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Optimal Location Determination For Boarding House Development In The Buffer Area Of The Sepuluh Nopember Institute Of Technology

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***Abstract*— The limited availability and consequent high cost of land have driven urban development to focus on vertical structures, such as student boarding houses. The selection of locations for these boarding houses is crucial, as it involves numerous subjective criteria. Public participation is vital in understanding preferences and ensuring the optimal choice of settlements. Moreover, stakeholders can use this information to enhance planning efforts for areas with high potential for boarding house development, significantly impacting urban infrastructure. Sepuluh Nopember Institute of Technology (ITS) significantly influences the growth of vertical buildings, including apartments and boarding houses in its surrounding areas. This study analyzes the optimal locations for boarding houses development in the ITS buffer zone using multi-criteria decision analysis. By adopting a bottom-up approach that incorporates student preferences, the study evaluates importance score and values from variables such as proximity to the campus center, supermarkets, food vendors, accessibility, and land price range. The findings indicate that Gebang Putih, Kejawan Tambak, and Upper Keputih are the most suitable locations for boarding houses development.**

Kata Kunci*— *Bottom-Up, Multi Criteria Decision Analysis, Analytical Hierarchy Process

I. INTRODUCTION

Surabaya's development has attracted a significant number of new residents, making it a popular destination for those seeking settlement. This trend is also particularly evident in the buffer area around Institut Teknologi Sepuluh Nopember (ITS), which has become a key attraction for settlement seekers. According to a primary survey, many ITS students are migrants from other cities or countries, contributing to the city's population growth, migration rate, and inhabiting activities. However, rapid urbanization often leads to problems [1] such as land insufficiency [10], which can threaten the city's sustainability and resilience [9].

The majority of residents attracted by ITS are students. As ITS expands its faculties and departments to accommodate more students, there is a growing demand for student housing in the surrounding buffer area. Consequently, numerous vertical student boarding houses have emerged. Developing vertical buildings for student housing is viewed as an effective solution to these settlement challenges. Vertical housing optimizes land use by accommodating more residents within the same area, enhances social interactions within the community, and is more affordable compared to individual houses [14].

Furthermore, data from Indonesia's Ministry of Agrarian and Spatial Planning National Land Agency indicate that land and housing prices in the ITS buffer area are above the lower-middle range, with some real estate areas featuring higher price points. This highlights the necessity of strategically planned vertical housing which includes student boarding houses to ensure both affordability and accessibility for students and other residents.

The challenge, however, lies in identifying the best locations for boarding houses around the ITS buffer area. Location determination is critical as it involves various criteria that differ based on individual preferences. This study employs a bottom-up approach by using purposive sampling to gather ITS students' preferences for optimal boarding housing locations. A questionnaire will be used to identify the criteria and score them based on student preferences. The results are expected to provide a detailed picture of the settlement typologies most desired by ITS students. Additionally, the findings can assist the government and stakeholders in developing the most potential areas for public facilities development, particularly in terms of building regulations and infrastructure development.

II. RESEARCH METHOD

To ensure scientific rigor, public perspectives collected through a questionnaire serve as a foundational reference for this study. The analysis employed encompasses multi-nodal accessibility assessment, multi-criteria decision-making (MCDM) utilizing Likert scales, and overlay techniques to determine the optimal location.

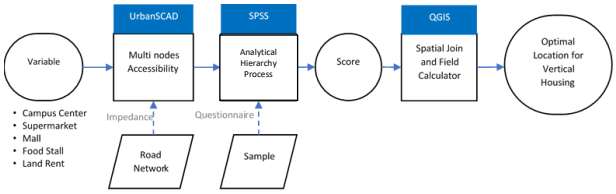

Figure 1. Research Methodology

A. *Data and Sample*

The population for this research comprises all students at ITS, totaling approximately 25,000. According to Mahmud (2011), a sample size of at least 30 is considered sufficient for a large population [4]. This is supported by Malhotra (1993), who recommends a minimum sample size of five

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times the number of variables used in the research [16]. Additionally, Roscoe (1975) suggests that sample sizes between 30 and 500 are appropriate for most studies [15]. In this study, 40 respondents were initially selected, with an additional 10 samples included to minimize the errors of the findings [17]. Given the focus on determining the most optimal location for boarding houses, particularly for ITS students, it is crucial to target individuals directly affiliated with ITS. Therefore, the selected sample primarily consists of ITS students or individuals closely associated with the institution. The approach utilized is stratified purposive random sampling, ensuring representation from various segments of the student population. The distribution of common student boarding house areas, as indicated from the pre-questionnaire, is as follows:

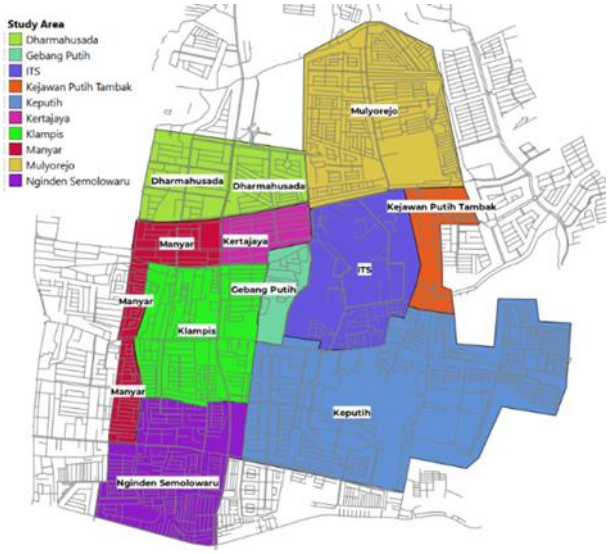

Figure 2. Common student temporary housing area

This study incorporates various variables assessed through a structured questionnaire. These variables include the proximity of potential boarding houses areas to the ITS Campus, the availability of food sellers, supermarkets, land prices in potential housing areas, and transportation accessibility to the campus. Through a comprehensive literature review, these variables were identified and followed by a pre-questionnaire administered to the samples to refine these variables. Subsequently, the importance of each variable was determined through Likert Scale ratings to assign appropriate weights. Information regarding the availability of food sellers and supermarkets was gathered through primary surveys, while data on distances from the ITS Campus and land prices were obtained from secondary sources. Additionally, the preferred locations within the ITS buffer zone for boarding houses were confirmed with the samples prior to variable assessment, ensuring that the visualized maps reflect only the relevant areas of the buffer zone.

B. Assessing the accessibility of housing around ITS

To calculate the value of accessibility, this study adopts the Geertman and van Eck model of modified potential gravity model [5]. They mentioned that a potential value cannot be easily interpreted considering the relationship to the geographical reality and developed a measure with meaningful unit to evaluate the aggregate accessibility at a site.

$$T_i = \frac{\sum_j (M_j / d_{ij}^{a-1})}{\sum_k (M_k / d_{ij}^{a})}$$

Where a is distance decay parameter (or impedance parameter), dij is travel time or distance, and Ti is average travel time or average distance. In this study, we use speed impedance parameter, so the output is on time unit not distance. We define impedance on each road segment based on maximum speed to improve the accuracy of the analysis result, which are classified on Minister of Transportation Regulation No. 11 of 2015 (PERMENHUB No.11 Tahun 2015).

To apply the modified potential model to analyze boarding houses potential location accessibility, we use Multi nodes Analysis in UrbanSCAD. That tool worked similarly to a Geertman and van Eck's model of the modified potential gravity. We analyze the accessibility from housing area to each location of criteria's point/centroid.

C. Assessing the weight of each variable

According to Raharjo et al., multi-criteria decision making (MCDM) is a decision-making technique from several available choices [6]. In this study, MCDM holds elements of attributes, objectives, and goals. By properly structuring complex structures and considering multiple criteria, decisions will be made better and more accurate.

The multi-criteria decision-making (MCDM) approach utilized in this research employs a scoring method based on the Likert scale. Factors influencing students' housing choices are collected via a questionnaire and processed using Likert weighting to assess their relative importance according to the respondents [7]. This study uses closed statements with a range of rating scales: (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree.

D. Determining the most optimal location for boarding houses

To pinpoint the most optimal location, the accessibility score of the housing area surrounding ITS is calculated by multiplying it with the corresponding weight using a combination of spatial and field calculators in GIS. This process allows us to analyze the accessibility of each criterion and subsequently multiply them by their respective weights obtained from the Likert scale

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III. RESEARCH ANALYSIS

A. *Accessibility Analysis*

From the results of the analysis by UrbanSCAD that has been carried out, it is found that there are differences in the value of accessibility in a place against each of the criteria being tested. For example, the Keputih area has high accessibility to food sellers but does not have high accessibility to malls and campuses. Mulyorejo is an area that in terms of accessibility is quite good in every criteria. The accessibility to food sellers in each area is considered balanced. While the other criteria are not balanced. Areas that have good accessibility to campus are Kejawan Putih Tambak, Kertajaya, and Mulyorejo. Then, areas that have good accessibility to supermarkets are Mulyorejo, Keputih, and Nginden Semolowaru. Meanwhile, the only area that has good accessibility to the mall is Dharmahusada.

