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GIS-MULTI CRITERIA ANALYSIS TO ENHANCE PLANNING JUDGEMENT FOR NEW TOWNSHIP DEVELOPMENT

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Abstract

Urban development is increasingly encroaching on hillsides, negatively impacting agriculture, particularly in developing countries like Malaysia, where flat land is scarce. To address this, the study aims to develop a GIS-based land suitability model that considers accessibility, environmental threats, and economic factors for optimal hillside development locations. Using multi-criteria decision analysis (MCDA) and the analytic hierarchy process (AHP) through Expert Choice software, key factors like accessibility, topography, land cover, and economics were analyzed. The study identifies Township 1, located 4.23 km northwest of UiTM, as the most suitable site for new development, considering current land use and proximity to key institutions. This model provides a framework for hillside development in Malaysia and other developing countries.

Keywords: Analytic Hierarchy Process, GIS, Land Suitability Analysis, Multi-Criteria Decision Analysis, New Township, Rembau

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PENDAHULUAN

The World Bank indicated that urban areas contain 56.15% of the world's population (World Bank, 2018). The concentration of people in urban areas has localized pressure on the environment and impacts various ecosystems, such as environmentally sensitive areas, forests, etc. (Hartatik, Wasino, & Trihatmoko, 2022; Zen, Noor, & Yusuf, 2014). In this sense, environmental factors are among the critical considerations for planning development as a basis of the information. Therefore, it is essential to integrate ecological concerns in urban planning and management to achieve the most suitable land for being developed. Furthermore, it is related to the 11th and 15th goals of sustainable development stated by the United Nations (UN) for sustainable cities and communities by protecting, restoring, and promoting sustainable use of terrestrial ecosystems, sustainably managing forests, combating desertification, and halting and reversing land degradation and halt biodiversity loss (UN, -).

Land suitability analysis, LSA mapping using geographical information system (GIS), categorizes the urban and agricultural areas into zones. Each of which has a different likelihood, or risk, of experiencing specific land-using processes. The function is more than just a GIS-based procedure where a selection of the most suitable location for new potential project development (Birch, 2009) due to its method to detect inherent capacities (K. Bandyopadhyay, 2009) and its potential and suitability for different purposes (Akinci, Özalp, & Turgut, 2013; FAO, 1976)

GIS is useful for analyzing multiple geospatial data with higher flexibility and precision in LSA (Mokarram & Aminzadeh, 2011). Shortly, LSA will be more accessible by showing the suitable land for certain uses spatially. Therefore, different studies have integrated the multi-criterion decision-making (MCDM) technique with GIS techniques to support land use decision-making (Cengiz & Akbulak, 2009; Mendas & Delali, 2012). Especially in complex land management problems with prioritized alternatives (Malczewski, 2004) by digital interpretation. Nine keys obtain the digital interpretation: hue, color, shape, size, texture, pattern, shadow, site, and associations to support the LSA (Lillesand & Kiefer, 1980). This technique is widely used for LSA to detect the potential lands for agriculture (S. Bandyopadhyay, Jaiswal, Hegde, & Jayaraman, 2009; Foshtomi, Norouzi, Rezaei, Akef, & Akbarzadeh, 2011; Mustafa et al., n.d.; Samanta, Pal, & Pal, 2011; Shalaby, Ouma, & Tateishi, 2006; Yu, Chen, Wu, & Khan, 2011) watershed management (Steiner, McSherry, & Cohen, 2000), settlements (Soltani, Mahiny, Monavari, & Alesheikh, 2012), and industries (Kauko, 2006). Multi-criterion evaluation, MCE technique is widely used for LSA. Multi-criteria evaluation in GIS is focused on the allotment of land to suit a specific objective based on an assortment of properties that the chosen regions ought to have (Eastman, 1999). It involves multiple criteria like bio-physical elements such as slope, relief, drainage, soil properties, atmospheric conditions, and vegetation, as well as socio-eco-cultural aspects which affect the decision-making process for further development (Akinci et al., 2013; Joerin, Thériault, & Musy, 2001; Wang, Brent Hall, & Subaryono, 1990; Yu et al., 2011) to find solutions of different problems related to land with multiple alternatives (Jankowski, 1995),

The study aims to understand the impacts of UiTM Rembau on Rembau District, Malaysia, by determining the spill of the area from UiTM Rembau and analyzing and suggesting the best land suitability for new housing and township areas surrounding UiTM Rembau. UITM Rembau was chosen as the research location because this new UiTM branch potentially affects the surrounding area in good or bad ways. In addition, the research location selected also

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took place to initiate the concept of campus sustainability at UITM, which has previously been promoted in other universities in Malaysia (Zen et al., 2016). The detailed descriptions of performing GIS-based suitability analysis models are as follows (Table 1):

