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Design Of A Decision Support System For Contractor Selection Using The Saw (Simple Additive Weighting) Method.

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ABSTRACT

This decision support system is designed to address the problem of selecting the best contractor at PT Integrasi Kreasi Zee (Zee Studio), a crucial issue given the project's significance to the company. By implementing the Simple Additive Weighting (SAW) method, a weighted addition algorithm, this system provides a comprehensive analysis tool that enables decision-makers to solve complex problems and produce more qualified and appropriate contractor choices. The system development utilizes the Rational Unified Process (RUP) method to ensure a structured, iterative, and architecture-centered approach, thereby ensuring the resulting system functions optimally according to the company's operational needs and is easy to manage throughout its development life cycle.
Keywords: Decision Support System, simple additive weighting (SAW), RUP

ABSTRAK

Sistem pendukung keputusan ini dirancang untuk mengatasi permasalahan pemilihan kontraktor terbaik di PT Integrasi Kreasi Zee (Zee Studio), sebuah isu krusial mengingat pentingnya proyek ini bagi perusahaan. Dengan menerapkan metode Simple Additive Weighting (SAW), sebuah algoritma penjumlahan terbobot, sistem ini menyediakan alat analisis komprehensif yang memungkinkan para pengambil keputusan untuk memecahkan masalah kompleks dan menghasilkan pilihan kontraktor yang lebih berkualitas dan tepat. Pengembangan sistem ini menggunakan metode Rational Unified Process (RUP) untuk memastikan pendekatan yang terstruktur, iteratif, dan berpusat pada arsitektur, sehingga memastikan sistem yang dihasilkan berfungsi optimal sesuai kebutuhan operasional perusahaan dan mudah dikelola di sepanjang siklus pengembangannya.
Kata Kunci: Sistem Pendukung Keputusan, simple additive weighting (SAW), RUP

INTRODUCTION

In today's dynamic and competitive business world, efficiency and effectiveness in decision-making are crucial factors for an organization's survival and progress. PT Integrasi Kreasi Zee, widely known as Zee Studio, is an entity actively involved in various construction projects. The success and quality of each project depend heavily on selecting the right and qualified contractor. The contractor selection process is no simple task, as it involves evaluating various complex criteria, such as previous project experience, reputation, financial capacity, availability of human resources and equipment, and cost and schedule proposals.

Currently, Zee Studio faces challenges in its contractor selection process. The methods used tend to be manual and lack structure, which can lead to several difficulties. These limitations can result in lengthy evaluation processes, subjective bias in assessments, and even dissatisfaction among contractors who are not selected due to a lack of transparency or objectivity. As a result, the company may not always be able to identify and select the contractor best suited to a project's specific needs, which in turn can impact the project's quality, efficiency, and overall success.

To address these issues, this research focuses on designing a Web-Based Decision Support System (DSS) for Contractor Selection using the Simple Additive Weighting (SAW) method. SAW, a type of Fuzzy Multiple Attribute Decision Making (FMADM) method, was chosen because of its ability to determine weighting values based on the decision maker's subjectivity, providing flexibility in determining alternative ranking factors. The advantages of SAW include ease of understanding, flexibility, the ability to solve complex problems, and learning based on human experience.

The software development methodology used is the Rational Unified Process (RUP). RUP was chosen for its end-user-centered approach, flexibility to change, and its ability to accelerate the information system development process, especially when user needs are difficult to identify, through the application of efficient development tools.

