DECISION SUPPORT SYSTEM FOR RESIDENTIAL LAND SELECTION USING SMART METHOD : SIMPLE MULTI ATTRIBUTE RATING TECHNIQUE

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ABSTRACT

PT. Abra, a property development company specializing in residential housing, faces challenges in selecting strategic land for its projects, often leading to inefficiencies in decision-making. The main issue is the lack of an integrated system to assess multiple criteria, such as location, price, accessibility, and infrastructure availability. To overcome this, a Decision Support System (DSS) is developed using the Simple Multi-Attribute Rating Technique (SMART) method, enabling systematic evaluation based on predefined criteria. The system follows the Rapid Application Development (RAD) methodology, which consists of requirements planning, user design, construction, and cutover phases, ensuring flexibility and efficiency. A MySQL database is used for structured data management, while Blackbox testing is conducted to validate system functionality, ensuring accuracy and reliability. The results show that the DSS improves decision-making efficiency, reduces selection errors, and optimizes land acquisition for residential projects. Furthermore, it enhances transparency in land selection by providing real-time data analysis and ranking of potential locations. This research contributes to the real estate sector by improving strategic planning, resource allocation, and overall project success, providing a structured and effective approach to optimizing land selection processes.

Key Words : *Decision Support System, SMART, Rapid Application Development, MySQL, Land Selection, Real Estate Development.*

1. INTRODUCTION

The rapid growth of the property sector has increased the demand for strategic land selection, particularly for subsidized and non-subsidized housing. PT. Abra Property, a company engaged in the sale of residential houses and land plots, continuously expands its market by developing housing projects across different regions in Kudus, Indonesia. The company has already established several housing estates in locations such as Prambatan, Megawon, Ngembal Iain, and Peganjaran. However, determining the most suitable land for new housing projects remains a critical challenge due to various factors such as land area, development costs, accessibility, infrastructure availability, and environmental conditions.

Traditionally, land selection is conducted manually based on subjective judgment, which often leads to suboptimal decisions and increased investment risks [1], [2].

To overcome these limitations, an advanced Decision Support System (DSS) is required to provide a systematic and data-driven approach to land selection [3].

One of the most effective methods for multi-criteria decision-making is the Simple Multi-Attribute Rating Technique (SMART) [4], [5], [6].

This method enables property developers to assign weighted criteria, ensuring that objective and rational decisions are made based on key land selection factors [7].

The objective of this research is to develop a Decision Support System (DSS) using the SMART method to assist PT. Abra Property in selecting suitable land for residential development [8], [9].

This system is expected to improve decision-making efficiency, minimize risks, and optimize profitability by providing a structured evaluation process for different land locations [10].

This study is supported by theoretical frameworks in decision support systems, multi-criteria decision-making, and property development strategies [11], [12], [13].

Research in these fields indicates that data-driven decision-making systems significantly enhance investment accuracy and operational efficiency in real estate development [14], [15].

By implementing a SMART-based DSS, PT. Abra Property can gain a competitive advantage by selecting optimal land locations that align with market demands, financial feasibility, and infrastructure readiness.

The expected results of this research include the development of a user-friendly and effective DSS that will help property developers, landowners, and investors make well-informed decisions. This system is anticipated to increase profitability, improve project success rates, and enhance customer satisfaction by ensuring that housing developments are built in the most suitable locations [16], [17], [18].

2. LITERATURE REVIEW

In previous research conducted by Andika, Dahria, and Siregar, titled *Decision Support System for Housing Location Selection Using the Weighted Product (WP) Method,* the study aimed to assist PT.

Romeby Kasih Abadi in determining strategic locations for residential development in Medan. The Decision Support System (DSS) considered multiple criteria, such as proximity to traditional markets, access to main roads, and population density. The results showed that the DSS effectively saved time and effort by providing accurate information on location feasibility, making the decision-making process more efficient and effective [19].

Another study conducted by Harahap, Iswan, and Murniyanti, titled *Implementation of a Decision Support System for Selecting Subsidized Housing Consumers Using the SMART Method*, aimed to assist PT. Segar Asri Pratama in Sibolga in selecting eligible recipients for subsidized housing in collaboration with Bank SUMUT. The developed system utilized the *Simple Multi-Attribute Rating Technique* (SMART) method to assess consumer eligibility based on various criteria. The findings indicated that the system made the selection process more systematic and fairer, ensuring that the benefits of the subsidized housing program reached those who truly needed them [20].

