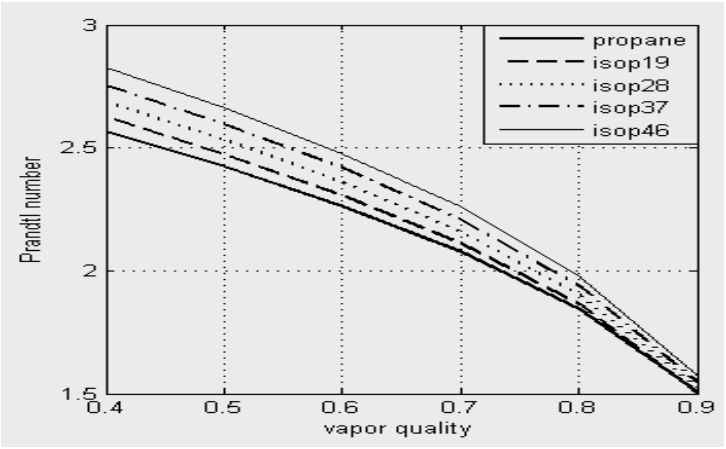


Fig. 6. Prandtl number.

The next important variable that affects the heat transfer coefficient is the Nusselt number. The variation of Nusselt number of the refrigerants is presented in **Fig. 7**. The figure shows that the trend of the Nu number of refrigerants in this research nearly similar throughout with the vapor quality change. Similar to the Re number, the refrigerants in this research have the same increasing trend. All the Re number of the refrigerants increase around 155%.

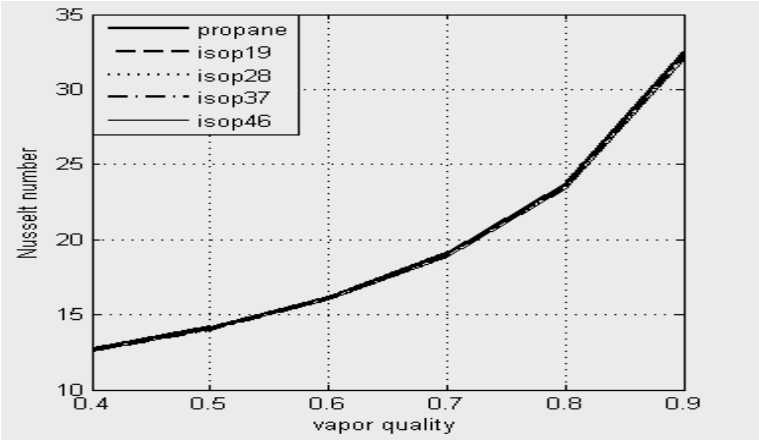


Fig. 7. Nusselt number.

In **Fig. 8**, the change in the heat transfer coefficient of the refrigerants is presented. Generally, the heat transfer coefficients of the refrigerants decrease by an increase in vapor

quality except for the blend of 40%R600a – 60%R290 at vapor quality of 0.8 to 0.9. The convective heat transfer coefficient is indicated to be increasing.

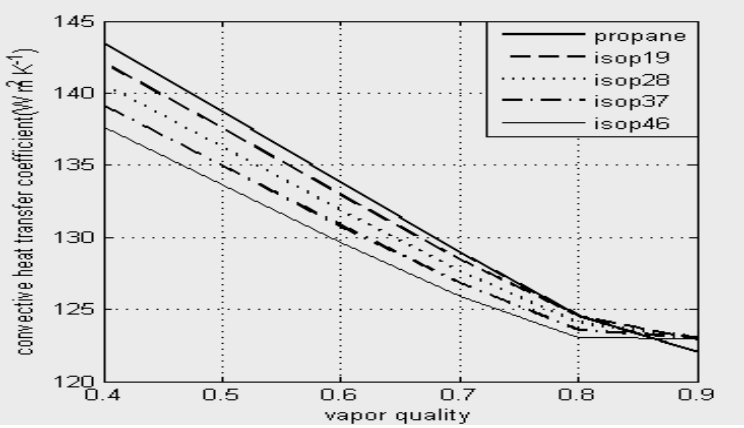


Fig. 8. Convective heat transfer coefficient.

Fig. 8 indicates that R290 has the highest value of convective heat transfer coefficient (h) at a low vapor quality of 0.4, and the lowest h is 60%R290 -40%R600a blend. But at 0.9 vapor quality, h of R290 is the lowest while all four blends (60%R290 – 40%R600a, 70%R290 – 30%R600a, 80%R290 – 20%R600a and 90%R290 – 10%R600a) have the similar value of h. The h is directly proportional to $Cp^{0.4}$ and $k^{0.6}$ while h is inversely proportional to $\mu^{0.4}$.

Table 2 shows the ratio of fluid density to the vapor density of the refrigerants. Table 2 shows that R290 has the highest density ratio. An increase in the percentage of R600a in the R290 – R600a blend brings to a higher density ratio.

Table 2.

Ratio of fluid density to vapor density of refrigerant.

Refrigerant	ρ_{liquid}	ρ_{vapor}	$\rho_{liquid}/\rho_{vapor}$
R290	542,900	7,513	72,261
90%R290 – 10%R600a	545,149	7,555	72,158
80%R290 – 20%R600a	547,303	7,625	71,780
70%R290 – 30%R600a	549,292	7,717	71,184
60%R290 – 40%R600a	551,07	7,827	70,406

4. CONCLUSION

The effect of the physical properties of the refrigerant on the convection heat transfer coefficient directly proportional to thermal conductivity and specific heat of the refrigerant. The effect of viscosity can be negligible in the present research. From Eq. 5, the convective heat transfer coefficient increases while the viscosity decreases.

In fact, the heat transfer coefficient remains decreases although the viscosity decreases. It can be caused by the power of viscosity is 0.4 but the power of thermal conductivity is 0.6 and (Eq. 5). Also, the combination of decreases in thermal conductivity and specific heat is more powerful compared to the decreases in viscosity. The ratio of the density of the refrigerants in Table 2 is around 70 – 73. Compared to Kandlikar (1991), it partially agrees with his work. In Kandlikar's work, the heat transfer increases with vapor quality at 1000 density ratio but decreases with vapor quality when the density ratio is 10. It is important to note that by converting the synthetic refrigerant with R290 and R600a will decrease the risk of global warming. This is because R290 and R600a have low GWP with short amospheric life time.

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OPTIMAL SCHEDULE IN URBAN TRANSPORTATION TO REDUCE THE PASSENGER CROWDED AREA

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ABSTRACT:
The crowded area in the bus stop are happen at the peak time where a lot of passengers wait for the bus. That kind of situations is one of the reasons for some people to decide not to use public transportation. This reseach is aimed to optimize the schedule time model of the urban transportation problems in high-density city, in order to reduce crowding in the area of bus stop. The condition that makes the bus stop becoming crowded is considered. An effective schedule is proposed in order to minimize the crowded area of the bus stop. The proposed schedule are evaluated and compared with the existing schedule which can predict the optimal schedule of the problem. The bus route and bus stop locations are constructed based on TransJakarta, operator of bus rapid transit system in Jakarta city, Indonesia.

Key-words: *Bus Rapid Transit, schedule, crowded area, TransJakarta.*

1. INTRODUCTION

Public transportation in urban area offers the potential solution for the problem of traffic which are normally becoming arise in high-density city. The traffic congestion problems contribute air pollution because of a lot of people use private vechiles. It will increases travel times, unsure to estimate time arrive, fuel consumption and feeling distressed. The congestion at the road make it difficult for people which using private vechiles, but this situation cannot make those people change to use public transportation, they still using private vechiles that give them more convenient, safe and secure. There are problems and challenges in public transportation, delay time of schedule or bus vechile did not arrive on time, this problem cause inconvenience for people due to crowded area and waited for long. The convenient transportation condition with good facilities and service support are nece, will attract people who use private vechile to . Large vechiles of public transportation such as buses can get easy access than train for the people looking convenient.

Bus rapid transit (BRT) in modern public transportation are equipped with using information technologies applications in large-scale networks that can be useful to know the situation of the bus enviroment inside and outside the bus. With development the application of passenger information systems software, nowadays passengers can know where the position of the bus then predict which bus will arive soon or suitable with their need. Giving passengers the right information is critical to high quality of BRT systems. The need of real-time passenger information that can be handled by device from any place such smartphone or computer devices are still in challenges. Type information should be part of the passenger

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information according to BRT standard must include with route maps, time arriva/schedule and service alert (ITDP, 2016).

Many BRT system research are proposed the solution of the transportation problem in the city. There is gaps between different levels of policy development and implementation of BRT projects (Wijaya & Imran, 2019). The government policy support is important to implement BRT system in the city. The standard of BRT is decided by Institute for Transportation & Development Policy (ITDP, 2016). The performance of BRT of the city is evaluated and mark is given according the operational condition of BRT. An ordered choice approach is developed for performance contributors of BRT systems within that standard (Li & Hensher, 2019). With this BRT Standard, the BRT operator and policy maker can have a reference to do the better services.

Research about schedule problems are developed for timetable optimization for single bus line (Nguyen, 2015; Tran et al., 2018) there is a another cost for a bus of different size. The advantage of different type of bus can have low cost of operation (Sun et al., 2015). The crowded area problem in BRT system is considered arise when the peak time comes for bus rapid transit in assigned route. During the peak time period, the number of passenger are becoming overloaded that cannot pickup some additional passenger at the bus stop. Understanding the platform at the bus stop based on the performance are considered. There are two model of crowded happen, in the BRT capacity and in the bus stop area (Duduta & Subedi, 2015; Al- Mudhaffar et al., 2016; Batarce et al., 2016; Sitorus & Permanasari, 2019).

In this research, the time schedule that related for crwded area is considered. The objective is to find the condition which makes the area of the bus stop becoming crowded is decreased. The crowded problem is arise from the human space calculations that exceeds the limits of the room such as geography, environmental studies, spatial planning, topography or economics.

2. STUDY AREA AND DATA

Jakarta is part of Java island which have high-density for the people who lived in area comprises 661,521 km^{2}and population reached 10,374,235 inhabitants in 2016 (BPS, 2017).

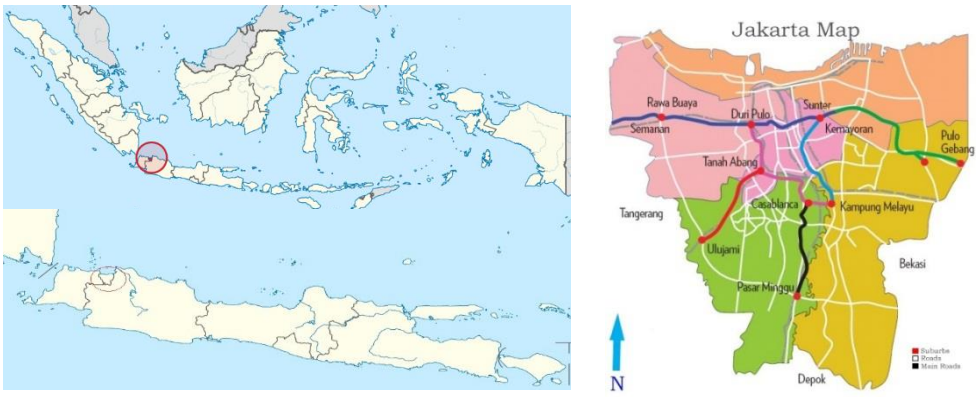

Fig. 1. Indonesia, Java Island and Jakarta City.