We divided the factors into four categories, which are i. environmental and ecological impact: ii. accessibility; iii. economy; iv. socio-economy. These categories were chosen in line with the increasing ecological marginalization and environmental apartheid issues due to the economic base

Table 1. GIS-based suitability analysis models

Component	Description
Data	The criteria for the model were defined by identifying relevant and possible layers that influence the site selection.
Distance buffer	Based on the distance criteria, single and multiple buffers were performed (Table 3).
Data conversion	All vector data involved in the analysis need to be converted to the raster's data.
Reclassified value	To make the comparison are possible, the suitability values of the factors must set to a common scale. For continuous data, the data will be re-classed and assigned a suitability value for each class using a scale of 1 to 3, where 3 is the most suitable, and 1 is the least suitable. For categorical data such as land use, suitable values will be assigned per class using a scale of 1 to 3.
Weighting data	We used the rating and raking method for these purposes. In this step, rankings, a metric method, were used to determine the weight of each suitability factor. Three factors were used, ranked 1, 2, and 3, respectively, where one is the least important while three is the most important. The rankings were converted to numerical decimal weights on a 0 to 1 scale, with an overall summation of 1 for normalization. Based on table 1, we can see the suitability criteria and the ranking values assigned to the factor.
Aggregating the criteria	In this step, weighted linear combination (WLC) was used by combining all maps' layers. It is the most used decision rule. This method is the easiest way to be used for multi-criteria decision-making solutions. It's based on a weighted average to influence the result.
Suitability criteria	Suitability criteria: Areas greater than one kilometer (km) outside of Major Roads and Highways have low suitability for development; areas within half km to one km of Major roads and highways have medium suitability for development; areas within half km of Major roads and Highways have high suitability of development.
Distance buffer	The transportation node is considered one of the most important factors for suitability. It is because the most popular mode for Kuala Lumpur commuters is due to less travel time.

(LSA)

Several factors enhance the suitability of land use based on the specific alternatives for the analysis.

Component	Description
	Suitability criteria: Areas greater than one km outside of a transportation node has low suitability of development; areas within half km to one km of transportation nodes have medium suitability of development; areas within half km of transportation nodes have high suitability of development.
Aggregating the criteria	The railways' network covers all rail services in Kuala Lumpur, including light rail transit (LRT), monorail and heavy rail, and electrified commuter trains.
	Suitability criteria: Areas greater than one km outside of railways networks have low suitability of development; areas within half km to one km of railways networks have medium suitability of development; areas within half km of railways networks have high suitability of development.

Ncwadi, 2016). The suitability classification was given based on criteria stated in the Kuala Lumpur Structure Plan 2020. Therefore, low, medium, and High suitability classifications were used. Suitability criteria: Areas outside of the 100-meter buffer for the river reserve are most suitable for development; the areas between 50 and 100 meters of the river reserve have medium suitability for development; the areas inside of the 50-meter buffer from the river reserve have low suitability for development. In line with Environmental Protection Zone (EPZ), the river buffer of 50-100-meter is functions as the preserve area. It protects ecosystems such as terrestrial wildlife habitat, aquatic habitat, and water quality (United States Environmental Agency, 2014; De Sosa et al., 2018; Valera et al., 2019). Indirectly the river buffer also functioned as the risk reduction for human life from the potential of mass movement of the riverside and also flood hazard (Renaud, Sudmeier-Rieux, & Estrella, 2013).

Environmental And Ecological Impact

It follows (1) riverside corridor, which includes land adjacent to and including the course of a river and has been listed as an EPZ of the Kuala Lumpur City Plan 2020. (2) Hillside (slope), this corridor includes land adjacent to and including the course of a river and has been listed as an EPZ of the Kuala Lumpur City Plan 2020.

Accessibility

The point of view of the accessibility factors consists of major roads and highways, train stations and main bus terminal (transportation node), and the last railway network (Table 2).

Socio-economy

The factors of socio-economy include (1) public facilities, a combination of all public amenities in the study area, including safety, health, education, and public uses. (2) Suitability criteria: areas greater than one mile outside of public amenities have low suitability of development; areas within half miles to a mile of public amenities have medium suitability of development; areas within half miles of public amenities have high suitability of development.