A similar study was also conducted by Ramadhan et al., titled *Utilization of the SMARTER Method with Rank Order Centroid (ROC) Technique in Housing Location Selection*. This research aimed to assist PT. Arima Karya Properti in Pekanbaru in determining the optimal location for residential development. The developed system considered factors such as land size, cost, soil conditions, and flood risk. The results demonstrated that implementing DSS with the SMARTER method and ROC technique improved decision-making accuracy, allowing the company to select more strategic locations and minimize investment risks in the property sector [21]

2.1. Definition of a System

A system is a logical and rational procedure designed to structure a set of interconnected components that work together to achieve a specific objective [22].

2.2. Definition of a Information

Information is processed data that provides meaning and supports decision-making. Raw data becomes useful when organized, analyzed, and contextualized to identify patterns or insights [23], [24].

For example, in a Decision Support System (DSS), processed data helps evaluate land suitability based on key criteria [25].

2.3. Definition of Web Aplication

A web application is an information system that supports user interaction through a web-based interface [26], [27].

One of the main objectives of a web application is to reduce business and user costs by minimizing support and maintenance requirements while lowering the dependency on end-user computer specifications for access [28].

2.4. Definition of Housing

According to Law No. 4 of 1992, housing and settlements are categorized into three main aspects. A house is defined as a building that serves as a residence and a place for family development. Housing refers to a group of houses functioning as a residential environment equipped with infrastructure and facilities. Meanwhile, settlements encompass residential areas outside protected zones, whether in urban or rural settings, that support daily life and livelihood activities.

2.5. Definition of SMART (Simple Multi Attribute Rating Technique)

SMART (Simple Multi-Attribute Rating Technique) is a multi-attribute decision-making technique used to support decision-makers in choosing between multiple alternatives [29], [30].

Each decision-maker must select an alternative that aligns with the predetermined objectives [31].

Each alternative consists of a set of attributes, and each attribute has a value that is averaged using a specific scale [32].

2.6. Step in The SMART Method

The sequence of steps in using the Simple Multi-Attribute Rating Technique (SMART) method is as follows [33]:

a. Determine the number of criteria to be used.
b. Assign weight values to each criterion using a scale of 1-100, with the most important criteria given higher priority.
c. Calculate the normalization for each criterion by comparing the weight value of each criterion to the total weight value of all criteria using the following formula:
   Normalization:
   $$\frac{W_j}{\Sigma W_j} \tag{1}$$
   Where Wj represents the weight value of a criterion, and $\sum$ Wj is the total weight value of all criteria.
d. Assign parameter values for each criterion across all alternatives.
e. Determine the utility value by converting each criterion's value into a standardized data value [34]. The utility value is calculated using the following equation:
   Utility Value:
   $$u_i(a_i)\frac{Cout-Cmin}{Cmax-Cmin} \tag{2}$$
   Where:
   ai represents the utility value of the i-th criterion.
   Cmax is the maximum criterion value.
   Cmin is the minimum criterion value.
   Couti is the criterion value for alternative i.
   The resulting values are:
   Couti = (a_i),*1 = 0 ; 2 = 0,5 : 3 = 1*

f. Determine the final score for each alternative by multiplying the normalized criterion value with the normalized weight value, then summing all results using the formula [35]:
Final Score Calculation:
$$U(a_i) = \Sigma_{J=i}^{m} Wj\ \mathrm{U_j}(a_i) \tag{3}$$
Where:
$U(a_i)$is the total score for an alternative.
W_j is the normalized weight of a criterion
$U(a_i)$ is the utility value obtained from the previous step.

3. RESEARCH METHODOLOGY

To achieve the research objectives, the author requires a precise and structured methodology. Therefore, the methodology and data collection techniques used in this study are as follows:

3.1. Primary Data Sources

3.1.1. Interviews

The author conducted interviews with the owner of PT. Abra Property to gather information regarding existing issues within the company. According to Winarto, the company owner, the property sector requires a Decision Support System (DSS) to assist in selecting land for customers based on budget, criteria, and ideal housing preferences.

3.1.2. Observations

To complement the collected data, the author also engaged in direct observations with the owner and business partners of PT. Abra Property to examine the challenges faced by the company firsthand.