As the national capital and largest city in Indonesia, Jakarta is the only city in Indonesia that has provincial level status. This city also the place where goverment head offices, private companies and foreign companies are located, and become center for business, politics, and culture. A lot activities need good flow mobility for moving from other city and inside the city. There is a network of highways and toll roads that serve the entire city, but the development of the number of cars with the number of roads is very unbalance. According to data from the Jakarta Transportation Department, there are 46 areas with 100 intersection points prone to traffic jams in Jakarta. The definition of congestion is unstable current, low speed and long queues. Congestion often occurs in the morning and evening, which is when the hours go to and from work.

Since 2004, the Jakarta Government has provided a public transportation service known as TransJakarta. This service uses air condition buses and bus stops that are on special lanes. TransJakarta is the Bus Rapid Transit (BRT) system in Jakarta, Indonesia. Transjakarta began operations that have one route with name Transjakarta Corridor 1. The definition of Corridor in BRT is a section of roads served by one bus route or multiple bus route that has dedicated bus lanes (ITDP, 2016). As shown in **Fig. 2,** illustrate for dedicated bus lane, the bus is running in the middle of the road. The term "bus-way" is popular word to simplify meaning for the road only use for BRT. Passengers go to bus stop by using pedestrian bridge and can choose which bus they would like to use.

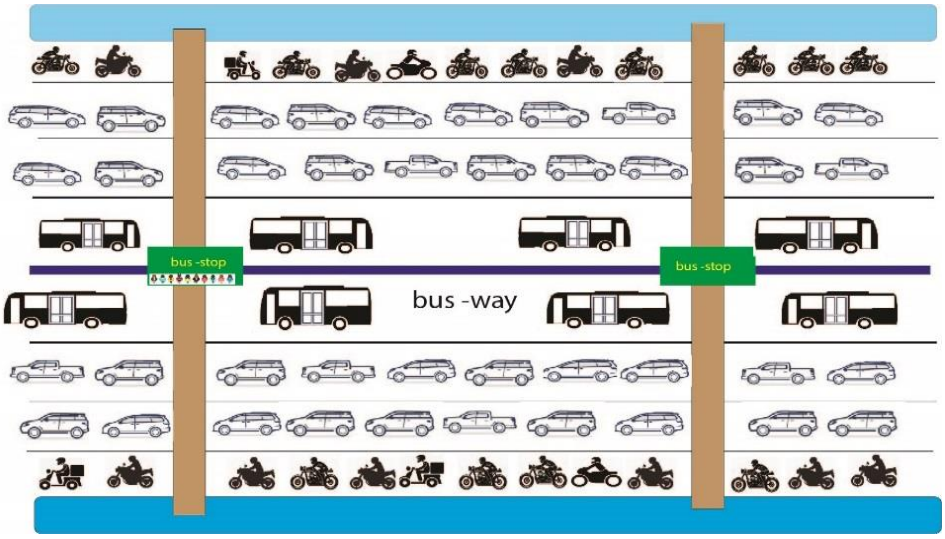

Fig. 2. Illustration of corridor for dedicated BRT bus lane.

Until 2019, TransJakarta has 13 corridors with a total length of 204 kilometers. Now, the transportation company owned by the Jakarta Provincial Government has served Jakarta residents for 15 years. TransJakarta has become a symbol of renewal of road-based public transportation in Jakarta and even Indonesia. Because of the dedicated lane, the speed of the BRT in the road is normal not affected by the congested surrounding road. The BRT is expected to be able to change private vechile user using BRT.

For the purpose of numerical experiments in this research, BRT TransJakarta Corridor 1 is used because in this route extrimely busy than other corridors. **Fig. 3** shown Corridor 1 which through protocol road in Jakarta.

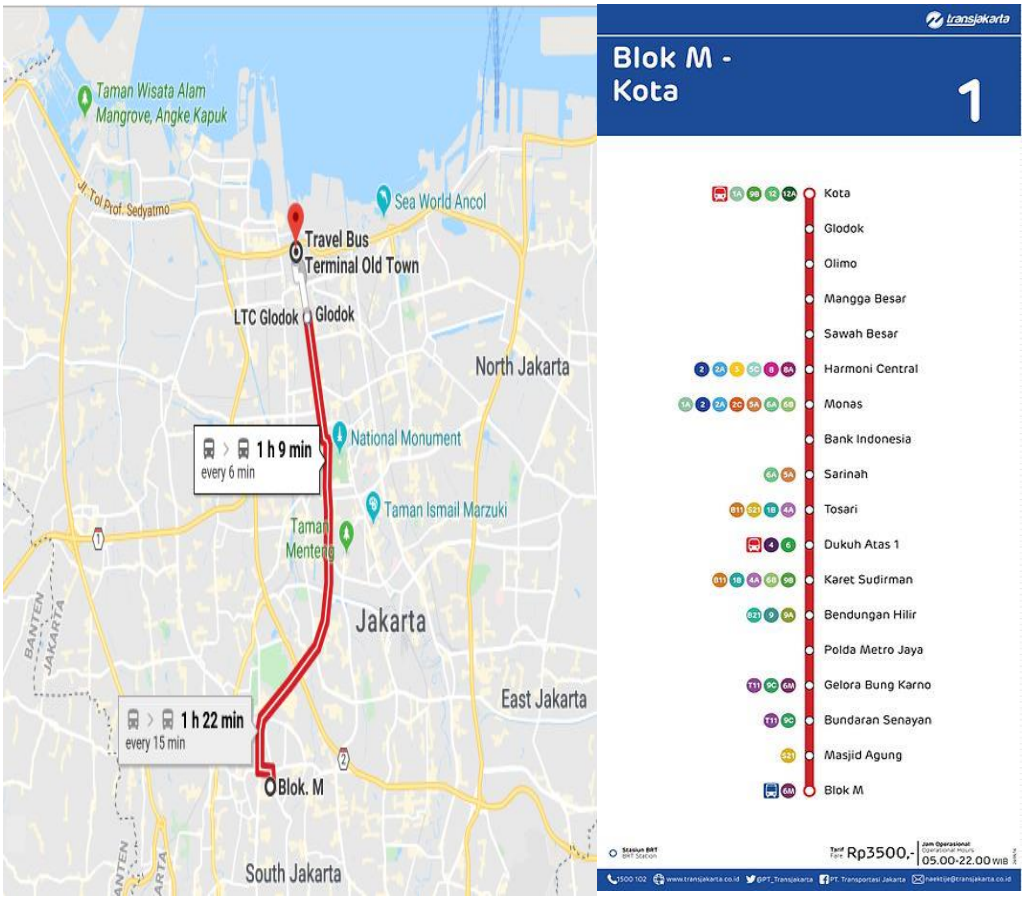

Fig. 3. TransJakarta Corridor 1 map in Jakarta City (red line) and bus stop routes.

In **Table 1** shows the existing schedule that provided to serve 24 hours operation time of TransJakarta Corridor 1. As the bus schedule operates for 24 hours, it has 10 periods of time with 3 types that is normal period, peak period and midnight period. The time schdule of schedule the normal period start from 5.00 in the morning on period 1 (5.00 - 6.00) where the number of active buses (#Active bus, shown in the Table 1) 30 buses operate which start with headway 3 minute. Headway is the length of time between a single bus route. If the headways of the buses is 3 minutes, that mean the buses on that route arrive every 3 minutes. The number of buses from starting point Blok M terminal is 15 buses and other 15 buses start from starting point Kota terminal. The peak time in the morning is in the period 2 of the schedule, the number of active bus is increased to maximum by using 60 buses. In the peak period headway of the bus becoming 1 minute. After peak time period then normal period

will start again. Some buses will be off from the activity to take rest, bus maintenance or refueling. This procedure runs repeatedly and flexible. This procedure runs repeatedly and is flexible depending on the condition of the bus and the the services to be provided from the operator to decide whether a bus will be active or not on the route. The number of buses which operates in this time schedule depart from the terminal orderly, the first bus will be follow for the second bus and so on. The rule of the order must be obey for driver to follow, there should not be a bus precedes the order, the reason is to maintain the range of the headway of buses.

Table 1.

Transjakarta daily time bus schedule for a day.

Corridor 1 route from Blok M terminal to Kota terminal					
Period	**Time Range**	**Start from Blok M**		**Start from Kota**	
		#Active Bus	**Headway**	**#Active Bus**	**Headway**
1	05.00 – 06.00	15 buses	3 min	15 buses	3 min
2	06.00 – 08.00	30 buses	1 min	30 buses	1 min
3	08.00 – 11.00	15 buses	3 min	15 buses	3 min
4	11.00 – 13.00	30 buses	1 min	30 buses	1 min
5	13.00 – 16.00	15 buses	3 min	15 buses	3 min
6	16.00 – 18.00	30 buses	1 min	30 buses	1 min
7	18.00 – 19.00	20 buses	2 min	20 buses	2min
8	19.00 – 21.00	15 buses	3 min	15 buses	3 min
9	21.00 – 23.00	10 buses	3 min	10 buses	3 min
10	23.00 – 05.00	5 buses	5 min	5 buses	5 min

3. METHODOLOGY

3.1. Evaluation of bus schedule time

In the peak time or rush hour the number of passenger has jumped and it is difficult to predict how many passengers will arrive at the bus stop and which destination they will go for the next stop. For bus stops that have locations close to business activities, offices and bus stops which intersect from the bus corridor, at the end of office hours the number of passengers will increase drastically at these stops. From the large number of active buses, because the bus has to wait until the previous bus moves even though it has a short headway, the slowdown occurs when the bus moves to the next bus stop.

3.2. Analysis of the relationship between crowded and schedule

From the given schedule, this research consider the relation of crowded area bus stop and the schedule of BRT will arrive at the bus stop. The capacity of bus is assumed same for the sake of simplify the calculation. If the number of passenger in bus is same or almost near to the capacity, this condition is becoming crowded inside the bus and cannot take in the number of passenger at bus stop.

To illustrate that situation, let define the number of the bus stop, the number of bus, headway long time, bus capacity and assume the number passenger are coming to the bus stop by random number. The example of numerical calculation can be describe as follow:

- The number of bus = 3
- The number of bus stop = 5
- Headway time = 5
- Bus capacity = 25

- Assume the number of passenger
  - Passenger from start terminal = 20
  - Passenger at bus stop 1 = 6
  - Passenger at bus stop 2 = 10
  - Passenger at bus stop 3 = 10
  - Passenger at bus stop 4 = 7

Constraint: The number of passenger must not exceed the capacity is 25

Table 2.

Bus 1 schedule for a route.

Stop Area	#Passenger	# Out	#diff	#In	#Capacity	#wait
Terminal	20	0	20	20	20	0
Bus Stop 1	6	3	3	6	23	0
Bus Stop 2	10	2	8	4	25	6
Bus Stop 3	10	3	7	3	25	7
Bus Stop 4	7	3	4	3	25	4

Table 2 shown the number of passenger at the bus stop which denoted by #Passenger in the column table. When the bus arrive at the bus stop, there is a number of passenger out from the bus (#Out), the difference from the number of passenger at bus stop and out from the bus (#diff), then the number of passenger to go in the bus (#In) can be calculate not to exceed the capacity. The number capacity (#Capacity) is decided to take the passengers or not. Then the number of people waiting in the bus will be happen that can make crowded area in the bus stop.