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Table 2. Accessibility factors to LSA

Component	Description
Major Road & Highway	Major roads and highways are the most important accessibility determinant for the suitability factor.
	Suitability criteria: Areas greater than one kilometer (km) outside of Major Roads and Highways have low suitability for development; areas within half km to one km of Major roads and highways have medium suitability for development; areas within half km of Major roads and Highways have high suitability of development.
Distance buffer	The transportation node is considered one of the most important factors for suitability. It is because the most popular mode for Kuala Lumpur commuters is due to less travel time.
	Suitability criteria: Areas greater than one km outside of a transportation node has low suitability of development; areas within half km to one km of transportation nodes have medium suitability of development; areas within half km of transportation nodes have high suitability of development.
Aggregating the criteria	The railways' network covers all rail services in Kuala Lumpur, including light rail transit (LRT), monorail and heavy rail, and electrified commuter trains.
	Suitability criteria: Areas greater than one km outside of railways networks have low suitability of development; areas within half km to one km of railways networks have medium suitability of development; areas within half km of railways networks have high suitability of development.

Economy

This factor assesses (1) land value, categorized by three prize ranges; high, medium, and low. (2) Landmark, one of the most important criteria in selecting a commercial development area is the area landmark or the tourist attraction area. Suitability criteria: The areas greater than one km outside of the landmark area have low suitability of development; the areas within half km to one km of the landmark's area have medium suitability of development; the areas within half km of the landmark's area have high suitability of development.

Constraints in Land Suitability Analysis (LSA)

The constraints will present the limitation of the suitability analysis alternatives whereby the selected element will represent the restriction area or unsuitable area for development.

Flood-prone Area

The flood-prone area was where flooding had been regularly occurring in Kuala Lumpur, with heavy downpours. It comprises surface water data, including rivers, lakes, reservoirs, and streams. Suitability classifications were selected based on whether water was present at any given location.

Therefore, only low and high suitability were used. Suitability criteria require the areas outside the 30.48 m (100 feet) buffer to surface water, including lakes and reservoirs, to be most suitable for development. Areas within 100 feet from the center of the stream or river have low suitability for development.

Erosion

Erosion occurs due to a project on the construction site. The areas inside the 100-meter buffer from the erosion area have low suitability for development; areas outside the 100-meter buffer with respect to erosion area are most suitable for development.

Landslide

The area where a landslide has occurred previously. The areas within a 100-meter buffer from the landslide area have low development suitability. Areas outside the 100-meter buffer with landslide area are most suitable for development.

White zones

These areas are classified as public facilities, infrastructure, and utility services. The areas within white zones are low suitable for development.

Vacant land

It is known as the land without development. The areas within vacant land are highly suitable for development.

Forest reserve

A residual Forest area for maintaining sustainable variety and population of flora and fauna. Areas within forest reserves are low suitable for development.

Flood zone area

The area where floods always occurred previously. The area within the flood zone area has low suitability for development.

Airport

One small airport in Kuala Lumpur district is used for military purposes. Therefore, the area within 500 ft. of an airport has low suitability for development.

METHOD

The general land use of Rembau District covers 41,512 hectares (Figure 1). Agriculture is the most dominant land use covering 60.04% (26,680 hectares). The least is commercial land use covers 0.06% (23.26 hectares). Rembau District consists of 17 Mukim and 6 Planning Blocks (PB), PB 1: Batu Hampar, PB 2: Pedas, PB 3: Kota, PB 4: Kundor, PB 5: Gunung Datuk, and PB 6: Angsi.

Rembau District consists of 8 urban centers categorized into two categories: the main urban center (3) and the small urban center (5), as stated in Table 3 and Figure 2.

UiTM Rembau will be developed about 86.9 hectares as a new development in Rembau. Therefore, UiTM Rembau acts as a growth catalyst for Rembau District. The current population in Rembau is 41,988 people. Due to the new development of UiTM Rembau, the estimated population will increase by 16,500 people, including students, lecturers, and staff. As a result, the population of Rembau is expected to be raised by 55,555 people in 2030. Thus, there will be demand for housing and a new town center.

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Table 3. Urban centers in Rembau District

Urban Hierarchy	Location
Main Urban Centers	Pedas
	Chembong
	Rembau
Small Urban Centers	Chengkau
	Lubok China
	Sri Kendong
	Kota
	Merbau Sembilan

The population and current land use data were collected from Pejabat Daerah dan Tanah Rembau and Majlis Daerah Rembau. A suitability Analysis was conducted to analyze the best location for a possible new township area near the new UiTM Rembau to cater to its new population. For the analysis, the criteria and constraints were identified based on the relevant development suitability factors for Rembau District.