3.2. Secondary Data Sources

Secondly data is information obtained from existing sources, such as journals, books, and previous research reports. The author acquired secondary data through a literature study approach, which involves gathering information and data from relevant literature, including books, journals, and online sources related to the research topic. This method allows the author to compile references from credible sources, providing a solid theoretical foundation for the study and ensuring a well-supported final research outcome.

3.3. System Development Methodology

The Rapid Application Development (RAD) method is designed to accelerate system creation while keeping costs efficient [36].

This approach focuses on an iterative process, prioritizing speed, flexibility, and success potential. By emphasizing prototyping and user involvement, RAD reduces redevelopment time after implementation, ensuring a more efficient system development cycle [37].

The following are the key phases of the RAD method, as illustrated in Figure 1.

Figure 1. Rapid Application Development (RAD) Method Cycle

a. Requirement Planning
At this stage, researchers conduct in-depth discussions with relevant stakeholders to identify system objectives and determine the necessary information specifications to achieve them. A comprehensive analysis is carried out, covering both software and hardware requirements, ensuring that all essential components are in place to optimize system performance.

b. RAD Design Workshop
This phase involves an interactive design and refinement process through collaborative workshops. In these sessions, analysts and software developers work together to create, refine, and present system models and designs to users. The duration of the workshop varies depending on the complexity and scale of the application. Stakeholders provide real-time feedback, allowing developers to immediately adjust and enhance the design based on user needs and expectations.

c. Implementation
During the implementation phase, analysts and users collaborate in a series of workshops to align business and non-technical aspects relevant to the company. Once these aspects are finalized and the system is developed accordingly, it undergoes testing at different levels. After successful testing, the customized system is officially introduced and deployed for operational use within the company.

4. RESULT AND DISCUSSION

4.1. Evaluation of The SMART Method Calculation

4.1.1. Identification and Weighting of Criteria

The initial step in the SMART process involves determining the criteria and their respective weightings, which serve as the basis for selecting the most suitable land for residential development by PT. Abra Property. The criteria considered in this study include price, strategic location, land area, road access, water access, electricity network, and legality. The assigned weightings for each criterion are presented in Table 1.

Table 1. Weight of Criteria

No	Criteria	Weight	Normalization (%)
1	Price	25	25%
2	Strategic Location	20	20%
3	Land Area	15	15%
4	Road Access	15	15%
5	Water Access	5	5%
6	Electricity Network	5	5%
7	Legality	15	15%
Total		**100**	**100%**

4.1.2. Determination of Sub Criteria

In the SMART method, each main criterion is further divided into sub-criteria, each assigned a specific value to facilitate decision-making. The classification of sub-criteria and their respective values is presented in Table 2 below.

Table 2. Sub-Criteria and Assigned Values

Criteria	Sub-Criteria	Value
Price	≤ 50 million	5
	≤ 100 million	4
	≤ 200 million	3
	≤ 300 million	2
	> 300 million	1
Location	Level 1	5
	Level 2	3
	Level 3	1
Land Area	≥ 1000 m²	5
	≥ 500 m²	4
	≥ 200 m²	3
	≥ 100 m²	2
	< 100 m²	1
Road Access	Easy	5
	Moderate	3
	Difficult	1
Water Supply	Available	5
	Not Available	1
Electricity	Available	5
	Not Available	1
Legality	Valid	5
	Not Valid	1

4.1.3. SMART Calculating Analysis

The SMART (Simple Multi-Attribute Rating Technique) method is utilized to facilitate an objective decision-making process by evaluating alternatives based on specific criteria and sub-criteria. This approach ensures a structured and systematic assessment of land options considering price, location accessibility, land area, road access, water availability, electricity supply, and legal status.

Each alternative is scored based on its alignment with predefined classification sub-criteria derived from survey data. These values serve as a reference for further calculations, enabling a comprehensive and rational selection of the most suitable land option. The detailed assessment results are presented in Table 3.

Table 3. Mapping Data to Slection Criteria

ID	Name	C1	C2	C3	C4	C5	C6	C7
1	Saripin	3	5	2	5	5	5	5
2	Suranti	5	3	2	5	5	5	5
3	Subajo	3	3	2	5	5	5	5
4	Solikin	3	1	3	3	5	5	5

4.1.4. Determining The Maximum Evaluation Value for Each Criterion

To ensure an optimal decision-making process using the SMART method, the first step is to identify the highest evaluation score for each criterion. This maximum value represents the best possible condition observed across all alternatives, which will serve as a reference for further calculations in the decision model.