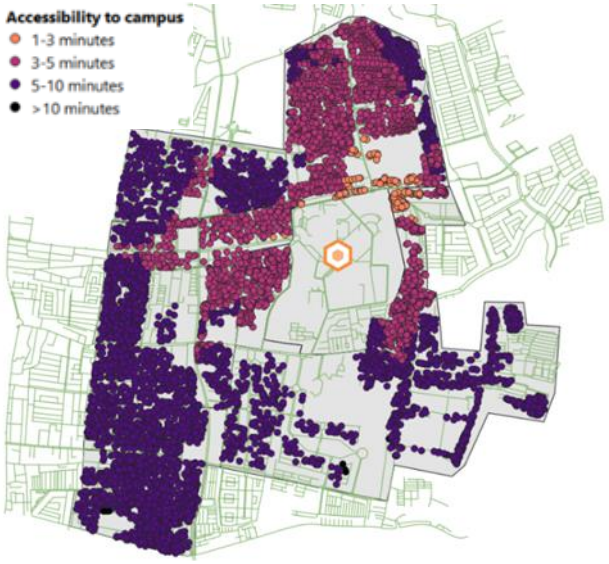

Figure 3. Accessibility to campus

Figure 4. Accessibility to food seller

Figure 5. Accessibility to supermarket

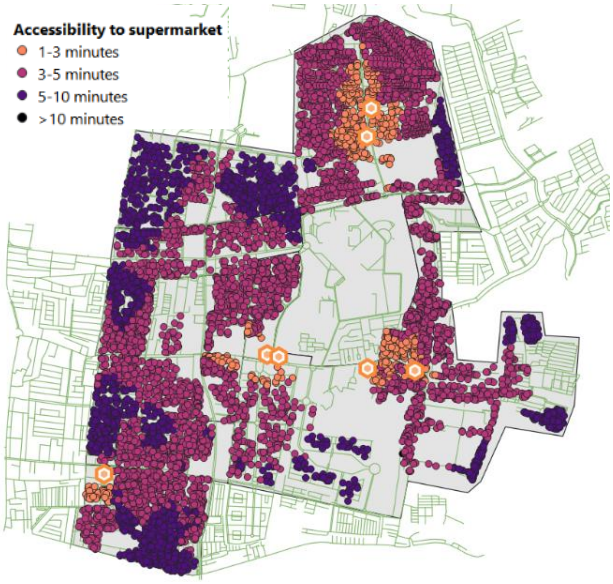

Figure 6. Accessibility to mall

B. *Land price*

As one of the criteria for ideal housing, we analyzed the current land price in the area from Indonesia's ATR/BPN (Ministry of Agrarian and Spatial Planning National Land Agency) interactive website to gather land price data. The surrounding area of ITS is considered one of the most expensive areas in Surabaya as the average suitable land for housing price is about 5-10 million and 10-20 million rupiah/square meter. The cheapest and closest area to ITS area Kejawan Putih Tambak and Keputih Gang Makam cost around 2-5 million rupiah. When the highest is the Kertajaya area that above 20 million rupiah.

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Figure 7. Land Price

C. *MCDA (Multi Criteria Decision Analysis)*

The multi-criteria decision analysis (MCDA) process was implemented using data collected from the distributed questionnaires. Criteria for the MCDA included the importance scores of factors (confirmed variables), as well as the value based on accessibility of each factors and the land price.

The Analytical Hierarchy Process was employed to obtain the importance scores of various factors according to the respondents by Likert scale, as shown in Table 1.

Table 1. Importance score per factor

Factors (X)	Reference	Research title	Score
Campus Centre (*X*1)	(Abdassah, Anandhita, and Sesotyaningtyas , 2013)	Determinants of Occupancy Type Preferences Among Students	0.22
Supermarket (X2)	(Janet Paruntu, Djoni Hatidja, Yohanes A.R. Langi, 2019)	Factors Influencing the Community in Choosing a Residential Location for Peri Urban Surabaya in Sidoarjo	0.20
Mall (X3)	(Abdassah, Anandhita, and Sesotyaningtyas , 2013)	Determinants of Occupancy Type Preferences Among Students	0.13
Food Stall (X4)	(Abdassah, Anandhita, and Sesotyaningtyas , 2013)	Student Decisions in Choosing Boarding Houses with Factor Analysis	0.22
Land Price (X5)	(Medina Ayesha Serlin, Ema Umilia. (2013))	Public Interest Relations in simple flats with accessibility and location	0.22
Total			1

In addition to deriving importance scores from the questionnaire results, the accessibility of boarding houses to malls, supermarkets, food stalls, campus center, and the land prices of boarding house development areas were categorized into the Likert scale, as illustrated in the table below.