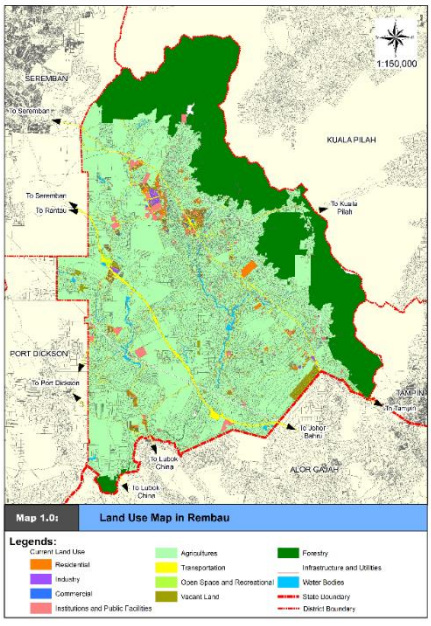


Figure 1. Land use map in Rembau

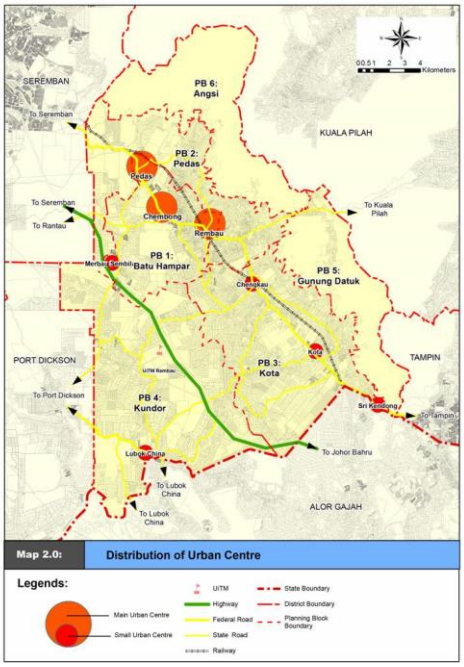


Figure 2. Urban center distribution in Rembau

Therefore, as a result, was being produced, several locations had a high possibility of being selected. The selection of the alternatives was considered by planning understanding that meets the planning standards. As the alternatives were identified, the network analysis was conducted to measure the distance between the 3 locations to UiTM Rembau so that the nearest location could be considered the best. However, to support the decision, crowdsourcing was conducted to make them vote for the best township area they prefer by sharing the results through ArcGIS Online (see Figure 3). This platform was chosen considering its interactive display of geographic information and ability to tell stories and answer questions. Those abilities are available on its web map feature analysis tools. The map contains a base map, a set of data layers (many of which include interactive pop-up windows with information about the data), an extent, and navigation tools to pan and zoom.

The LSA was emphasized using a raster-based visual model. It revealed that the raster calculator appeared

as the most significant and powerful GIS analysis (ESRI, 2010).

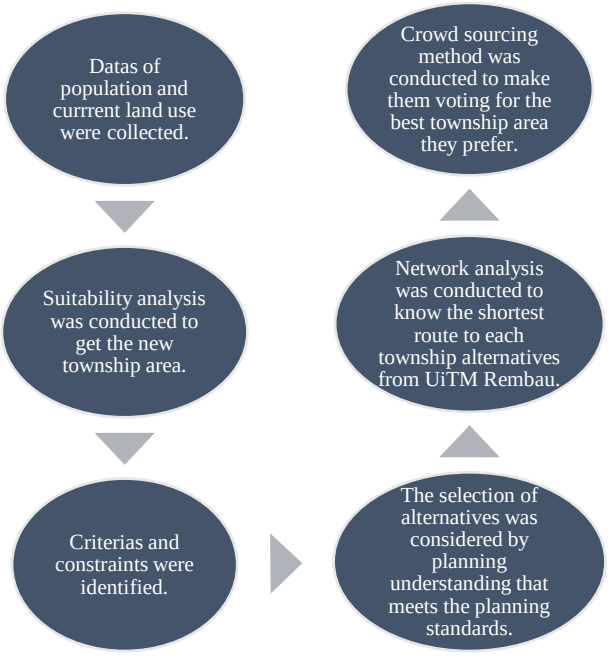


Figure 3. The methodology analysis to get the best new township area around UiTM Rembau

This analysis also performed less error than vector analysis, considering that vector converting remains distortion or generalization for the polygon since the analysis was not enhanced with the additional conversion software (Congalton, 1997; Lacroix, 2009). More than that, the processing during raster conversion to vector will lead to error results, or the size of the output shapefile will fall (ESRI, 2016). The distortion or error is shown in Figure 4.