The table below presents the maximum scores obtained for each criterion, reflecting the highest performance level observed among the surveyed land alternatives. These values are crucial in normalizing the data, facilitating an objective evaluation of the potential land locations. The maximum values for each criterion can be seen in Table 4.

Table 4. Determining the Maximum Evaluation Value for Each Criterion

Criterion	Maximum Value Across All Alternatives
Price (kriteria1)	5
Location (kriteria2)	5
Land Area (kriteria3)	3
Road Access (kriteria4)	5
Water Availability (kriteria5)	5
Electricity Supply (kriteria6)	5
Legal Status (kriteria7)	5

4.1.5. Calculation of Utility Values and Total Utility for Each Alternative

To ensure a comprehensive and objective evaluation of each alternative, the utility value for each criterion is calculated using the formula:

$$normalization \frac{(criteria\ value)}{(maximum\ criteria\ value)} \quad (4)$$

After obtaining the utility values for each criterion, they are then multiplied by the respective weight (based on the importance of each criterion) to determine the weighted utility for each alternative. The total utility for each alternative is the sum of these weighted utilities. Table 5 below presents the detailed calculations for the utility values and their weighted sums for each land alternative. This process allows for a clear comparison of alternatives based on the criteria defined.

Table 5. Calculation of Utility Values and Total Utility for Each Alternative

ID	Alternative	Criterion	Score	Utility Calculation	Utility x Weight
1	**Saripin**	Price	3	$\frac{3}{5}$ = 0.60	0.60 x 0.25 = 0.15
		Location	5	$\frac{5}{5}$ = 1.00	1.00 x 0.20 = 0.20
		Area	2	$\frac{2}{3}$ = 0.6667	0.67 x 0.10 = 0.10
		Road Access	5	$\frac{5}{5}$ = 1.00	1.00 x 0.15 = 0.15
		Water	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Electricity	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Legality	5	$\frac{5}{5}$ = 1.00	1.00 x 0.15 = 0.15
	Total Utility				**0.85**
2	**Suranti**	Price	5	$\frac{5}{5}$ = 1.00	1.00 x 0.25 = 0.25
		Location	3	$\frac{3}{5}$ = 0.60	0.60 x 0.20 = 0.12
		Area	2	$\frac{2}{3}$ = 0.6667	0.67 x 0.10 = 0.10
		Road Access	5	$\frac{5}{5}$ = 1.00	1.00 x 0.15 = 0.15
		Water	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Electricity	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Legality	5	$\frac{5}{5}$ = 1.00	1.00 x 0.15 = 0.15
	Total Utility				**0.87**
3	**Subajo**	Price	3	$\frac{3}{5}$ = 0.60	0.60 x 0.25 = 0.15
		Location	3	$\frac{3}{5}$ = 0.60	0.60 x 0.20 = 0.12
		Area	2	$\frac{2}{3}$ = 0.6667	0.67 x 0.10 = 0.10
		Road Access	5	$\frac{5}{5}$ = 1.00	1.00 x 0.15 = 0.15
		Water	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Electricity	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Legality	5	$\frac{5}{5}$ = 1.00	1.00 x 0.15 = 0.15
	Total Utility				**0.77**
4	**Solikin**	Price	3	$\frac{3}{5}$ = 0.60	0.60 x 0.25 = 0.15
		Location	1	$\frac{1}{5}$ = 0.20	0.20 x 0.20 = 0.04
		Area	3	$\frac{3}{3}$ = 1.0	1.00 x 0.10 = 0.15
		Road Access	3	$\frac{3}{5}$ = 0.60	0.60 x 0.15 = 0.09
		Water	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Electricity	5	$\frac{5}{5}$ = 1.00	1.00 x 0.05 = 0.05
		Legality	5	$\frac{5}{5}$ = 1.00	1.00 x 0.15 = 0.15
	Total Utility				**0.68**

4.1.6. Final Rangking

The ranking process aims to determine the best alternative based on normalized criteria values. Each alternative's total score is calculated through a weighted evaluation, ensuring a fair and objective comparison. A higher score indicates a more optimal choice. The results are presented in Table 6, showcasing the ranking of each alternative based on their total performance calculation.