4. RESULTS

By using crowded area concept as shown in **Fig. 4**,numerical calculation is performed. Calculation based onthen method of this study, the results were found as follows.

Fig. 4. Crowded area concept

Fig 5. Comparative result of schedule.

By comparative experimental results measurement as shows in **Fig. 5**, the experimental schedule can decrease the number of crowded areas rather than the current schedules.

5. CONCLUSIONS

Optimal time schedule data obtained by numerical calculation proved to be useful in using bus schedule. Numerical experimental is comparing the existing schedule by ordering the bus to depart, with proposed schedule for bus to depart by priority to the heavist crowded area bus stop first.

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THE ENVIRONMENTAL THERMAL COMFORT ANALYSIS OF PUBLIC SPACE IN JETAYU PARK, PEKALONGAN CITY

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ABSTRACT:
The study examined the thermal conditions in Jetayu Park, Pekalongan City. Pekalongan city is known as the City of Coast with high temperatures, so the impact on the inconvenience of outdoor activities, especially in the daytime. On the other hand, the City Government is trying to increase public space as a green space function to improve the microclimate in Pekalongan City. Jetayu Park was chosen as a case study because the site is in a strategic position and a high level of use compared to four other public spaces. In this study, a field survey conducted in May 2019, which was a transitional month between the dry season and the rainy season. Observation of the activities of the use of Jetayu Park was carried out in the morning, afternoon, and evening. Besides, observation of the velocity, humidity, and air temperature also done using the Envirometer to find out the thermal conditions in the area. The results show that during the daytime activities at Jetayu Park are very few when compared to morning and evening. It is also reinforced by thermal condition measurement data, which shows conditions during the day do not meet thermal comfort.

Key-words: *Envirometer Microclimate, Public Space, Thermal Comfort, Sustainable.*

1. INTRODUCTION

Nowadays, cities in Indonesia have limitations in meeting the public space for citizens to express, interact, communicate, and transact. Generally, what happens in the cities in Indonesia is experiencing a deficit because the amount of public space provided by the City Government has not been able to facilitate the needs of various social activities that should be the rights of its citizens. Learning from the city of Surabaya in promoting the development of green open space since 2008 turned out to have a significant influence on the decline in air temperatures in the city. It is evidenced by air measurement using an air quality indicator tool, where the average temperature of the City of Surabaya has fallen from 30-31 degrees Celsius to 28-29 degrees Celsius (Kompas, 2019). Mean while, in the tropical cities, due to the abundant solar radiation and the relatively high air temperature and relative humidity levels, long periods of outdoor thermal discomfort are common. Considering also the impact of urban heat island (UHI) effects in the urban areas, the need for designing outdoor spaces for outdoor comfortable criteria is critical (Amirhosein et al., 2019)

A city should provide a minimum of 9 m² of green spaces for each person based ond the requirement from World Health Organization-WHO, to ensure the adequate amount of urban green spaces for enhancing people's quality of life (Suthat et al., 2019). Pekalongan City like other developing cities struggling to provide the need of green spaces (**Tab. 1**). There are now several public spaces that also have a function as green spaces.

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The local government has developed it into creative public spaces. One of them is public space in the Jetayu area, where the location is in District Panjang in the north of Pekalongan City. The green space with a total area of about 1.16 hectares, divided into active and passive parks (Alkadri, 2014). An alive park, with big yard and grass which has edges with pavement and is surrounded by quite shady trees. Along the sidewalk, there is also some street furniture such as flower pots, lighting lamps, flagpoles, and billboards. Around the park, several street vendors sell street food and stuff from early morning to evening. Pekalongan City Government not only intends to increase the amount of green open space in the city but also to make public space with the approach of the creative space concept. It aims to strengthen Pekalongan City's branding as a Creative City on the north coast of the island of Java. The public open spaces that have been developed by the Government of Pekalongan City include Monument '45 Park, Jetayu Park, Pekalongan City Hall Green Space, Alun-Alun Nusantara, Sorogenen Park. When compared between the five city parks, it concluded that Jetayu Field is a public green open space which plays the most important role for Pekalongan City compared to other parks. It is due to the high intensity of activities carried out in this region, including the celebration of national and international batik week festival, the commemoration day of national technology. Besides, Jetayu Park is also surrounded by valuable buildings. Such as the Batik Museum, Al Ikhlas Mosque, the Indonesian Christian Church, St. Peter's Church, Pekalongan Post Office, Mylpaal Monument (a marker believed to be the zero point of the island of Java), GOR Jetayu, up to the Loji bridge.

The Pekalongan City Government is quite active in making improvements to meet the needs of public open space. This stressed by the Mayor of Pekalongan conveying in one of his speeches that there were still many Pekalongan City Communities who complained about public space. Moreover, his party took the initiative to add public space, and then he developed into a revolutionary movement to build a comfortable public space for the community. While relating to aspects of 'thermal comfort' actually has dominated human life, especially in terms of interacting with the physical environment. It dramatically affected the existence of public space. Most people talk about their thermal sensations about the air around them, such as 'too hot' or 'too cold,' or maybe just saying that at some point they feel 'hot,' 'cold,' and so on. It shows that the aspect of thermal comfort is very influential in everyday life.

2. STUDY AREA

Green Open Space

The rapid development of urban areas in cities in Southeast Asia has an impact on increasing the ecological burden of the urban areas. One most visible thing is the change of green land into built land, which then contributes to the vulnerability of climate change (Beta & Wayan, 2019; Gunawan et al., 2015; Yusuf & Francisco, 2009; Manik & Syaukat, 2015; Kalnay & Cai, 2003). The existence of green open space The public can be a supporter of the realization of healthy settlements, wherein government regulations it has also been required for urban areas to have a public space with an area of at least 20% of the downtown area. Without green open space, the microclimate in an urban village can be affected. There is no green open space as a source of oxygen, causing poor and imperfect air exchange. If a house is built with lousy material that cannot absorb heat properly, it can change the temperature or increase the temperature and cause urban heat island. Urban heat island is a phenomenon that usually occurs in big cities where the temperature at night is hotter than the temperature in

the morning due to heat reflection by building materials (Beta & Wayan, 2019; Nuruzzaman, 2015).

Green open space also has a contribution due to implement the concept of sustainability in urban design nowadays. Sustainable urban design must be flexible and adapt to changing societies; if not, no one wants. Green open space also has a function in maintaining and preserving the equality of urban ecosystems, such as the environment, social and culture, so that green open space can act as the identity of the city, filtering out particles from the air, preserving groundwater and improving the city's aesthetics (Bambang, Murni, Defry, Setyo, 2019; Adriaens, 2005)

Thermal Comfort

Thermal comfort is a condition of the human mind that shows satisfaction with the thermal environment (Nugroho, 2011; Floriberta 2017). Olgyay (1963) in Floriberta (2017) defines a comfort zone as a zone where humans can reduce the energy that removed from the body in adapting itself to the surrounding environment. Based on ASHRAE, thermal comfort is a condition where there is satisfaction with the surrounding thermal conditions. This comfort is felt by the body when there is a thermal balance. Then the heat produced by the body is equivalent to the release and acquisition of heat in the body. According to Szokolay (1980), comfort influenced by several factors, namely air temperature, wind movement, air humidity, radiation, subjective factors, such as metabolism, clothing, food and drink, body shape, as well as age and sex. Climatological factors that influence thermal comfort are: Air temperature/temperature (C), Wind speed (m/s), Air humidity (% Rh), Solar radiation (watts/m2), Clothing insulation, Activities

Table 1.

The Average temperature and humidity of Pekalongan City in 2015.

Month	Temperature Maks	Temperature Min	Temperature Average	Humidity maks	Humidity min	Humidity Average
January	32,8	24,80	28,80	93	72	83
February	31,8	24,40	28,10	96	83	90
March	32,80	24,70	28,75	91	79	85
April	33,10	25	29,05	90	79	85
May	33,40	24,70	29,05	87	72	80
June	33,00	24,20	28	82	66	74
July	32,4	23,50	27,95	84	68	75
August	32,80	23,50	28,15	85	71	78
September	34,00	24,20	29,10	80	64	72
October	35,30	24,60	29,95	79	64	72
November	35,80	25,80	30,80	86	70	78
December	35,70	25,60	30,65	87	72	80

In thermal comfort study Micro Climate is a specific weather condition on a building/site that is different from the climate in its zone. Climate can be modified or modified through site elements to form the terms of the temperature of the air humidity and wind speeds that produce thermal comfort (Nur, 2015). Site elements that make up the Climate Micro:

1. Topography, land surface shape mapped in the form of contour lines and surface relief, differences in elevation, slope, and shading effects can affect the distribution of solar thermal radiation, air temperature, and wind direction
2. Surface material, in the form of soil, stone, grass, and an artificial pavement made on site. Natural materials such as soil and green tend to have a lower albedo than artificial

pavement such as concrete and brick, so natural materials are very suitable to be applied in public spatial planning.

3. Vegetation, can modify the climate into a microclimate in the following ways: Shading of sunlight through the canopy; as a surface material. The texture of the plant is rough. On the other hand, the direction of reflection scattered. Passive cooling where water vapor from plant respiration as it evaporates will take heat from the air; Angina barrier directors because the row of plants can direct or obstruct the motion of the wind; plants filter out wind-borne dust.
4. Surface water, water found on the surface of the plain. Helpful in the formation of a microclimate is to produce passive cooling.

3. METHODOLOGY

This research is an exploratory study with qualitative data collection (**Fig. 1**). The data processed of Jetayu Park to get more information about land size, microclimate including (air temperature, wind speed, to humidity) through observations, in-depth interviews. As for remarks made to assess the dimensions associated with physical elements (objective). While meetings for evaluating aspects related to social factors, as a result of the presence of the public space (subjective).

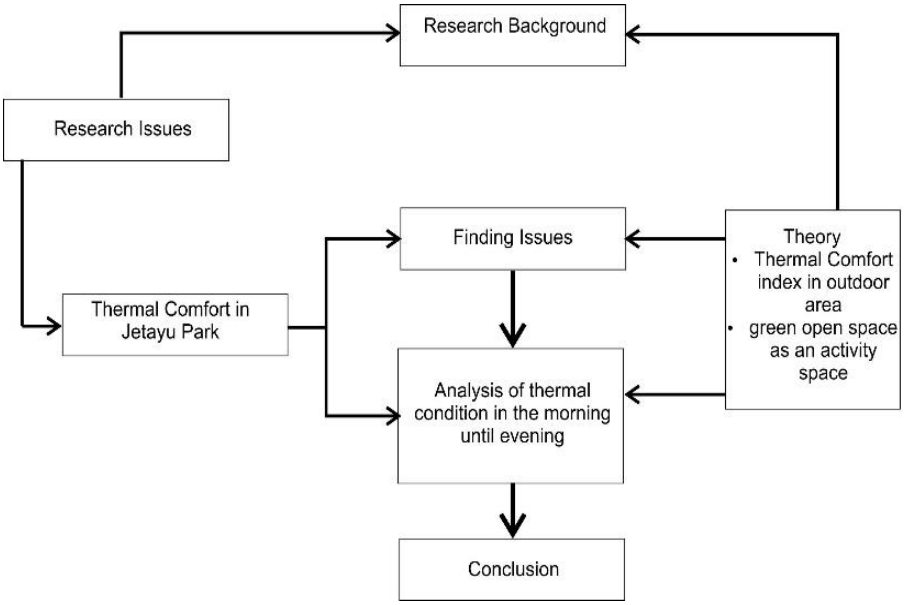

Fig. 1. Study flow chart.