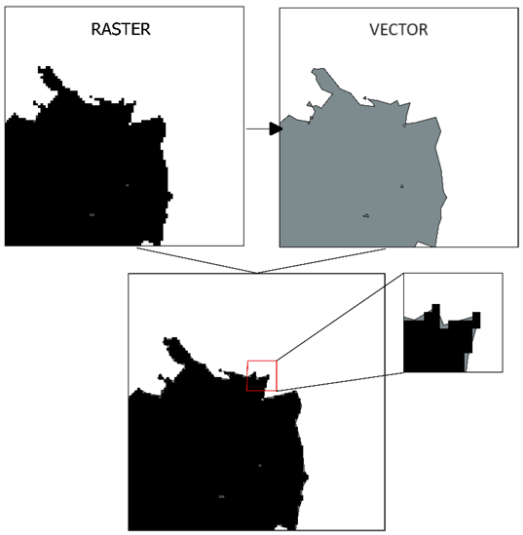


Figure 4. The distortion was seen after the original raster superimposed the research location's vector data (polygon)

From Figure 4, the vector shape was "smoothed" by the raster conversion process. This process will leave some areas out of the delineation or even create some disappeared areas.

Factors/Criteria

There are several factors and criteria identified for Rembau township development. The factors are:

Proximity to UiTM Rembau

The proximity to UiTM Rembau is the most important criterion in selecting new housing and township area development. This criterion is prioritized because UiTM Rembau is the growth catalyst in Rembau. Therefore, the areas within a 5 km buffer from UiTM Rembau are the most suitable development, 5 to 7 km is medium, and the last outside the 10 km buffer have low development suitability.

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Proximity to Roads

Major roads and highways are the most important accessibility determinants for the suitability factor. Areas less than 0.5 km buffer from roads are the most suitable development, 0.5 to 1.5 km is medium, and greater than 1.5 km buffer has low development suitability.

Proximity to Institutions

This data combines masjids, schools, and clinics in the study area. Areas less than 0.5 km buffer from roads are the most suitable development, 0.5 to 1.5 km is medium, and greater than 1.5 km buffer has low development suitability.

Constraints

There are a few constraints that have been identified in Rembau to propose a suitable new township area, as mentioned below:

Highway

The highway is the most important accessibility determinant for the suitability factor. Areas greater than one km outside of highways have low development suitability, within half km to one km is medium, and within half is high.

Environmental Sensitive Area (ESA)

ESA needs to be preserved and maintain the sustainable diversity and population of flora and fauna. Therefore, areas within ESA are prohibited from development.

Heavy Industry

This area is zoned for heavy industry that is not suitable for new development around it. **Table 4.** Database design for the suitability analysis

Core Dataset Entity	Spatial Layer	Spatial Data Type	Tabular Table
1.0 Infrastructure			
1.1 Highway	Roads	Line	Road Hierarchy
1.2 Main Roads	Railways	Line	
1.3 Railway			
2.0 Land Use			
2.1 Land Use Unit	Land Use	Polygon	Land Use Type Land Use Sub-Type
3.0 Urban Centre			
3.1 Urban Centre	Urban Centre	Point	Urban Centre Hierarchy The function of Urban Centre
4.0 Demography			
4.1 Population	Population	Polygon	Population Population Density
5.0 Community Facilities			
5.1 Cemetery	Facilities	Polygon	Cemetery

The areas inside of the 1000-meter buffer from the heavy industry have low suitability for development.

Cemetery

This area is not suitable for new development around it. The areas inside the 400-meter buffer from the cemetery area have low suitability for development.

Database Design

A query layer in ArcGIS is created automatically. It is defined to include all columns of

supported data types in the table. The first row of the table is used to determine the geometry type (point, line, or polygon), spatial reference, and dimensionality (2D or 3D). The database design for the suitability analysis is shown in the table 4.

All the criteria will be standardized and combined with assigned weight to produce a suitability map. The composite suitable score *S* is formulated by the sum ∑ of factor scores *xi*, weights assigned to each factor *Wi*, and multiplied with constraints (or Boolean factors) *Cj*. The formula is as follows (Eq. 1):

$$S = \sum W_i \, x_i Cj \qquad (1)$$

RESULT AND DISCUSSION

Criteria and Rating of Development Suitability Factors

Several factors/criteria and constraints of Rembau must be considered in proposing the new township area. Therefore, buffer analysis was used to rate the criteria to define the most important to the least important factors regarding the area of the new township. Table 5 shows the data layers used for this analysis. The metrics for the suitability rates were organized based on the criteria for suitability development: high, medium, and low. The criteria can be defined as factors and constraints on table 5.

Suitability Analysis

The detailed descriptions in performing GIS-based suitability analysis models for proposing new townships are by using a GIS raster calculator. The GIS processing was indicated by calculating the digital number of each pixel to parcel and producing a raster-based visual model (Lacroix, 2009; Dedeoglu and Basayigit, 2018; ESRI, 2016; Trihatmoko et al., 2021) (Figures 5 and 6). The following expression lists (Eq. 2) the multiplier used in the raster calculator tools in the Spatial Analyst extension.

$$S = ((\text{SpilloverofUiTMRembau} * 0.375) + (\text{Roads} * 0.375) + (\text{Institutions} * 0.250)) * \text{Constraints Boolean} \qquad (2)$$

Table 5. Criteria and rating of development suitability factors

Layer Name	Criteria and Rating			Assigned Weight	Percent Weight	Multiplier
	Low (1)	Medium (2)	High (3)			
Proximity to UiTM Rembau	7-10km	5	7-10km	3	37.5	0.375
Proximity to Roads	-7km	<5km	-7km	3	37.5	0.375
Proximity to Institutions	>1.5km[a]	0.5	>1.5km[a]	2	25.0	0.250
Total				8	100.0	1.000

[a] Buffer within 10 km.