METHODOLOGY

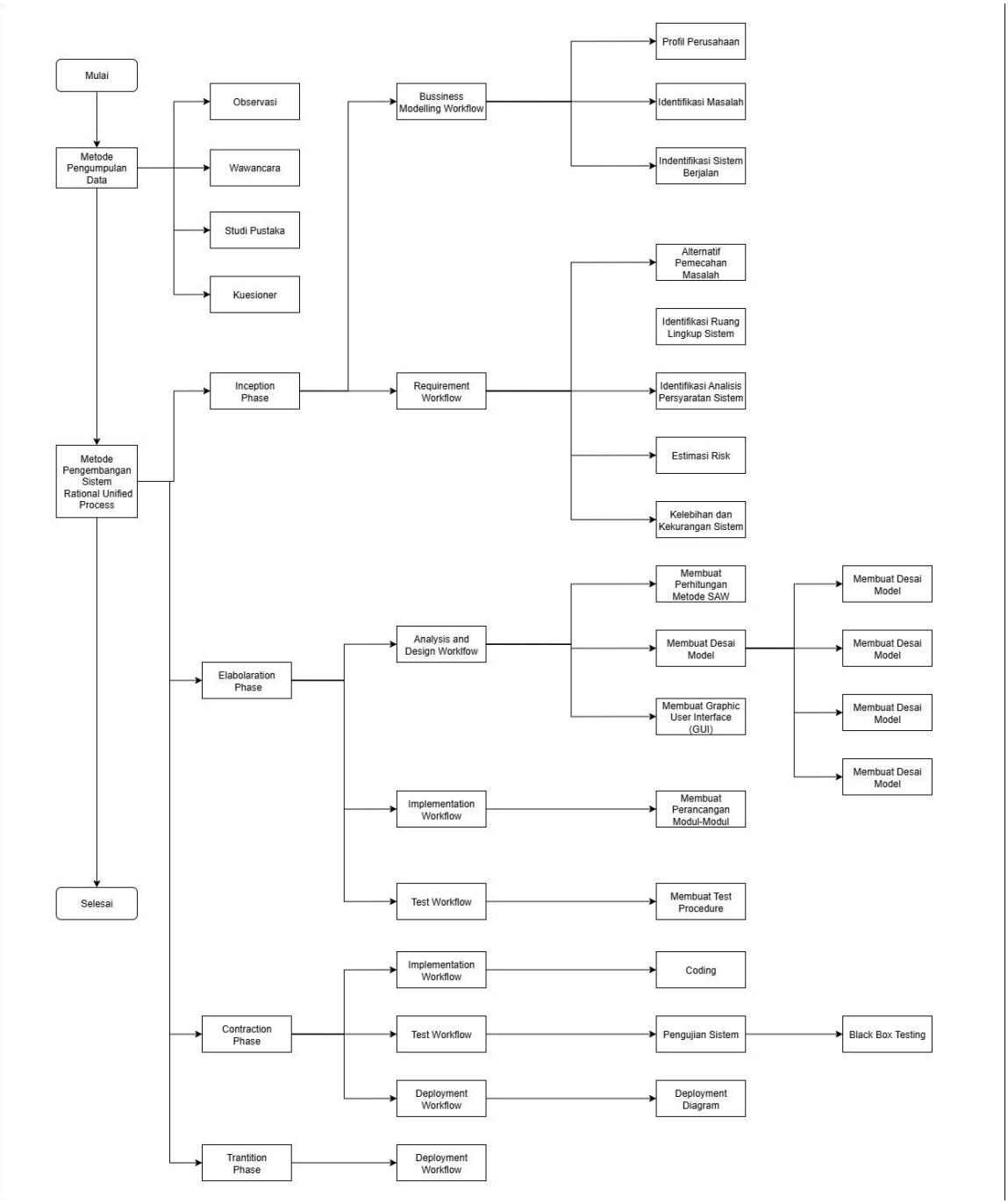


Figure 1 Reasearch Stage

A. System Development Method

In researching the design of a decision support system application for contractor selection, a systematic and structured software development approach is essential to ensure project quality, efficiency, and success. Therefore, this study adopted the Rational Unified Process (RUP) method as the primary development framework. RUP is known as an object-oriented, iterative, and incremental software development methodology that provides a disciplined approach to clearly defining tasks and responsibilities throughout an organization's development cycle (Kroll and Kruchten, 2003). The flexibility of RUP allows for adaptation to changing requirements throughout the project while maintaining a focus on architecture and risk mitigation.

1. Inception Phase

This phase is the starting point of the project, with the primary focus being on establishing the vision and scope of the system. In the context of designing a contractor selection SPK at Zee Studio, this phase identifies the primary problem to be addressed, namely the difficulty in objectively selecting contractors. Key activities include formulating project objectives, determining the technical and business feasibility of the SPK, identifying key stakeholders, and gathering high-level requirements (e.g., general criteria for contractor assessment). The output of this phase is an initial vision document and high-level use cases that provide an overview of the system's functionality.

2. Elaboration Phase

After the initial vision is established, the elaboration phase aims to define the system architecture in more detail, identify key risks, and detail functional and non-functional requirements. For the contractor selection SPK, this phase involves an in-depth analysis of specific contractor assessment criteria (e.g., experience, qualifications, track record, price, facilities), determining weights for each criterion, and modeling how the Simple Additive Weighting (SAW) method will be implemented. Initial user interface designs (mock-ups) are also created, and the overall system architecture is designed to ensure scalability and maintainability. By the end of this phase, the basic system architecture has stabilized, and development plans for the next phase become more concrete.