Table 6. Final Rangking

ID		Alternative	Total Score	Rank
1		Saripin	0.85	2
2		Suranti	0.87	1
3		Subajo	0.77	3
4		Solikin	0.68	4

Based on the SMART analysis, Suranti emerges as the most optimal choice, achieving the highest score (0.87), followed by Saripin (0.85). The results demonstrate the effectiveness of SMART in systematically evaluating and ranking alternatives. This approach provides a structured, transparent, and rational decision-making framework for selecting the best land option based on predefined criteria.

4.2. Implementation of The System

The Decision Support System for Residential Land Selection utilizing the SMART (Simple Multi-Attribute Rating Technique) method is designed to assist in selecting the most suitable land based on criteria such as price, location, and area. This system comprises a responsive web interface, a backend for business logic, and a database to store criteria data and calculation results. Users can input data, perform automatic calculations using weighted normalization and preference values, and efficiently receive accurate land recommendations.

4.2.1. Login Interfaces

The login page serves as the initial interface presented to users for accessing their accounts. The admin login page interface, as shown in Figure 1, provides a clear and secure entry point for system access.

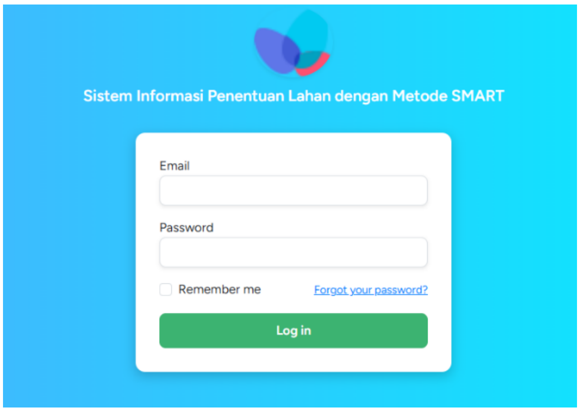

Figure 2. Login interfaces

4.2.2. Add Land Page

The Add Land page is used for entering new land data. The interface of the Add Land page, as shown in Figure 3, provides a user-friendly layout for efficient data entry.

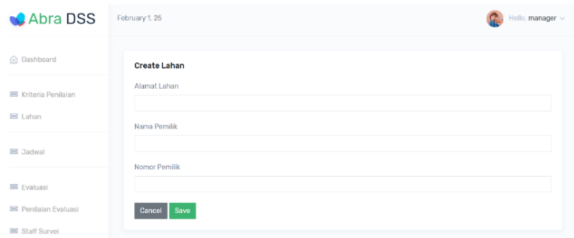

Figure 3. Add land page

4.2.3. Survey Staff Page

The Survey Staff page is designed for adding survey staff members who will conduct land surveys. The interface of the Survey Staff page can be seen in Figure 4.

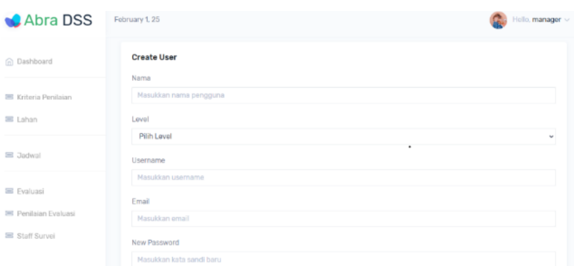

Figure 4. Survey Staff Page

4.2.4. Survey Data Page

The Survey Data page is used to add and fill in survey data. The interface of the Survey Data page can be seen in Figure 5 below.

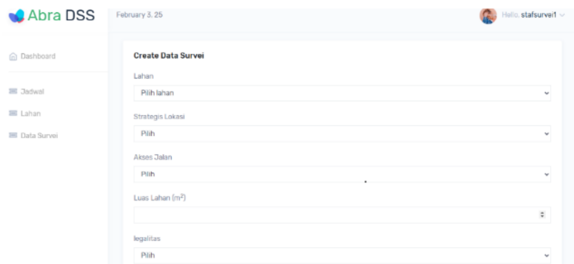

Figure 5. Survey data page

4.2.5. Evaluation Result Page

Evaluation Results page displays the outcomes of the evaluations that have been conducted. The interface of the Evaluation Results page can be seen in Figure 6.