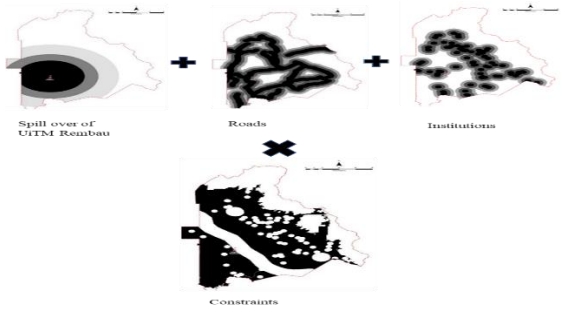


Figure 5. Multilayer GIS-based suitability analysis models for proposing new townships are by using a GIS raster calculator

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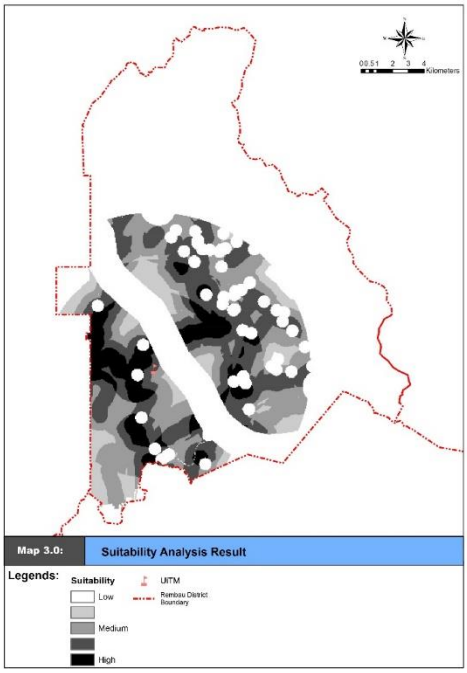


Figure 6. Suitability analysist result

Three alternatives proposal for new township area

Based on the result of the suitability analysis, three areas have been identified as having the potential to be new township areas. These three alternative townships are selected based on the higher value of pixels through raster data. In addition, the existing land use is also being considered, and mostly is agriculture in each township. The Mean shown below calculates the average pixel values in each township. The area with the highest pixel value indicates the most suitable area to propose a new township. Township 1 has the highest value of Mean out of the three areas (Table 6). The area of Township 1 also has 314.20 acres and is the least acre of all three townships. Thus, this shows that Township 1 is the best location for new development, such as housing and commercial, that will cater to the population of UiTM Rembau (Figure 7).

Table 6. Mean, standar deviation and area of each township

Township	Mean	Standard Deviation	Area (Acre)
1	2.79	0.14	314.20
2	2.62	0.20	371.95
3	2.11	0.36	388.65

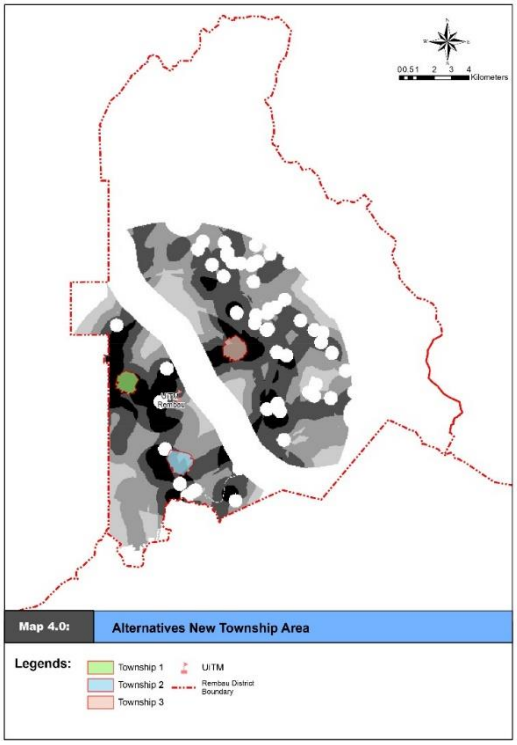


Figure 7. New township area alternatives

Analysis of shortest route from UiTM Rembau to proposed township

Network analysis was conducted to identify the shortest route of each township from UiTM Rembau. The shorter the distance to UiTM Rembau, the more effective the area is in being developed (Figure 8). This statement refers to the main objective of the analysis to identify the new township area of UiTM Rembau. This new township is to provide services closer rather than go to other urban centers far from it. Out of the Township Area Alternatives,

Township 1 has the shortest route, which is 4.23 km from UiTM Rembau. However, the result shows the longest route to UiTM Rembau is Township 3 (7.82 km), with the least (Table 7).