4. RESULTS AND DISCUSSIONS

To find out the thermal conditions in the Jetayu area, measurements of air temperature, wind, and air humidity levels in this area taken. The results of field data measurements are as follows **Figures 2 - 7**.

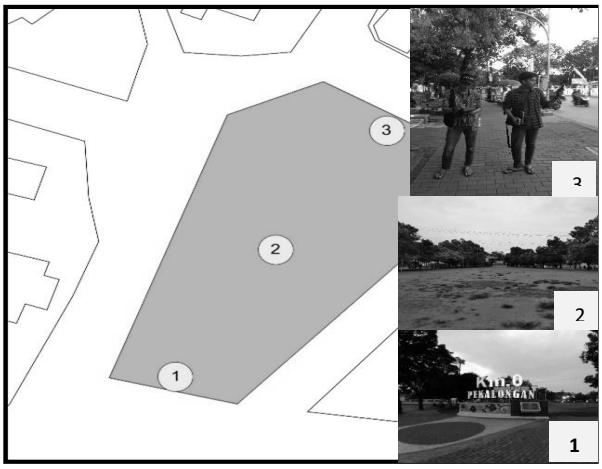

Fig. 2. Location of observation sites in the Jetayu Park.

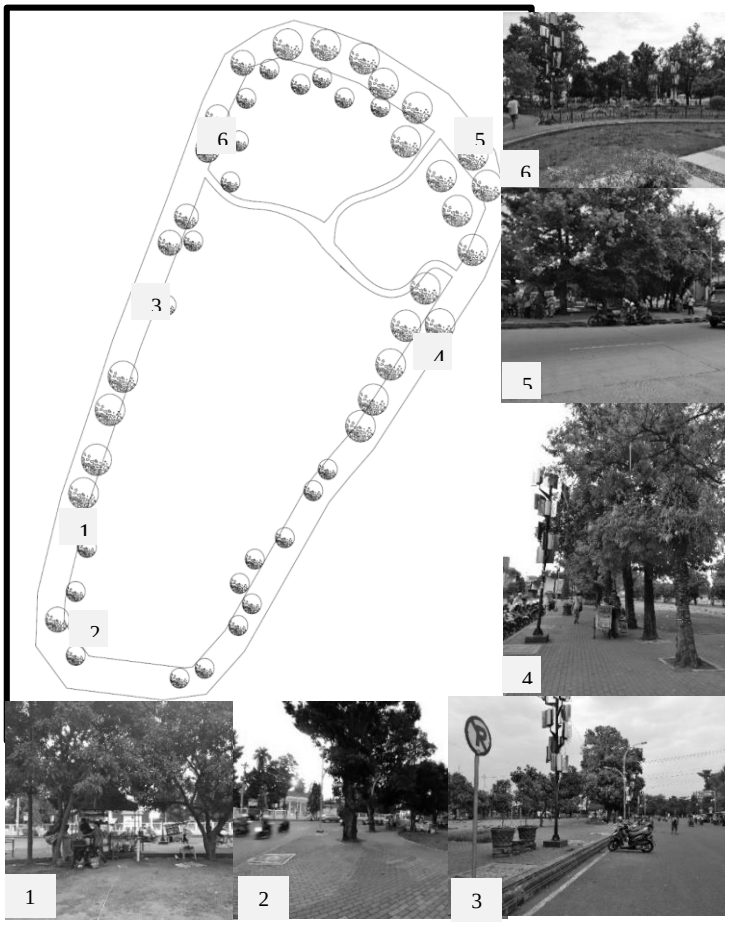

Fig. 3. The Eksisting of Jetayu Park.

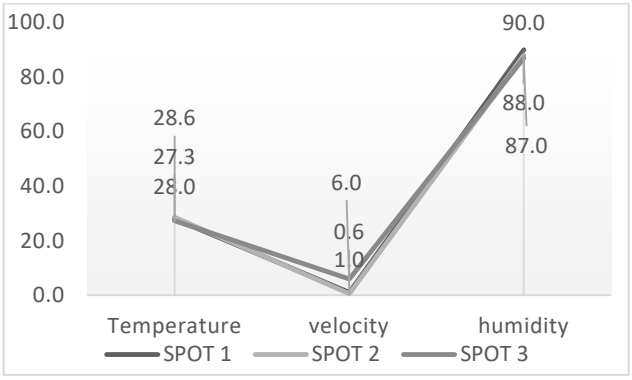

Fig. 4. conditions of Jetayu Park microclimate in the morning (06.00-07.00)
Source: observation, 2019.

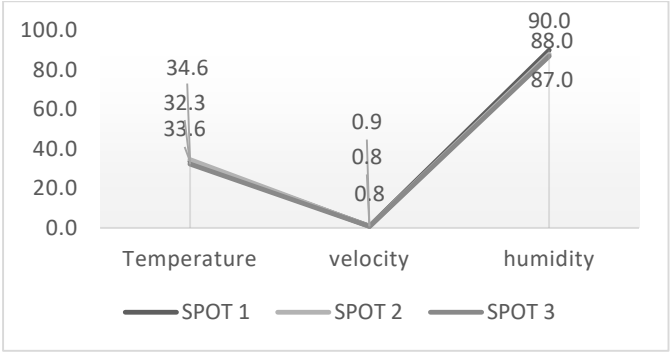

Fig. 5. conditions of Jetayu Park microclimate in the afternoon (11.00-12.00)
Source: observation, 2019.

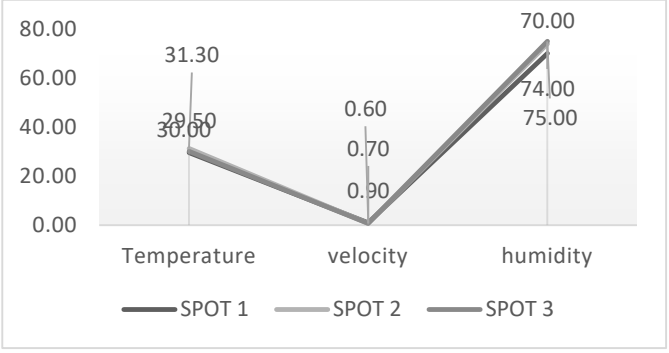

Fig. 6. conditions of Jetayu Park microclimate in the late afternoon (16.00-17.00)
Source: observation, 2019.

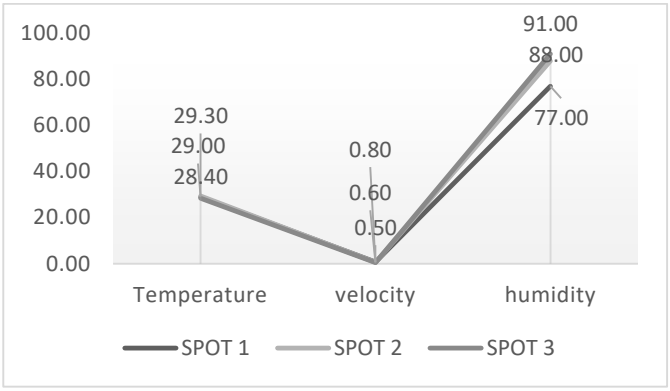

Fig. 7. conditions of Jetayu Park microclimate in the evening (21.00-22.00)
Source: observation, 2019.

Table 2.
Comparison of the number of Jetayu Park users in each time zone.

Observation Time	Number of user
Pagi (06.00-07.00)	75 – 100
Siang (11.00-12.00)	0 – 25
Sore (16.00-17.00)	125 – 150
Malam (21.00-22.00)	75 – 100

Source: observation, 2019.

From the results of field observations (**Tab. 2**) and measurements obtained the following results:

1. In the morning, the Jetayu field was used maximally by the local community for activities such as exercising, selling food, having breakfast, or just sitting on a park bench.
2. During the day, the temperature changes significantly enough to more than 5°C, so the impact on the use of open space is not optimal enough.
3. In the afternoon, there is a decreasing in air temperature, which impacts on thermal comfort, which is better than during the daytime.
4. At night the Jetayu field is still quite busy with activities because the temperature at night is also quite useful for outdoor activities
5. The most crowd use of Jetayu Park occurs in the afternoon at exactly 16:00 to 17:00, while the lowest intensity of space usage occurs during the daytime.

5. CONCLUSIONS

The result of this observation is related to the theory of thermal comfort. Then, it shows in this Park cannot be used during the day, and Jetayu park has not fulfilled the thermal comfort yet. Creating a public green open space to help to control the microclimate certainly requires comprehensive planning, starting from considering the thermal conditions of the area to choosing the type of greening that will be used as a filler element for the city park along with other amenities. This study shows the thermal conditions of the Jetayu Park during

the day showed quite high air temperatures at 34.6 C in Spot B, where is located in the middle of the park, which is part of the location without greening. At certain times even the air on the Envirometer moves up to 36 C, which in these conditions makes no one doing activities in the middle of this city park. Changes in air temperature have a significant effect on Jetayu park use activities. Besides, the existence of open space with trees also affects the distribution of its activities. With the increase in air temperature, the center of activity in this park will move in the part of the park that has shade trees and shown in spot 3. The condition also indicates the influence of the number of food traders more in spot three than in other places. Therefore, if the Pekalongan city government wants to make the Jetayu Park an active open space throughout the day, it is necessary to consider designing a green open space that adjusts to the thermal conditions in this area.

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THE RISKS TO HUMAN HEALTH AND ENVIRONMENTAL IMPACTS FROM COMMUNITY E-WASTE SEPARATION

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ABSTRACT:
The environmental and health impacts on the case study 'Khok Saat community' of the toxic substances and gases produced in this e-waste processing, are obvious and measurable. Two scenarios were developed. A life cycle assessment approach was carried out focusing on the end-of life phase. The ReCiPe Endpoint (H) v.1.10 method was used as the main LCIA method in this study. The result showed that all of impacts in scenario 2 were higher than scenario 1. For 'Human Health (HH)' impact, Human Toxicity indicator was highest and 'Resource Availability (RA)' impact, Fossil Depletion indicator was highest in both scenarios. For 'Ecosystem Diversity (ED)' impact, Terrestrial Ecotoxicity indicator was highest in scenario 1 and Climate Change Ecosystem was highest in scenario 2. The knowledge and understandings gained in this research can be used to inform policy makers and regulating bodies on the need for, and benefits of, a proper and enforceable legal and regulatory framework for the e-waste recycling industry.