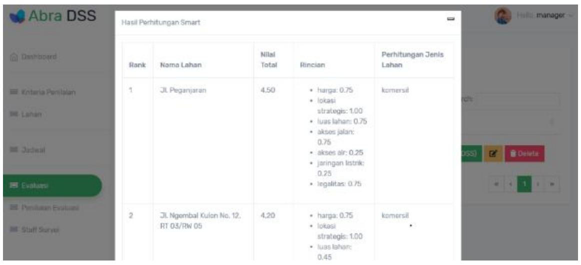

Figure 6. Evaluation results page

4.2.6. Evaluation Report Page

Evaluation Report page is designed to display the evaluation results in a report format, which can be printed. The interface of the Evaluation Report page can be seen in Figure 7.

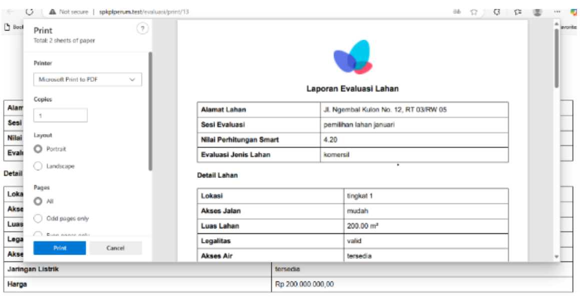

Figure 7. Evaluation Report page

The system was tested using blackbox testing, covering SMART method calculations, result display and recommendations, and user management. The results confirm that the system functions correctly, processing valid inputs while providing appropriate warnings for errors. The testing ensures accurate preference calculations, proper filtering and sorting of recommendations, and secure user authentication and management.

Table 7. Blackbox testing

No	Function Tested	Scenario	Expected Result	Result
SMART Method Calculation				
1	Calculate Preference Value	Calculation with complete data	Criteria and alternative data	Preference value is calculated correctly
2	Calculate Preference Value	Criteria weights are unbalanced	Extreme weights (0 or 100)	Calculation remains accurate
3	Calculate Preference Value	No alternative data	No alternative data input	Warning message appears
4	Calculate Preference Value	Calculation with negative values	Criteria value = -10	Error message appears
5	Calculate Preference Value	Calculation with duplicate data	Identical alternative data	Result remains accurate or warning appears
Displaying Results and Recommendations				
1	View Recommendations	Display recommendation results	Valid data	Recommendation list is displayed
2	View Recommendations	Sort results by score	Sorting command	Data is sorted by score
3	View Recommendations	No recommendation data	Empty data	"No data found" message appears
4	View Recommendations	Filter results by criteria	Filter = Specific location	Results displayed according to filter
5	View Recommendations	Check recommendation consistency	Repeat the same input	Results remain consistent
User Management				
1	User Login	Login with valid credentials	Correct Username & Password	Login successful
2	User Login	Login with incorrect credentials	Incorrect Username/Password	"Login failed" message appears
3	Restricted Access	Access without logging in	Direct access to main page	Redirected to login page
4	Reset Password	Reset password with valid email	Registered email	Reset link is sent
5	Reset Password	Reset password with invalid email	Unregistered email	"Email not found" message appears

5. CONCLUSION AND RECOMENDATION

This research successfully demonstrates the effectiveness of the Simple Multi-Attribute Rating Technique (SMART) in optimizing residential land selection by incorporating multiple weighted criteria such as price, location, land area, accessibility, infrastructure availability, and legal status. The proposed Decision Support System (DSS) provides a structured, data-driven, and objective approach to decision-making, enhancing accuracy, reducing investment risks, and improving efficiency in land selection for property development. Furthermore, the integration of the Rapid Application Development (RAD) methodology accelerates system development, ensuring adaptability and user engagement. The results indicate that the system significantly aids property developers, investors, and landowners in making informed decisions aligned with strategic business goals and market demands.

Despite its advantages, this study acknowledges certain limitations, such as reliance on predefined criteria weights and the need for broader data validation. Future research should explore the integration of machine learning techniques to enhance adaptability, automate weight adjustments, and further refine decision-making accuracy. Nevertheless, this research contributes to the advancement of intelligent DSS applications in the real estate sector, laying a foundation for more data-driven, efficient, and strategic property development planning.

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