Table 7. Route Distance from UiTM Rembau to each new township area

Township	Route Distance from UiTM Rembau (km)
1	4.23
2	4.25
3	7.82

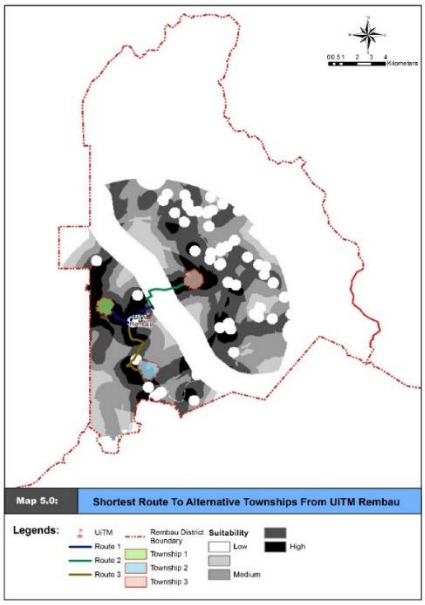


Figure 8. Route map for the shortest way to the alternative township from UiTM Rembau

Estimated population and land use composition in proposed township

The new development of UiTM Rembau is expected to have a population of about 16,500 people in the future. The population will need support from the new residential and commercial development as the current condition does not meet the future population's requirements. Therefore, as projected in Table 8 below, the new township will have a new development of housing a total of 4,153 units supported by commercial development, which is 416 in total.

Table 8. Estimated Population in the Proposed Township

	Number of People
Local People	5,556
Staffs	10,890
Total	16,446

Planning judgement

The three township alternative have a different compositions of existing land use (Table 9-11). Township 1 already has built-up areas, which consist of housing, commercial, institutional, and so on, giving it advantages as the current land use may quickly expand its boundary. However, the other township alternatives only consist of agricultural land use and road. This situation may limit development as it is a greenfield area. Thus, Township 1 is the most suitable to be chosen as the new township area (See also Figure 9).

Table 9. Existing composition of land use in township 1

Land Use	Area (Hectares)
Housing	9.49
Commercials	0.17
Institutional and Community Facilities	20.87
Infrastructure	12.20
Transportation	50.22
Open Space and Recreational	2.03
Water Bodies	23.11
Agricultural	202.19
Total	314.20

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Table 10. Existing composition of land use in township 2

Land Use	Area (Hectares)
Transportation	75.59
Open Space and Recreational	0.03
Agricultural	152.98
Total	371.95

Table 11. Existing composition of land use in township 3

Land Use	Area (Hectares)
Transportation	75.59
Agricultural	165.61
Total	388.45

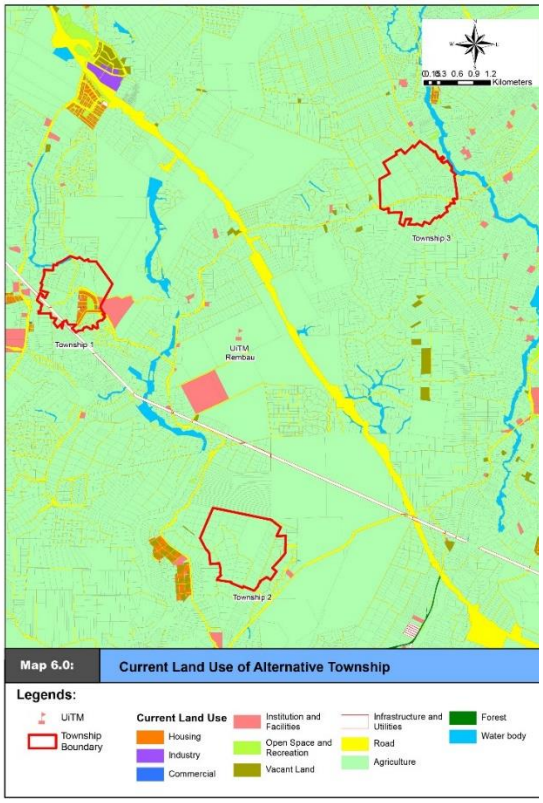


Figure 9. Land use in the alternative township

Crowd sourcing: polling

Crowd Sourcing is one of the ways to approach community engagement. It is the process of collecting volunteered information from people. A web-based application (Polling) by GIS was used to obtain views from the public to choose the new township area. The result of network analysis and the current land use is shown in the application to assist the public in making a decision. The public can vote for their choice of possible township area (Figure 10).