Table 2. Value Based on Accessibility and Price

Accessibility in minute	Land Price (Rp)	Value
<1	< 2 million	5
1-3	2–5 millions	4
3-5	5–10 millions	3
5-10	10–20 millions	2
>10	>20 millions	1

The accessibility score (in minute) obtained from the calculation through UrbanSCAD (figure 3 to 6). To obtain the final output of this study which is the value/score of every boarding houses development area location, the accessibility value and the land price value for each area is then multiplied by each weight/score according to the following formula:

$$Location\ Value$$

$$= (Score\,X1)X1 + (Score\,X2)X2 + (Score\,X3)X3 + (Score\,X4)X4 + (Weight X5)X5$$

From that formula, score refers to importance scores (table 1). X1, X2, X3, X4, and X5 refers to the accessibility (for X1—X4) and land price (for X5) value of every area according to table 2.

D. *Ideal Location for Boarding Houses*

After all data were collected, accessibility scores were assigned, and location values were calculated using the specified formula. The results were expressed as numerical scores. Each potential site for boarding house development was evaluated, and the scores were divided into five equal-ranged categories: not recommended, moderately recommended, recommended, ideal, and extremely ideal for boarding house construction.

Our analysis identified Kejawan Putih Tambak, Mulyorejo, the upper side of Keputih, and Gebang as the most ideal locations for boarding houses development in the ITS campus buffer area. These areas received the highest total scores based on the five criteria used to determine the optimal boarding house locations. The criteria included proximity to the campus, availability of essential amenities such as food stalls and supermarkets, accessibility to transportation, and land prices. These factors were weighted according to their importance as determined by student responses, ensuring that the analysis was closely aligned with the preferences and needs of the ITS student

population.

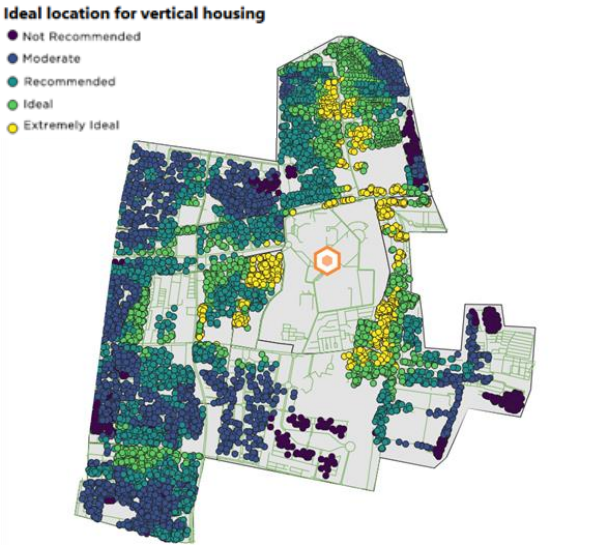

Figure 8. Ideal location distribution for boarding houses

Table 3. Description of the indicators

Indicator		Description
	Not Recommended	not recommended to be developed as vertical houses location
	Moderate	can still be considered to be developed as vertical houses location
	Recommended	ideal enough to be developed as vertical houses location
	Ideal	recommended to be developed as vertical houses location
	Extremely Ideal	very ideal and suitable to be developed as vertical houses location

IV. CONCLUSION

The study identifies Kejawan Putih Tambak, Mulyorejo, the upper side of Keputih, and Gebang as the most ideal locations for developing boarding houses for ITS students. These areas were found to have the highest scores based on the specific criteria used in the analysis. Additionally, the middle part of Keputih, Nginden Semolowaru, and parts of Kertajaya were also considered worthy of consideration for boarding house development. These conclusions underscore the potential of these areas to meet the housing needs of ITS students effectively.

The criteria used in the study included factors such as proximity to the campus, availability of amenities like food stalls, supermarkets, and malls, as well as land prices and transportation accessibility. The weighting of these factors was determined using student responses, ensuring that the identified locations align closely with the preferences and requirements of the student population. However, it is important to note that if different methods or criteria were applied, the results might vary, indicating the need for flexibility and adaptability in planning.

For future research, it is recommended to increase the number of respondents to enhance the accuracy and reliability of the findings. A larger sample size would provide a more comprehensive understanding of student preferences and ensure that the results are more representative of the broader student population. Additionally, researchers should consider including other influential factors in the questionnaire that might affect the optimal location for boarding houses. For instance, preferences for ideal travel time to each destination could provide deeper insights into student priorities and help refine location selection.

Furthermore, incorporating additional considerations such as crowd density and road Level of Service (LoS) in the calculation of ideal impedance could improve the robustness of the results. These factors could significantly impact the livability and convenience of the boarding house locations, thereby affecting student satisfaction. By expanding the scope of the analysis to include these elements, future studies can develop a more holistic understanding of the factors influencing optimal boarding house development and provide more targeted recommendations for urban planners and policymakers.

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