Key-words: *E-waste, Life cycle assessment (LCA), Global warming potential (GWP), Human health and environmental impact, Co-benefit*

1. INTRODUCTION

Cheap labor cost and a weak legislation system are two important factors of the existence, and increase in the number of informal or community e-waste separation operations in developing countries (Awasthi et al., 2016; Sadhan et al., 2016). Approximately 80% of e-waste from developed countries such as the United States, Western Europe, China, Japan, and Australia, amongst others, is transported to many developing countries such as India, Ghana and Nigeria and also China for material separating and recycling by using primitive techniques, without appropriate facilities to safeguard environmental and human (Aimin, et. al., 2011). The e-waste import not only offer the business, but also satisfy the demand for cheap second-hand electrical and electronic equipment which is a source of livelihood for the urban and rural pool (Sadhan et al., 2016) and strongly related to financial motivation (Vi & Matthew, 2014). Hazardous substances, improper disposal methods, and inefficient recycling methods have created an environmental problems of near disastrous proportions, especially for local communities close to informal and uncontrolled e-waste recycling sites, with the generated pollutants having a significant impact on human health by skin absorption, inhalation, and digestion

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(Awasthi et al., 2016). Also, poorly waste management causes a high impact on health, environment, and economy (Tantanee et al., 2019). Hazardous substances such as Pb in CRT monitors, Freon gas from air conditioners and refrigerators are also dangerous (John-Michael & Yaakov, 2015). The seriously polluting metals are Ni, Cu, Pb, and Cd. Especially, Pb and Cu are the most hazardous metals demanding effective protection for the workers, but which is usually missing (Takashi et al., 2012). There are many obstacles such as the lack of environmental awareness, workers' unwillingness to be regulated or inability to be regulated because of fear of losing their job, income or profits. Activists at the local level are often fearful of becoming socially marginalized if they try to take action because of the dependence of the community on the profits and incomes generated. Therefore, informal and unregulated e-waste recycling is firmly established in these communities and cannot be phased out (Sabrina & Dabo, 2016). Both recognizes the efficiency of the informal recycling industry and to strengthen work-place health and safety requirements for the recyclers, by moving away from end-of-pipe technologies and move towards Design for Environment (DfE) thinking (Sabrina & Dabo, 2016). Eco-design with producer responsibility is increasing recovery of value from waste, creating a demand for recycled materials, and decreasing the potential harmful effects of waste (Wonorahardjo, 2019). Building informal e-waste recycling strengths while operating in cleaner ways and still retaining livelihoods is essential for reducing the ill effects of current practices (John-Michael & Yaakov, 2015). Futhermore, law enforcement, and the e-waste recycling system are the key successful to reduce the impacts of mobile phone recycling (Vi & Matthew, 2014) and the key factors in reducing the overall impacts are optimizing energy consumption efficiency, reducing waste effluent, using proper waste treatment method, and clearly defining the duties of all stakeholders (Jinglan et al, 2015). To reach the sustainable development goals, changing the environmental resource consumption, behavior routines and governance mode are nescessary (Kabisch, 2019). Furthermore, awareness of natural resources sustainability is very important to be motivated to increase stakeholder control over the application of good governance and must be intergrated in school currucula (Wonorahardjo, 2019; Dwianika et al., 2020).

The impact of heavy metal contamination on human health takes a long time to become apparent. Environmental measurement studies are necessarily longitudinal and conducted over a long period of time, and are therefore expensive. The life cycle assessment method (LCA) is apply to assess the environmental and health impacts in e-waste recycling activities and e-waste management (Jinglan et al., 2015; Souza, et al., 2016). Therefore, an appropriate method for measuring the current and future environmental and health impacts is the LCA which measures such parameters as global warming potential (GWP), human health (HH), ecosystem diversity (ED), and resource availability (RA) impacts. This study utilized the LCA method, and calculations and simulations were done using the SimaPro 8.0.3 software computer program.

2. STUDY AREA

This study focused on the community recycling processing sites which are located in many regions throughout Thailand. There are four big e-waste recycling comunities (**Fig. 1**). Khok Saat community was selected because there are several community recycling sites owned by local people who have operated their business for a long time. This study site utilizes both residential and separate recycling areas. There is located in the Khong Chai District of Kalasin province in the northern east of Thailand.

From prior studies, it was known that the concentrations of mercury, lead, cadmium, copper and nickel in surface water and rice paddy adjacent to the dumping area were lower than the regulatory threshold but higher than other residential area (Saetung, 2009). The concentation of heavy metals (Co = 37 mg/kg, Cu = 6,416 mg/kg, Pb =2,527 mg/kg, Zn=2,253 mg/kg) in top soil (0-5 cm) in dumping site area were higher than the agricultural area standard. The tests on soils collected from informal recycling activities area, which showed levels of copper, lead and zinc contaminations higher than other residential areas (DDC, 2011). At the commencement of the current study, data was collected by taking 207 blood samples from local people working in informal recycling households, people not associated with a recycling household and children from the school in Khok Saat sub-district area. Tests on these blood samples confirmed the prior information when they showed that 21 children and 3 adults had high levels of lead in their blood samples contained. One child's blood sample did show higher lead concentrations than the standard allowable value (Pb concentration >60 µg/dl; (DDC, 2011). There is also every reason to believe that the levels of these heavy metals will rise in the future with continuing e-waste recycling activities, unless action is taken to regulate the industry, and introduce safe practices.

Fig. 1. The administrative boundaries of Khok Saat sub-district

3. MATERIAL AND METHOD

The environmental performance of the e-waste separation community at Khok Saat community was assessed by conducting a life cycle assessment according to the international standard of ISO 14044 series (ISO 14044: 2006). The life cycle assess framework is shown in **Fig. 2**.

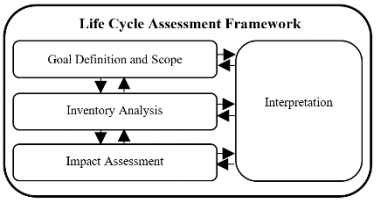


Fig. 2 Phase of LCA (Source: ISO 1997)

3.1 Goal and Scope

The objectives of this study were to assess (i) the environment and health impacts from e-waste separation activities, and (ii) the co-benefit from e-waste separation activities. For System boundaries step, the major activities in the Khok Saat community were taken into account when using the life cycle assessment (LCA) method as the analysis tool **(Fig. 3).** Two scenarios were conducted. Scenario 1 included six main separation sub-processes (A1, A2, B, C, D, and E) in the Khok Saat community area. The dumping site area was also

included in this scenario as (F). Eight semi-products were produced that cannot be used as raw material directly. They are sent to a smelter or refinery, or other processing factories. Therefore, scenario 2 was constructed with the six main separation sub-processes in scenario 1 plus seven other sub-processes (G, H, I, J, K, L, and M) being taken into account.

The assumption in this study was that all of the e-waste was disassembled in separation sub-processes (Sub-Processes A-E). Some recyclable materials were sent to a recycling factory, a refinery, or a smelter in Bangkok (Sub-Processes H-M) while only electronic scrap material was sent for precious metal extraction in Japan (Sub-Process G). Materials that cannot be recycled were disposed in the dumping site area (F). The data for separation processes, Sub-process A-F, in Khok Saat area were surveyed by the authors. However, data for the recycling by smelter and refining processes were provided by an independent company in a SimaPro 8.03 dataset.

3.2 Life cycle inventory

Based on both the investigation in the field and a literature review, an e-waste flow diagram illustrating the two scenarios and the four types of e-waste was developed **(Fig. 3)**. By reusing this waste material to produce new material, the consumption of energy and virgin material can be reduced. Our calculations of the dimensions of this benefit are shown in

Fig. 5, and discussed further below.

The life cycle inventory analyzed in this research, the raw materials were four types of obsolete equipment. Two energy sources, electricity and diesel oil, were used. The assumption in this study was that the residual, unrecyclable wastes were created from sub-processes A2, B, C, and D, in the case of scenario 1. The main residual wastes were CFC, oil, and urethane from refrigerator waste separation, burned PVC from electric wire burning, and panel glass, funnels, guns, and yokes from CRT monitor disassembly. These processes all created emissions into the air and/or contamination of the soil. In scenario 2, wastes were created from G, H, I, J, K, L, and M sub-processes.

3.3 Life Cycle Impact Assessment

Life Cycle Impact assessment (LCIA) was developed and used to evaluate and interpret the environmental impacts of a production system by assigning quantifiable measurement to specific dimensions. The “ReciPe Endpoint (H) v.1.10” method was used as the main LCIA method in this study. ReciPe 2008 comprises two sets of impact categories with associated sets of characterization factors. Eighteen input categories are addressed at the midpoint level. At the endpoint level, most of these midpoint categories are further converted and aggregated into the following three endpoint categories; damage to human health (HH), damage to ecosystem diversity (ED), and damage to resource availability (RA). (ReciPe 2008, update February 2013).

3.4 Limitation of the Study

The environmental impact results in this study were underestimated due to the limited fundamental data. First, the impact from toxic substances composition in e-waste that can be emitted from manual dismantling processes (sub-process A2 and B) is irrelevant, and have no effect on workers’ health and do not contaminate the soil and surface water. As such, they were not taken into account in this study. Second, the amount of waste in scenario 1 was not included due to its being low quality and/or broken recyclable material that cannot be recycled. Therefore, the percentage of recyclable material is an overestimation.

4. RESULT AND DISCUSSION

This field study considered the real production percentage of the Khok Saat community. Two scenarios, shown in **Fig. 3** were classified. The functional unit was the e-waste separation system of Khok Saat community. One tonne of e-waste was considered as the recycling sample. It consisted of four types of obsolete electronic equipment; mobile phones (2.44%), desktop computers with cathode ray tube type (22.11%), television sets with cathode ray tube type (39.09%), and refrigerators (36.36%). The percentage of the total weight of each type of material was showed in **Fig. 3.** The impacts in terms of 'Global Warming Potential (GWP)', 'Human Health (HH)', 'Ecosystem Diversity (ED)', and 'Resource Availability (RA)' were analyzed.

4.1 Global Warming Potential (GWP)

The result of 'GWP' of the semi-products and finished products from 1 tonne of e-waste are presented in a comparative manner in **Fig. 4**. In both scenarios, the fraction of plastic material was higher than the other products, meaning that the GWP of the plastic material was highest. Almost plastic scraps are plastic cabinet and case from CCRT, TCRT, RF, and MP. There were 38.53 kgs CO2eq for 'Mixed Plastic material' and 'Crushed plastic material' and 781.06 kgs CO2eq for Plastic (M). The 'GWP' of 1 kilogram of each material; 'Crushed Plastic Material' was highest (0.1887 kgs CO2eq/kg of product) in the case of semi-product but 'Silver (Ag)' was highest (5.2733 kgs CO2eq/kg of product) in the case of finished product. Total GWP of eight of the semi-products was 87 kgs CO2eq/tonne of e-waste (1.175 kgs CO2eq/kg of products). Total GWP of the 13 finished product was 1,153 kgs CO2eq/tonne of e-waste (48.2838 kgs CO2eq/kg of products).

4.2 Damage to Human Health (HH), Ecosystem Diversity (ED), and Resource Availability (RA)

The results of 'HH', 'ED', 'RA' of the semi-products and finished products from 1 tonne of e-waste are presented in a comparative manner in **Fig. 4** that showed the results from Scenario 1 and 2 from 1 tonne of input e-waste. Unsuitable treatment at 'Dumping site area (F)' and improper recycling process of 'Electric Wire Separation Househouse (C)' by open burning produced toxic emission to air (Cl, Pb, Carbon, PM, PCDD/PCDA) and soil (Cl, Pb, Cu, Sb). There were high potential impacts to human and ecosystem. However, in this study the ferrous metal material product was highest by weight (42.14% of products) so it's the main impacts for 'HH' and 'ED'. From **Fig. 4**, 'HH' in terms of 'Human Toxicity' was highest (9.65E-04 DALY). The production process of 'Ferrous metal material' produced the main fraction in 'Human Toxicity' (4.02E-04 DALY). The total 'HH' impact was 1.22E-03 DALY/tonne of e-waste (1.69E-05 DALY/kg of product). 'ED' in terms of 'Terrestrial Ecotoxicity' was highest (4.77E-06 Species.yr). The production process of 'Ferrous metal material' produced the main fraction of 'Terrestial Ectoxicity' (1.99E-06 species.yr). The total 'ED' impact was 6.09E-06 species.yr/tonne of e-waste (8.46E-08 species.yr/tonne of product). 'RA' in terms of 'Fossil Depletion' was highest (USD$3.8415).