3. Construction Phase

The construction phase is where the bulk of the system development takes place. This is the most intensive phase in terms of coding, testing, and component integration. In developing this SPK, the team will begin building the system's core modules, including implementing the SAW algorithm, creating a database to store contractor and criteria data, developing a web-based user interface, and integrating the modules. Unit testing and integration testing are conducted continuously to ensure each component functions correctly and integrates seamlessly. The outcome of this phase is a version of the system that can be tested internally and that has developed core functionality.Fase Transition

4. Transition Phase

This final phase of the RUP focuses on handing over the system to end users and ensuring its operational success in a production environment. Key activities include user acceptance testing (UAT) by Zee Studio, training system users, data migration, if necessary, and the development of user and technical documentation. During this phase, user feedback will be gathered to make final adjustments before the system is officially launched. The goal is to ensure that the contractor selection SPK is well-received by Zee Studio and provides significant added value to their decision-making process.

B. Contractors

Contractors are the key pillars of any construction project, acting as the implementers responsible for translating project plans and designs into physical reality. In the context of a Decision Support System (DSS) for contractor selection, a comprehensive understanding of the roles, characteristics, and classifications of contractors is crucial. Selecting the right contractor directly impacts the success, efficiency, and final quality of a project.

Generally, a contractor is a business entity or individual engaged in construction services, possessing the expertise and resources to carry out construction or physical repair work under a contract with the employer (project owner). The scope of a contractor's work is broad, ranging from initial planning and material procurement to workforce management, construction implementation, and project completion and maintenance.

C. Simple Additive Weighting

The Simple Additive Weighting (SAW) method, also known as the weighted sum method, is a popular and relatively simple multicriteria decision-making (MCDM) method. This method is used to find the best alternative from a number of alternatives based on specific criteria with different weights. The basic concept of SAW is to sum the results of multiplying the normalized criterion values by the assigned preference weights. This method is known for its ability to provide a clear picture of the performance of each alternative against all criteria.

The formula for this normalization is as follows:

$$r_{ij} = \begin{cases} \dfrac{x_{ij}}{Max_i\ x_{ij}} & jika\ \text{j adalah atribut keuntungan (benefit)} \\ \dfrac{Min_i\ x_{ij}}{x_{ij}} & \text{jika j adalah atribut biaya (cost)} \end{cases}$$

Where:

rij = normalized performance rating of alternative Ai (i=,2,...,m)

Max i = maximum value of each row and column.
Min i = minimum value of each row and column. xij = row and column of the matrix.

SYSTEM ANALYSIS AND DESIGN

A. SYSTEM ANALYSIS

Based on the data collection conducted at PT. Integrasi Kreasi Zee, it can be concluded that the contractor or vendor selection process for projects remains conventional. To reach a valid decision, management manually compares the criteria between contractors.

For example, in one project, a contractor offered a competitive price, but often experienced delays in implementation, and the quality of the work did not meet expectations. Conversely, another contractor completed the project on time with good quality, but their price offer did not meet expectations or the budget.

This situation results in suboptimal contractor selection results. In addition to being time-consuming, the process often involves elements of subjectivity, which can lead to cost overruns and sub-optimal project results. This issue indicates the need to develop a more objective and efficient contractor selection system.

B. Implementation of the Simple Additive Weighting (SAW) Method

After conducting direct interviews with users, PT Integrasi Kreasi Zee established criteria for selecting contractors. These criteria are presented in Table 1.

Table 1 Criteria

Code	Selection Criteria	Definition
C1	Pengalaman dan Keahlian	Assess the contractor team's track record, portfolio, and technical expertise.
C2	Izin Usaha	Ensure the legality of contractor operations, including obtaining necessary business permits and maintaining relevant legal documents.
C3	Keuangan dan Modal	Focus on the contractor's financial health, capital availability, and the quality of their financial reports.
C4	Kemampuan Manajerial	Assess the contractor's project management capabilities, organizational structure, and planning systems to ensure they meet the project's requirements.

C5	Kualitas Kontruksi	Measuring the contractor's work quality standards, material use, and construction methods.
C6	Komitmen Kerja Sama	Assess the contractor's willingness to cooperate, schedule commitment, and transparent communication.