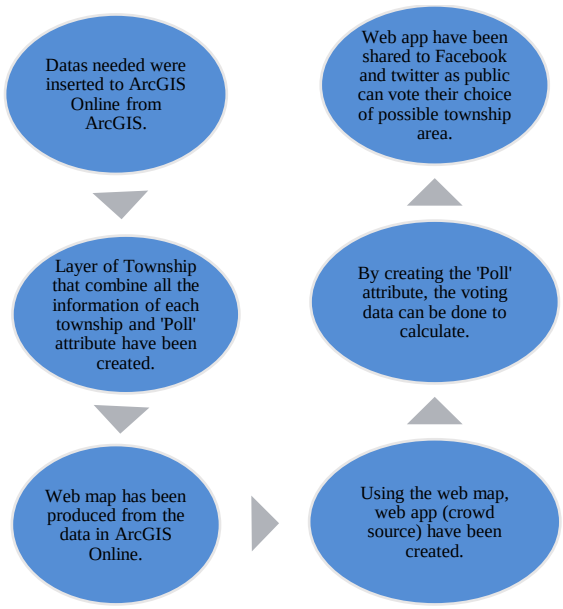


Figure 10. Methodology framework of crowd sourcing (polling)

Main Settlements and Small Settlements Center, the result of network analysis showing the shortest road distance from UiTM Rembau to each proposed township, and the proposed township itself was inserted into ArcGIS Online. The information of the network analysis result and the existing composition of land use of each township were given in the attribute to assist and ease the public to make the best decision. The 'Poll' attribute also has been created so that the votes can be calculated. To simplify it, each person can only vote for one township. The base map and layers are generally hosted and shared through ArcGIS Online (Figure 11).

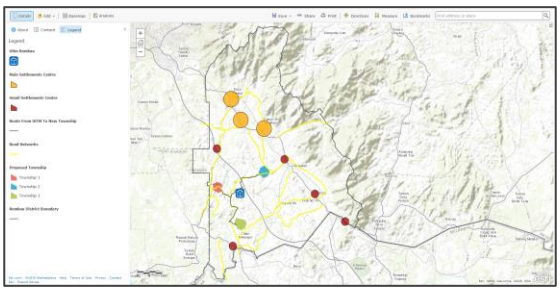


Figure 11. Web map that has been produced by adding the layers from data of ArcGIS online

As the Web map has been produced, the web app has been created by using a configurable app or Web App Builder. Different configurable apps and Web App Builders offer various functionality, such as different layouts and color schemes, editing and identification tools, social media feeds, side-by-side map viewers, and so on. In this study, Crowd Sourcing Polling has been used. It is a configurable web application template that allows users to submit comments or feedback on existing plans and proposals. The application is responsively designed to be used on tablets and desktop computers. Afterward, the web app was shared on Facebook and Twitter, and the public could vote for the township they preferred (Figure 12). After some time, the vote has been calculated and is shown in Table 12 below.

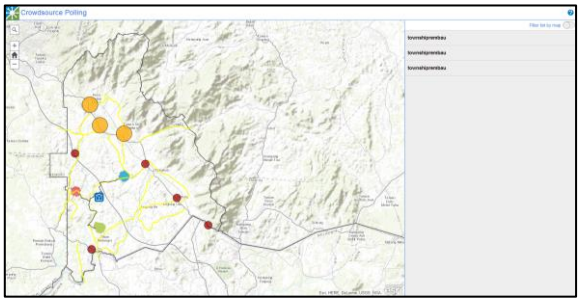


Figure 12. Web App that has been created as public can vote their choice of possible township area

Table 12. Public vote for the township they preferred

Township	Vote
1	10
2	2
3	1

The crowdsourcing result shows that Township 1 has the highest vote from the public, which strengthens the planning judgment from the analysis that has been conducted. In addition, township 1 has high suitability, the shortest distance from UiTM Rembau (4.23 km), and the minor area to develop that will cost the least. Also, part of Township 1 has already been built up, which gives an advantage for it to expand the boundary.

COCLUSSION

The suitability analysis helps identify the best township area near the UiTM Rembau to cater to new development (residential and commercial). Furthermore, the network analysis helps identify the shortest distance from UiTM Rembau to each alternative township. Finally, the web-based application by GIS helps to reaffirm the result of the analysis made before and engage the public to help make a decision. Therefore, with all the results, Township 1 should be chosen as a new township area that will cater to UiTM Rembau.

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