The results from Scenario 2 where eight semi-products from Scenario 1 were sent for processing at a smelter, refinery or recycling factory. Fuel (Diesel, Gasoline) from transpotation process and electricity from pulify processes were the major impacts for 'HH', 'ED', 'RA'. From **Fig. 4**, 'HH' in terms of 'Human Toxicity' was highest (1.67E-03 DALY). The production process of 'Plastic (M)' was the main fraction in 'Human Toxicity' (8.92E-04 DALY). The total 'HH' impact was 3.52E-03 DALY/tonne of e-waste (1.51E-03 DALY/kg

of product). 'ED' in terms of 'Climate Change Ecosystem' was highest (9.14E-06 Species.yr). The production process of 'Plastic (M)'was the main fraction in 'Climate Change Ecosystem' (6.19E-06 species.yr). The total 'ED' impact was 1.50E-05 species.yr/tonne of e-waste (6.12E-07 species.yr/tonne of product). 'RA' in terms of 'Fossil Depletion' was highest (US$10.69). The production process of 'Steel an Iron (H)' was the main fraction (US$4.04). The total 'RA' was US$11.69 per tonne of e-waste (USD$0.8483 per tonne of product). The human health impact 'HH' was highest impact in every products. Ferrous metal and plastic product were the major source.

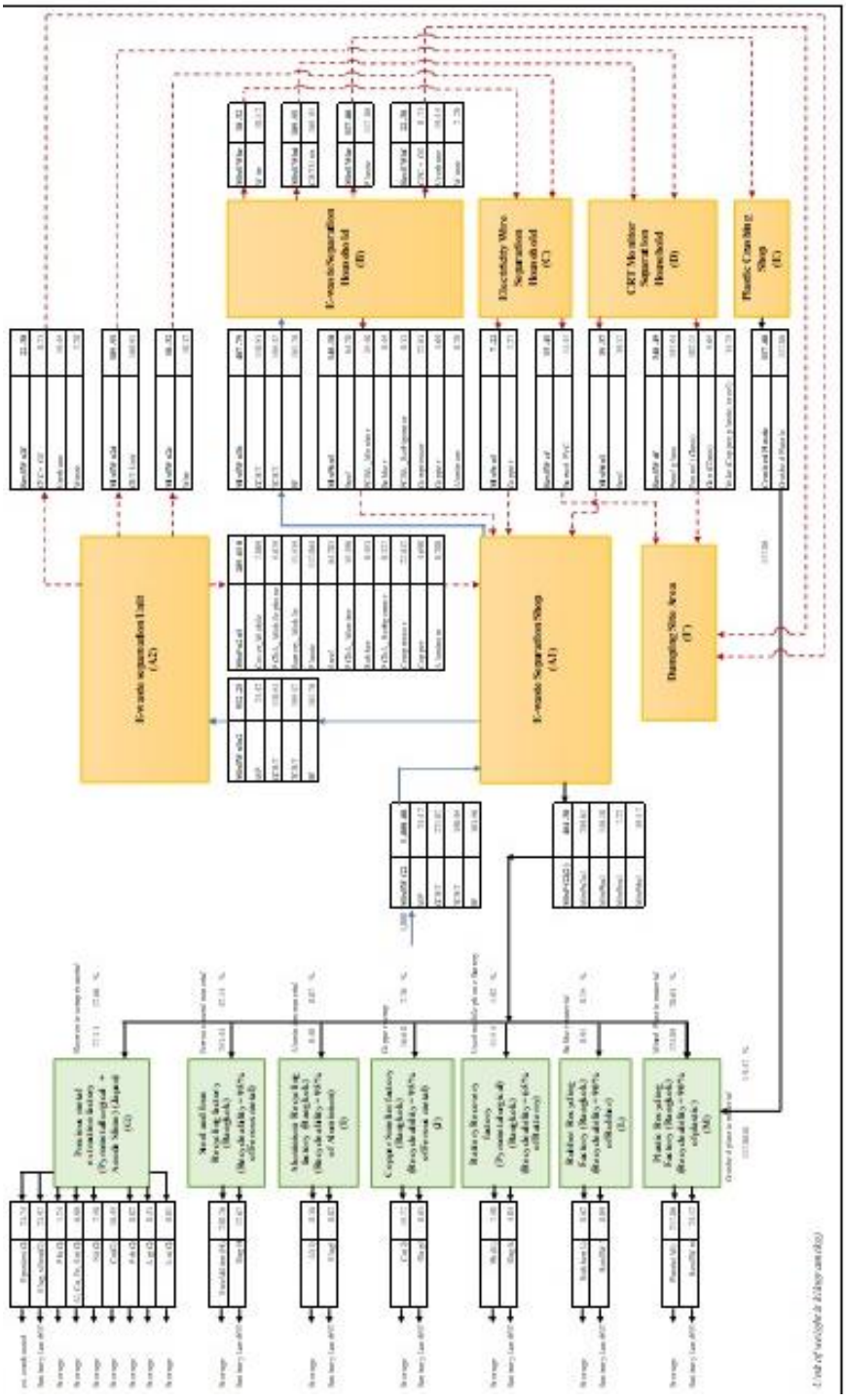
4.3 Co-benefit for recycling as compared to the virgin product

Materials which were recovered from recycling e-waste can be used as feedstock in further processes in order to minimize utilization of virgin material, and which also reduces energy consumption. At the same time, environmental degradation can be reduced. In this study, the impact in the term of 'GWP', 'HH', 'ED', and 'RA' for finished products were compared with virgin production. The health and environmental impacts of different types of virgin materials were obtained from the dataset in SimaPro 8.0.3. Twelve finished-products from 7 processes were compared **(Fig. 5)**. For 'GWP', the recovery of lead (Pb) from used mobile phone battery and rubber from CRT monitor was not relevant. The other finished-products were. In all cases, the 'GWP', 'HH', 'ED', and 'RA' impacts of Au (G) was the highest, followed by Pd (G) an Ag (G).

From our study 'Human health (HH)' impact in the term of 'Human toxicity' was highest in both scenarios. The results were the same impact from mobile phone Printed Circuit boards (PCBs) recycling in Malaysia (Vi & Matthew, 2014). The environmental impact study of e-waste recycling in China was different, ecosystem diversity was highest. For e-waste treatment with end-life disposal (ET-D) scenario ecosystem diversity impact in marine ecotoxicity indicator is highest but terrestrial ecotocixity indicator is highest for e-waste treatment without end-life disposal (ET-ND) (Jinglan et al., 2015). For the ReCiPe midpoint assessment method, the impacts from plastic recycle product were lower than virgin plastic product. The impact from virgin plastic are higher 1.43 times in GWP, 1.20 times in HH, 1.04 times in ED and 18.51 times in RA. The results are in line with another study on plastics recycling, which showed that the virgin plastic production has a higher impact than recycling plastic production by 6-10 times (Patrick & Roland, 2015).

5. CONCLUSIONS

Two scenarios of e-waste recycling were investigated in this study. Scenario 1 investigated six separation activities in the Khok Saat community area. This represented the first level of the e-waste treatment system in that area. Scenario 2 included the first, second, and third levels of the e-waste treatment system in the area. The knowledge and understandings gained in this research can be used to inform policy makers and regulating bodies on the need for, and benefits of, a proper and enforceable legal and regulatory framework for the e-waste recycling industry, which we have identified as being both a potentially profitable activity for small businesses, but also being highly damaging to the environment and to public health, unless properly controlled and regulated. Law enforcement, and the e-waste recycling system are the key successful to reduce the impacts of e-waste recycling and the key factors in reducing the overall impacts are optimizing energy consumption efficiency, reducing waste effluent, using proper waste treatment method, and clearly defining the duties of all stakeholders.



Abbreviations: MP =Mobile phone, CCBT =Desktop computer with CRT Monitor, ICRT =Television set with CRT Monitor, BT =Battery source, MxSW(G2) = Mix e-waste group 2, MxSW24 =Mix e-waste from A2 to G, MxSW2A2C =Mix e-waste from A2 to C, MxSW2C =Mix e-waste from A2 to C, MxSWBatb =Mix e-waste from A1 to B, MxSWBtc =Mix e-waste from B to C, MxSWBtd =Mix e-waste from B to C, MxSWBtc =Mix e-waste from B to C, RasSW2F =Residual e-waste from C to F, RasSW2F =Residual e-waste from D to F, RasSW91 =Residual e-waste from L, RasSWm =Residual e-waste from M, MxSOG12 = (Mix product Group 2, MxSPm1 =Mix product from B to A1, MxSOa1 =Mix product from C to A1, MxSOb1 =Mix product from D to A1,

Fig. 3 System boundary and mass balance of e-waste separation activities in Khok Saat sub-district

Fig. 4. Environmental and health impact of Product from 1 tone of E-waste at Mid-point Impact

Fig. 5. Co-benefit for recycling as compare to the virgin product

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COMPARATIVE STUDY OF THE PATTERNS AND CHARACTERISTICS URBAN MORPHOLOGY IN THE OLD CITY, CASE STUDY ROAD AND BLOCK PATTERNS BENGKULU AND SINGAPORE

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ABSTRACT:
Urban morphology is an applied science that learns about the history of the spatial patterns of a city and learns about the development of a city. The old town area of Bengkulu was an English-built city from 1719 while Singapore was a British formation city as well, due to the London Treaty agreement occurring between the two regions. This Paper aims to be a comparison study between two cities with historical linkages in terms of identifying patterns and characteristic of its city morphology. This research is quantitative descriptive research using two analytical techniques namely diachronic reading and Tipo-morphology. The indicators used to acquire patterns and characteristics of the urban morphology are Bengkulu and Singapore which are aspects of detail consisting of road and block patterns. Through this research is expected to get similarities and differences in the patterns and charactheristic the morphological of both cities. This study will provide an overview and input for the development planning of the more advanced city of Bengkulu.

Key-words: *comparative studies, urban morphology, history, Bengkulu and Singapore.*

1. INTRODUCTION

1.1 Theory of urban morphology

Urban morphology is "an approach in understanding the city as a geometric collection of buildings and artifacts with the configuration of the unity of certain physical spaces the product of socio-spatial changes. “Our understanding of" urban morphology "cannot be separated from the physical form of the city which is formed primarily by the physical conditions of the environment as well as the dynamic socio-economic interactions of the people. Herbert (1932) In Conzen (2003), the scope of the study of urban morphology is emphasized on the physical form of the urban environment which can be observed from its appearance which includes elements of (1) existing road system, (2) building blocks both residential and non-residential areas (trade / industry), and (3) individual buildings. Smailes (1955) emphasizes the scope of morphological studies including (1) land use, (2) street patterns and (3) building types.