Each criterion in Table 1 will be weighted based on PT Integrasi Kreasi Zee's standards. Five weighting categories are used: Sangat Tinggi (ST), Tinggi (T), Sedang (S), Rendah (R), dan Sangat Rendah (SR).

Table 2 Bobot

Variable	Nilai Bobot
Sangat Tinggi	1
Tinggi	0,75
Tengah	0,5
Rendah	0,25
Sangat Rendah	0

Based on the six criteria listed in Table 1, a detailed assessment will be prepared for each criterion. This breakdown will use the weighting scale established in Table 2 as a guideline for determining the assessment requirements for contractor selection at PT Integrasi Kreasi Zee. The following table shows the detailed assessment for each criterion based on PT Integrasi Kreasi Zee's weighting standards:

1. Pengalaman dan Keahlian Criteria

Pengalaman dan Keahlian criteria assess the contractor team's track record, portfolio, and technical expertise, with weighting values as shown in Table 3.

Table 3 Pengalaman dan Kehlian Critria

Kategori Lokasi	Range Nilai	Variabel	Nilai Bobot
10 Years	>90	Sangat Tinggi	1
5 Years	60-89	Tinggi	0,75
3 Years	30-59	Rendah	0,5
1 Years	<30	Sangat Rendah	0

2. Izin Usaha Criteria

The criteria for the **Izin Usaha** value are to ensure the legality of the contractor's operations, including business permits and legal documents with weighting values as in table 4.

Table 4 Izin Usaha Criteria

Kategori Lokasi	Range Nilai	Variabel	Nilai Bobot
ISO, IUJK, SBU, Penyetoran Pajak	>90	Sangat Tinggi	1
IUJK, SBU, Penyetoran Pajak	60-89	Tinggi	0,75
IUJK, SBU	30-59	Rendah	0,5
Tidak Punya	<30	Sangat Rendah	0

3. Keuangan dan Modal Criteria

Keuangan dan Modal value criteria are focused on financial health, capital availability, and healthy financial reports of contractors with weighting values as in table 5.

Table 5 Keuangan dan Modal Criteria

Kategori Lokasi	Range Nilai	Variabel	Nilai Bobot
Sangat Baik	>90	Sangat Tinggi	1
Baik	60-89	Tinggi	0,75
Cukup	30-59	Rendah	0,5
Sangat Buruk	<30	Sangat Rendah	0

4. Kemampuan Manajerial Criteria

Kemampuan manajerial is assessing the ability to manage projects, organizational structure, and contractor planning systems with weighting values as in table 6.

Table 6 Kemampuan Manajerial Criteria

Kategori Lokasi	Range Nilai	Variabel	Nilai Bobot
Sangat Baik	>90	Sangat Tinggi	1
Baik	60-89	Tinggi	0,75
Buruk	30-59	Rendah	0,5
Sangat Buruk	<30	Sangat Rendah	0

5. Nilai Kualitas Kontruksi Criteria

Kualitas kontruksi is to measure the quality standards of work, use of materials, and contractor construction methods with weight values as in table 7.

Table 7 Kualitas Kontruksi

Kategori Lokasi	Range Nilai	Variabel	Nilai Bobot
Baik	100	Sangat Tinggi	1
Buruk	0	Sangat Rendah	0

6. Komitmen Kerja Sama Criteria

Komitmen kerjasama is to assess the contractor's willingness to cooperate, schedule commitment, and transparent communication with weighted values as in table 8.

Table 8 Komitmen Kerjasama Criteria

Kategori Lokasi	Range Nilai	Variabel	Nilai Bobot
Baik	100	Sangat Tinggi	1
Buruk	0	Sangat Rendah	0

The SAW Method for Calculating Decision Support Systems
Prepare Decision Metrics

Table 9 Assessment Alternatives

Alternatif	C1	C2	C3	C4	C5	C6
A	100	70	100	100	100	100
B	100	100	50	70	100	100
C	50	50	50	70	100	50
D	50	100	100	70	70	70
E	70	50	50	50	100	50

Decision Matrix Normalization

1. Calculating Normalized Matrix (R_{ij})
   Calculation of benefit criteria (*Benefit)*

$$\text{Rij} = \frac{x_{ij}}{MAX\ X_{ij}}$$

   Calculation of cost criteria (*cost*)

$$\text{R}_{\text{ij}} = \frac{MIN_{ij}}{x_{ij}}$$

Then the normalization results are as follows:

Table 10 Normalization Results

Alternatif	C1	C2	C3	C4	C5	C6
A	1.0	0.7	1.0	1.0	1.0	1.0

B	1.0	1.0	0.5	0.7	1.0	1.0
C	0.5	0.5	0.5	0.7	1.0	0.5
D	0.5	1.0	1.0	0.7	0.7	0.7
E	0.7	0.5	0.5	0.5	1.0	0.5

Final Stage calculates preferences ($V_{i)}$

At this stage, determine the rating value of each alternative. The highest value indicates that alternative i is preferred.

$$V_i = \sum_{j=1}^{n} \quad W_j R_i$$

Maka :

A1= (0.2857×1.0)+(0.1429×0.7)+(0.1429×1.0)+(0.1429×1.0)+(0.1429×1.0)+(0.1429×1.0)

=0.95733

A2= (0.2857×1.0)+(0.1429×1.0)+(0.1429×0.5)+(0.1429×0.7)+(0.1429×1.0)+(0.1429×1.0)

=0.88588

A3 = (0.2857×0.5)+(0.1429×0.5)+(0.1429×0.5)+(0.1429×0.7)+(0.1429×1.0)+(0.1429×0.5)

= 0.60013

A4 = (0.2857×0.5)+(0.1429×1.0)+(0.1429×1.0)+(0.1429×0.7)+(0.1429×0.7)+(0.1429×0.7) =0.72874

A5 = (0.2857×0.7)+(0.1429×0.5)+(0.1429×0.5)+(0.1429×0.5)+(0.1429×1.0)+(0.1429×0.5) =0.62869

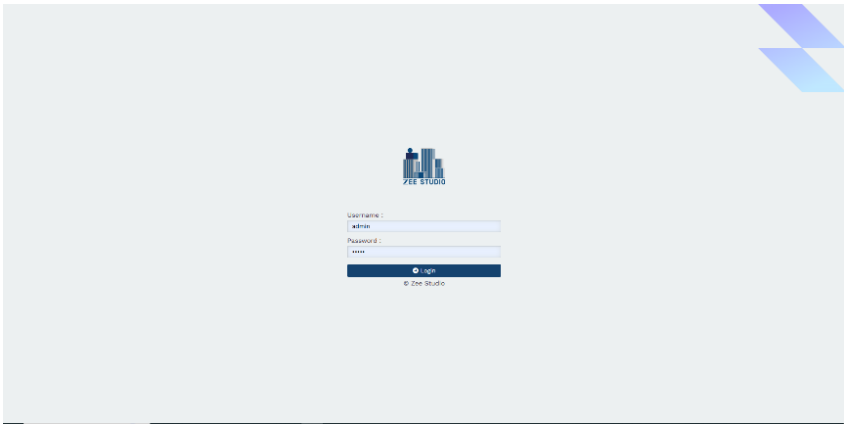
From the calculations above, the best supplier recommendation is A1 with a value of 0.95733

IMPLEMENTATION

Based on the previous discussion, the system is ready for actual operation, which will determine whether it has been created correctly and appropriately. The implementation of the contractor selection decision support system application based on predetermined criteria consists of several pages. These pages will be displayed sequentially according to the program.