Morphology means the science of form. In the urban context, Carmona et al (2003: 61) argue that morphology is the study of the forms and shapes of residential environments. Form means an observable form and is a configuration of several objects, while a shape is a geometric feature or an external shape and outline of an object. Although they have almost the same meaning, these two words (form and shape) have a different basic understanding,

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where the form emphasizes the form consisting of various elements and each element can be clearly observed its characteristics and visually each element is in one unit (configuration). For example: a road corridor is visually formed from a row of buildings with a certain height and arranged within a certain distance from the road border. Shape emphasizes the external form of the form, or in other words the silhouette in the context of townscape is often referred to as the skyline. A collection of objects located above the ground surface will form certain patterns (shapes), such as linear, grid, concentric, radial, cluster, and so forth.

Smailes (1955) in Yunus (1994) introduces 3 elements of city morphology, namely land use, road patterns and building types or characteristics. Meanwhile Conzen (1962) in Yunus (1994) also suggested elements similar to Smailes, namely plan, architectural style and land use.

1.2. Morphological components

M.G.R. Conzen considers that it is necessary to pay attention to the four components of morphology (Carmona et al., 2003), including:

Land use

Land uses (land uses) is a principal component in the growth of the region. This component is considered as an activity system generator which determines the pattern and direction of regional growth (Kaiser, 1995). This component has

the level of temporality is very high in terms of being able to easily change literature, especially in relation to the economic value it holds. Land use greatly influences the physical appearance of the area, especially in determining the development of built and non-built areas.

Several studies and literature explain how the level of mixing (land use) mixture greatly affects the vitality of the region, economic value and several other environmental quality components (Choi and Sayyar, 2012; Barton et al, 2003: 194).

Building structure

This component is a representation of typology in morphological analysis and can be discussed in two aspects, including mass structuring and building architecture. The structuring of the masses is related to how buildings are scattered within the site along with their density and intensity while building architecture is more a physical manifestation of spaces and buildings that represent the culture, history and creativity of a community.

Pattern

This component can be discussed in terms of size (dimensions) and distribution. The size of the plot will affect the intensity of land use while the distribution of the plot will affect the establishment of a connecting network. In general, the pattern of this plot is strongly influenced by natural potential, especially contours and geological conditions. Legally, the plot is limited by ownership boundaries which greatly affect the pattern of control, use and management of space.

Road network

This component is a derivative function of land use. As a connecting line, the road network greatly affects the efficiency and effectiveness of regional functions. The road network as a representation of public space is considered as the core generator of the vitality of the region as explained.

There are three types of street pattern, namely (summarized from Northam, 1975): a. Irregular street pattern (irregular system). Any irregularity home placement and lanes in either direction and width. This pattern was seen in the early growth of cities but at this stage of development towns in western countries follow the type of planned city regularly. b. Radial road pattern of concentric (radial concentric system). The design of the road use this fortification pattern appears to anticipate the progress of weapons and war tactics. The road pattern is predominantly see in Europe, can not be see in Asia. c. System-shaped road pattern rectangular lattice or grid (rectangular or grid system). In this system, the city is divided into rectangular blocks and streets parallel to form a right angle.

An important component of cities is their street and road networks. These networks can be thought of as a simplified schematic view of cities, which captures a large part of their structure and organization (Southworth M, 2013). and contains a large amount of information about underlying and universal mechanisms at play in their formation and evolution. Extracting common patterns between cities is a way towards the identification of these underlying mechanisms. At stake is the question of the processes behind the so-called 'organic' patterns—which grow in response to local constraints—and whether they are preferable to the planned patterns which are designed under large-scale constraints (Haggett P, 1969)

City block is a fundamental element of the physical structure of urban forms. Town and cities have generally been laid out in relatively simple patterns of streets and blocks, both in planned and unplanned settlements. Therefore, it can be expected that the properties of different sized, shapes and arrangements of blocks would be well known with documented (Siksna, 1997).

The street network or roads is an important aspect of cities and contains crucial information about their organization and evolution. Characterizing and comparing various street networks could then be helpful for a better understanding of the mechanisms governing the formation and evolution of these systems. For understanding characteristic of the roads is not easy. Simple tools for classify planar networks and most of the measures developed for complex networks are not useful when space is relevant (Barthelemy,2015).

Roads and block patterns become an important element for known the physical structure of urban form and urban morphology and crucial information configuration of the city. Beside that urban structure described by the building coverage ratio (BCR), floor area ratio (FAR), and canyon (H/W) not only give affects for the microclimate but also the location of the building (Paramita and Suparta, 2019). So in this paper the identification of patterns and characteristics of urban morphology is done by using only one indicators namely road and block patterns.

1.3. Bengkulu City

Bengkulu City is one of the colonial cities of the former British and Dutch colonies which until now its legacy can be found in the city of Bengkulu, especially the old city of Bengkulu. The old city of Bengkulu was an area in Bengkulu which was used as a trading center in the 16-18th century and built a fort called Fort Marlborough as its center of defense.

The British began to build the city of Bengkulu starting in 1719. As the British colonial authorities to form and design the city of Bengkulu with a good and unique. In addition, the UK also adopted the form of cities with different characteristics in each city under their control. As the ruler at that time the British placed Bengkulu city based on its function, namely the city whose economy was focused on shipping and trade. The focus of this city arrangement adjusts to the location of Bengkulu city which is located along the coast.

1.4. Singapore City

The geographical position of Singapore to the south of the Malay Peninsula is a country in the form of a small island on the Malacca Peninsula. Astronomically at latitude 1 '15 "LU-1 '26" LU and longitude 103 '40 "BT-104'BT. The area of this country is 818 km2 with 54 islands around it.

Singapore's national borders are

- North: Johor Strait
- East: South China Sea
- South: Singapore Strait
- West: Malacca Strait

Modern Singapore occurred in 1819 by Sir Stamford Raffles, at that time he established a port for the colonies from England. Under British colonial rule. Singapore has turned into a very strategic port, given its location in the middle of the trade route between India and China which has finally become one of the most important ports in the world to this day. Raffles arrived in Singapore on January 29, 1819. He encountered a small Malay village at the mouth of the Singapore River, chaired by a Temenggung Johor. Because of the abundant fresh water at that time, Raffles made the place for his colonists to live. After signing the agreement on February 6 of the same year, Raffles left the settlement, and handed over responsibility to Colonel William Farquhar and at the end of May, Raffles returned, because of the rapid development of the city, he realized the need for a formal urban plan to guide physical expansion. Then Raffles went back and in October 1822 Raffles returned to Singapore and formed a City Committee led by Lieutenant Philip Jackson to formulate a formal plan for the colony which came to be known as the Jackson Plan, namely by laying the foundations of city roads and Zonal layout. For example, the allocation of civic institutions on the north bank of the Singapore river and creating a major commercial area that came to be known as "Commercial Square" and on the southern edge developed into civic and CBD districts on both sides of the river in a grid pattern. While the settlement zone is in China town, Little India, and Kampong Glam, which can attract the attention of tourists. But the city committee plan led by Jackson only lasted eight years because of the rapidly growing population and severe population density, eventually many residents moved to the suburbs of eastern Singapore. This growth also caused suburban roads to become congested with traffic, especially along Geylang Road which leads to the East Coast.

In 1927 the government tried to capture the situation by establishing the Singapore Improvement Trust (SIT) with the main objective of reducing urban congestion and the provision and improvement of public infrastructure, particularly in widening roads to accommodate and modernize traffic. Their efforts are only in the local area, because they do not have legislative power to produce comprehensive plans or to control urban development. And because the Second World War caused disruption in efforts to reduce the problems of the city, this lasted for 1941-1945. In 1947 the SIT effort did not succeed in overcoming the overcrowding in Singapore. And under the auspices of the ruling People's Action Party at the time, the SIT (Singapore Improvement Trust) was replaced by the HDB (Housing Development Board) which was founded in 1960. This proved to be Singapore's turning point in dealing with population density. HBD has built 5000 housing units that have been built in a span of more than 20 years. In the 1970s, a large proportion of the population had found adequate housing. Most of the current urban planning policies originate from the HDB practices. And Singapore's Regional and municipal planning policies are under the Urban Redevelopment Authority which is to create independent cities and districts that are served

by regional centers that have their respective functions. The purpose of urban plans is to maximize land use efficiently but comfortably and to serve as many residents as possible with their respective functions, such as infrastructure, environmental preservation, space for water catchment and land for military use all require consideration and national urban planners.

2. METHODOLOGY

Kuntowijoyo (2003) revealed that the morphological approach can be explored with synchronic and diachronic. Synchronic study emphasis on observation and analysis of morphological elements to know the city shape at one time. This assessment is generally used to evaluate the present layout of city to problems solve the spatial existing. Studies in diachronic emphasis on observation and analysis of the elements of the morphology of a city from time to time (Kuntowijoyo, 2003). These studies see at the process of development of a city or region from the beginning until nowday. Besides used as the basis for the evaluation of the problems and designing the layout, the diachronic viewpoint will produce a history of the city development and the processes that occur therein, and the result is an expression of the city identity**.**

To represent morphology or geomorphology of elements and objects in a region can be done through cartography or map (Gomis and Turon, 2018). Using qualitative methods, the research technique is carried out by analyzing data archives originating from the old maps of Bengkulu and Singapore, observations and evaluating detailed aspects including road patterns and blocks. All of them are intended to identify patterns and characteristics of the old cities of Bengkulu and Singapore (see **Table 1**).

Table 1.

Data analysis process scheme

Target	Analysis of :	Analysis Techniques	Results Obtained
Identify the pattern and characteristics urban morphological of the old city of Bengkulu and the old city of Singapore	Detailed Analysis - Road and block patterns -	Diacronic reading and morphological typologies and figure-ground techniques	Get patterns and characteristics urban morphology of the old city of Bengkulu and the old city of Singapore Knowing the similarities and differences urban morphological between the two citys.

Source: Wardhani, 2019.

3. RESULTS AND DISCUSSIONS

This study is to identify the patterns and morphological characteristics of the city, namely the old city of Bengkulu and the old city of Singapore. The two cities have a historical background in which the two cities are the result of the London Treaty Exchange exchange between England and the Netherlands. In the beginning Bengkulu was formed by the British then switched to forming and developing Singapore. This comparative study begins by analyzing the detailed identification of the patterns of roads and blocks. Identification is done by using diachronic reading and morphological typography analysis techniques. From the identification results it is expected to get similarities and differences in patterns and characteristics of the morphology of the two cities, namely between the old city of Bengkulu and the old city of Singapore (Whardhani, 2019).

3.1. Patterns and Characteristics Urban Morphological of Bengkulu Old City

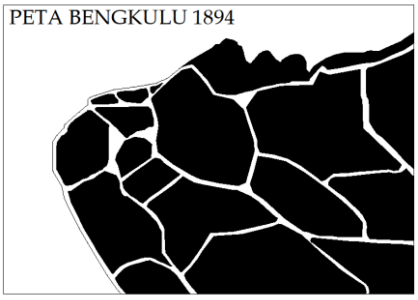
Identification of road and block patterns, by using diachronic reading, typo-morphology and figure ground analysis techniques

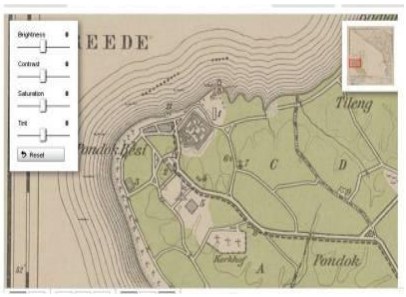
The pattern of roads and blocks is the second identification carried out to determine the pattern and morphological characteristics of the old city of Bengkulu. The analysis is done using figure ground analysis. This analysis is used to identify road and block patterns by looking at the texture and patterns of an urban fabric.

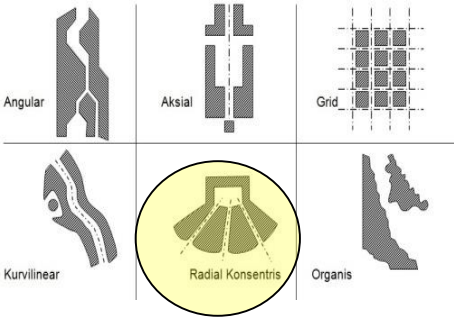
Identification of the city morphology is done by using the figure / ground analysis technique, it can be known the pattern of existing roads and blocks by looking at the existing ones and historical information of the past. This analysis is carried out on the map of the city of Bengkulu in 1867-208 (see **Table 2**). Then it will be known the changes and characteristics of the existing road and block patterns in the old city area.

Table 2.

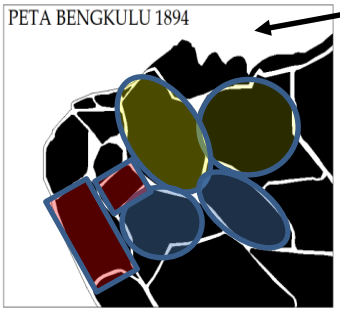
Analysis road and block patterns.

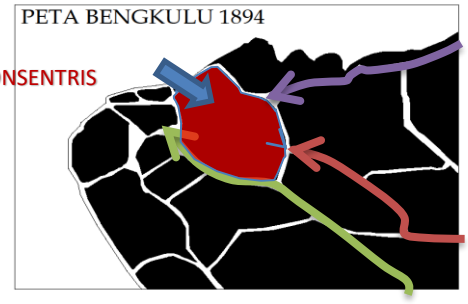
No	Map	Identification
1.	**Road and block patterns in 1894** 	Based on the figure ground analysis, it can be seen that the pattern of the road is a Rounded Cities (round) form. This is the most ideal form for the city, because it can develop into all direction and has balanced, as the advantages. Besides that, the pattern of roads and mass blocks formed in 1894 is a concentric radial pattern. The old city of Bengkulu is a city formed by the British as a place for trade and defense that focusing the city on the fort area.



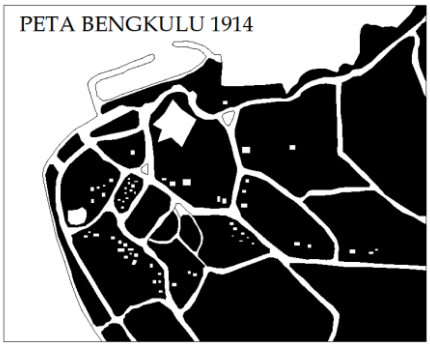


Form Rounded Cities





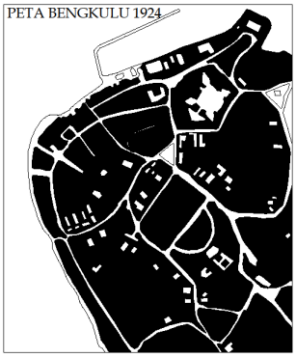
2. Road and Block Patterns in 1914



In 1914, the road and block patterns were still the same but the distribution of mass blocks were growth and there were several additional roads, but the pattern and initial shape of the road was still maintained. Radial concentric patterns have been changed. The wider distribution of the mass made current pattern tends to be heterogeneous.

The center of Bengkulu city in British colonial period was located on the beach, so it was called the coastal city which emphasized its social economy on shipping and trade. The City Center was designed to have three main node arrangement patterns that confirm the city center. The road pattern forms the city into a form of constellation (constellation) a series of city blocks that almost have the same size in close proximity. The road pattern produced by this area in the colonial era is homogeneous, where there is only one road arrangement pattern.

3 Road and Block Patterns in 1924



In 1924, The pattern of mass distribution has become wider and denser. The main road pattern is still maintained but the mass distribution is increasingly widespread.

Radial concentric patterns have shifted not to the fortress anymore. This is because the growth of the city and the spread of the masses are expanding to the south.

4. Road Patterns and Blocks in 2018

At this time after the Independence of Bengkulu there were many changes. If Bengkulu city development used to be on the beach, but now the development of the Bengkulu city moves in the direction of the north and west of the city, no longer on the beach. This is marked by the relocation of the city center in an area known as the Suprapto area which is the current trade and government area. The Urban Patterns no longer follow the pattern of British heritage where the main path is to use north-south oriented linear pattern. Resettlement blocks are no longer in the form of concentration. The composition of the area becomes increasingly complex. No longer homogeneous but now heterogeneous, where two or more patterns colliding because the influence of building masses and higher building density.

So based on the analysis of road and block patterns it can be concluded that in the early 1800s the pattern of roads and rounded cities (round) and radials concentric centered on the fortress area as a center of defense and trade later in its development the form was abandoned where the pattern of roads and blocks becoming increasingly complex and heterogeneous and the trade and government center has shifted towards the middle of the city of Bengkulu while the fortress area has been abandoned and turned into a tourist attraction for cultural heritage and beaches.

3.2. Patterns and characteristics urban morphological the old city of Singapore

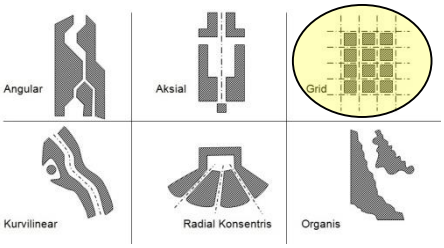
Identification of road and block patterns, typo-morphology

The pattern of roads and blocks is the second identification carried out to determine the pattern and morphological characteristics of the old city of Singapore. The analysis is done using figure ground analysis. This analysis is used to identify road and block patterns by looking at the texture and patterns of an urban fabric.

Identification of the city morphology is done by using the figure / ground analysis technique, it can be known the pattern of existing roads and blocks by looking at the existing ones and historical information of the past (see **Table 3**). This analysis is carried out on the map of the city of Bengkulu in 1867-208. Then it will be known the changes and characteristics of the existing road and block patterns in the old city area.

Table 3.

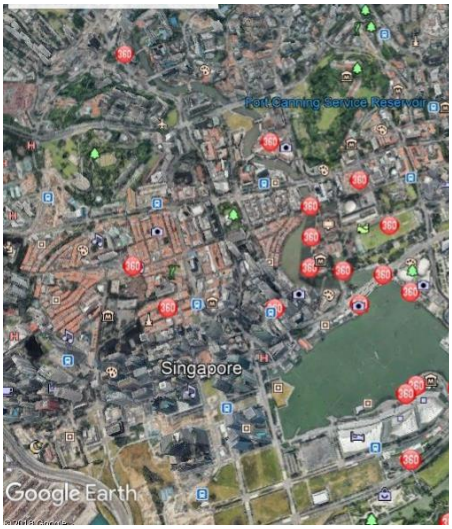
Analysis road and block patterns in Singapore.

No	Maps	Identification
1.	**Map of Singapore, Jackson Plan 1822** 	Based on the picture analysis of the ground figure in addition, it can be seen that the road pattern in the form of a grid is the most ideal form for the city, because it has the advantage of being in all directions and balanced. The formation of the city in 1822 by Jackson was with laying the foundation of city roads and zonal layout, for example the allocation of civil institutions on the north bank of the Singapore river and locating the main commercial areas which became known as the distric civid and CBD on both sides of the river, while the settlement zones are in Chinatown, Little India and Kampong Glams are grouped by race and religion. 

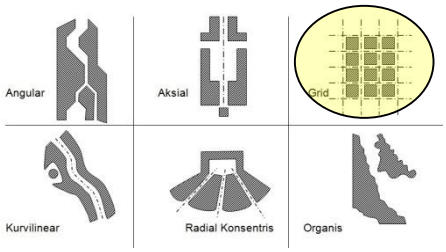
2. Map of Singapore 1900

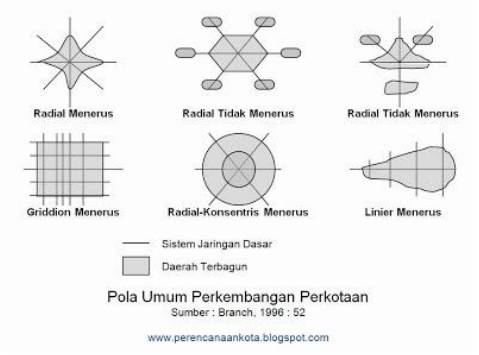
In 1990, the road and block patterns in the old city of Singapore still retained the shape of the grid, but in its development of the city, pattern had experienced impure mixing using grids like the early Jackson Plans again but incorporated curvalinear and radial patterns into urban morphology.

3 Map of Singapore 2019, google earth

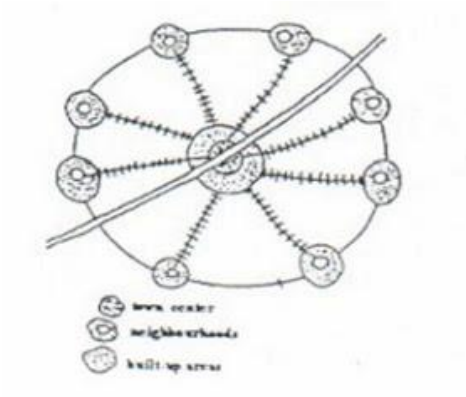


Based on the map image, the old city of Singapore still uses grid patterns like the Jackson plan, but there has been development of road and block patterns.





The development is in the form of road patterns and blocks form the city of Singapore forming a satellite city. The form of satellites and new centers (satellite and neighborhood plans), the main city and small cities will be established effective and efficient functional linkages;



It also forms a stellar or radial. Stellar or radial plans (stellar or radial plans), each tongue is formed a second center of activity that serves to provide services in urban areas and protrudes into the planned as a green line and functions as the lungs of the city, recreation areas and sports areas body for city dwellers.

The development of the city of Singapore did not leave its old city, but synergized with the old city to form the CBD area which remained centered in Marina Bay. The concept of structuring CBD areas in developed countries generally uses a simple pattern of a superblock grid. The central commercial buildings are arranged in such a way that they are squeezed together so that the line is commensurate with only a tight 0 meter. Bangu-nan immediately met the sidewalk next to the skyscraper. Super block pattern besides practical, rapid and unsightly. The purpose of the Singapore city plan is to maximize land use efficiently but comfortably and to serve as many residents as possible with their respective functions, such as, infrastructure, environmental preservation, space for water catchment and land for military use all require consideration and national urban planning.

4. CONCLUSIONS

So, based on the above identification it can be concluded that the similarity of patterns and morphological characteristics of the cities of Singapore and Bengkulu are the pattern of roads and blocks used by different British colonies in Bengkulu uses a pattern concentric radial and rounded cities centered in Marlborough Fort while Singapore uses a grid pattern. The city center is equally located in the Port, namely Marina Bay and Fort Marlborough in Bengkulu. But in the development of the city of Singapore City Center is still located in the Marina Bay Area which synergizes with the old City, but the city of Bengkulu left the old city and the city center shifted towards the North and South.

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