1. Login Page

Figure 2 Login Page

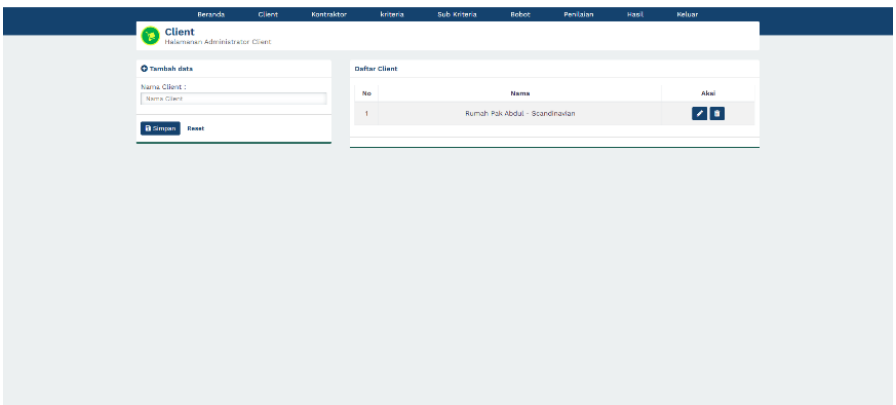


2. Homepage

Figure 3 Homepage

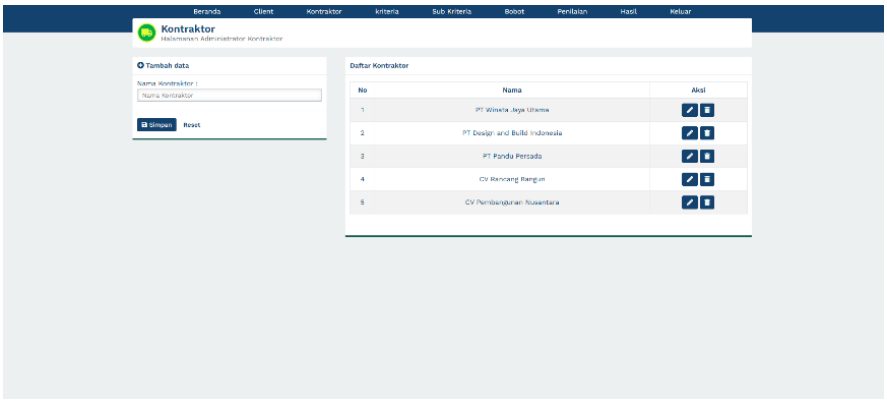
3. Input Client Page

Figure 4 Input Client Page



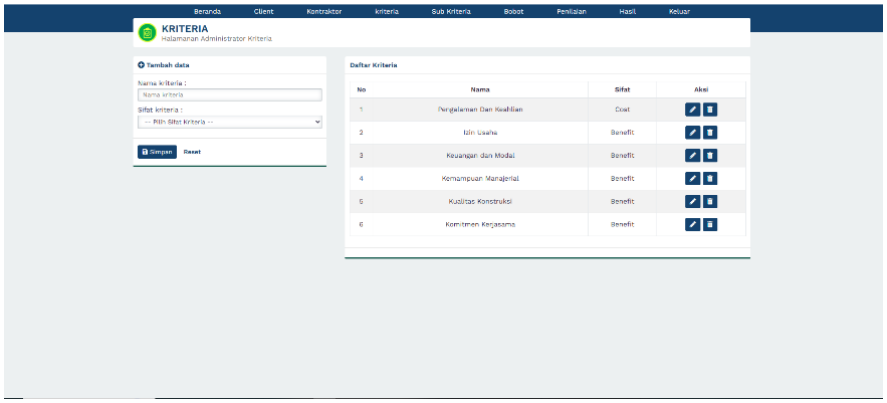
4. Input Contractor Page

Figure 5 Input Contractor Page



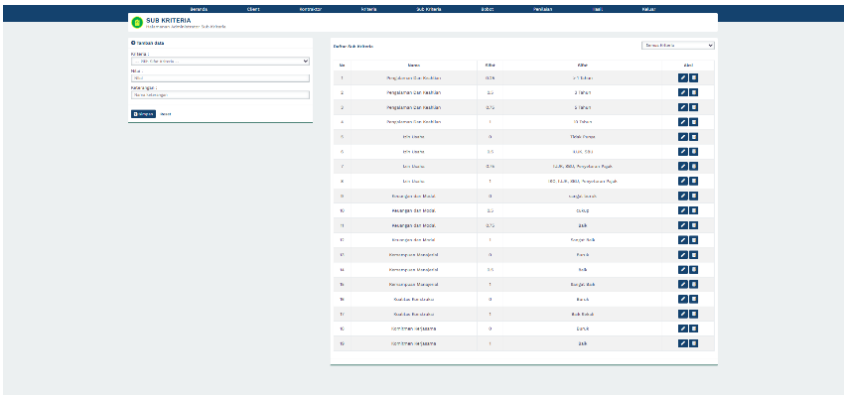
5. Input Criteria Page

Figure 6 Input Criteria Page



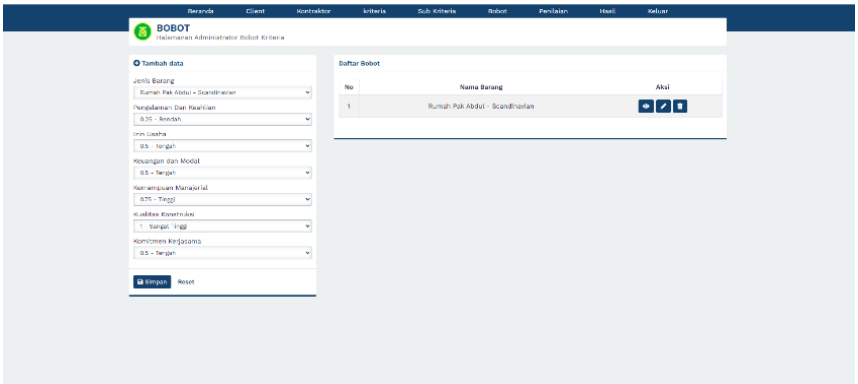
6. Input Sub Criteria Page

Figure 7 Input Sub Criteria Page



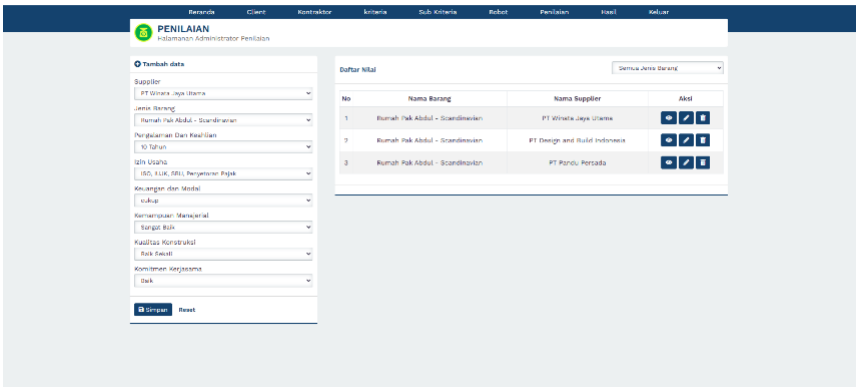
7. Input Weight Page

Figure 8 Input Weight Page



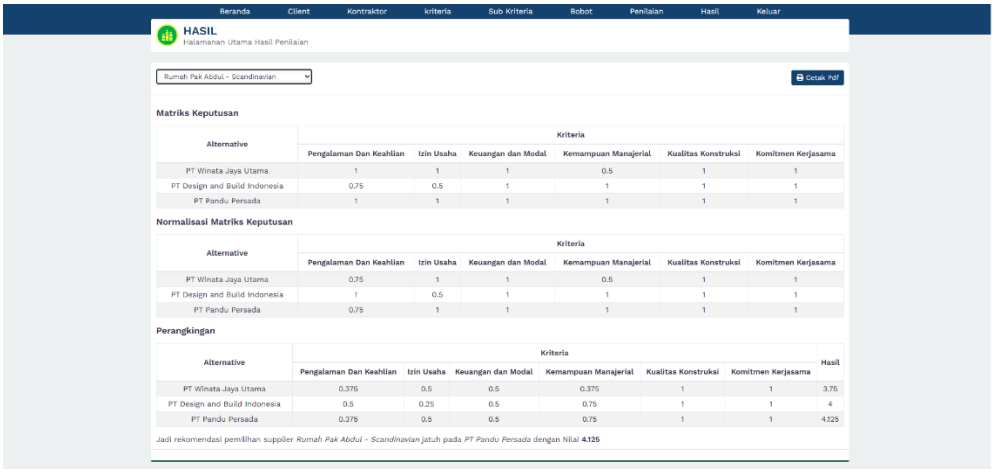
8. Assesment Page

Figure 9 Assesment Page



9. Assesment Result Page

Figure 10 Assesment Result Page



CONCLUSIONS AND SUGGESTIONS

Research conducted at PT Integrasi Kreasi Zee on selecting the best contractors has shown very positive results with the implementation of a decision support system. This system has proven to be an effective solution in simplifying the contractor assessment process. Now, assessments are no longer conducted manually, but rather through a more systematic and efficient method, minimizing the potential for human error.

The presence of this system ensures that PT Integrasi Kreasi Zee can identify the best contractors that best meet the company's needs and standards. With predetermined criteria and weighting, the system provides objective recommendations, resulting in more accurate and data-driven decisions. Furthermore, one crucial benefit of this system is its ability to manage the contractor database. All data is stored securely and organized, simplifying information retrieval and significantly reducing the risk of losing important data. This is a significant step forward in improving PT Integrasi Kreasi Zee's operational efficiency.

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