APPLICATION OF THE WEIGHT PRODUCT METHOD FOR PRIORITIZING CONSTRUCTION PROJECTS

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ABSTRACT
As a dynamic and complex sector, the construction industry is often faced with challenges in managing projects and determining their priorities. In the context of intense business competition and changes in the external environment, this research highlights the importance of developing efficient methods for prioritizing construction projects. The focus is on applying the Weight Product (WP) method, a decision-making framework, to score projects based on cost, time, quality, and risk criteria. The method integrates data collection, analysis, modeling, and ranking. The results identify projects that align with the company’s priority objectives, while the systematic steps can provide practical guidance for construction companies in optimizing resource allocation. This research also has the potential to contribute to the literature and practice of the construction industry, as well as be the basis for developing more advanced applications and decision-making methods and priority project selection applications.

Keywords: Project Prioritization, Weight Product, Decision Support System.
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INTRODUCTION
The construction industry is a highly dynamic and complex sector where companies often face challenges managing and prioritizing their projects. In the face of a changing environment and increasing competition, it is essential for construction companies to develop efficient methods of prioritizing their projects (Divya Sankar & Selvam, 2020; Ingle & Mahesh, 2022; Trask & Linderoth, 2023).

Construction companies often manage multiple projects simultaneously, and prioritization becomes crucial in ensuring optimal resource allocation. In the context of intensifying business competition, construction companies need to ensure that the projects they undertake significantly impact the company's growth. In addition, changes in external conditions such as regulatory changes, market conditions, or environmental factors can also affect the prioritization of construction projects (Fredriksson & Huge-Brodin, 2022; Guo et al., 2023; Lai et al., 2016; Nieto-Morote & Ruz-Vila, 2012).

Construction companies must consider technology integration in their projects in the era of information technology and digitalization (Sihombing, 2023). Construction companies need applications in their business processes to improve operational efficiency, speed decision-making, and increase visibility over ongoing projects. Modern apps can simplify project management by facilitating real-time monitoring of work progress, resource allocation, and budget projections. In addition, apps can improve team collaboration by enabling instant and integrated information sharing. With the adoption of app technology, construction companies can reduce human errors, optimize time, and manage projects more precisely, increasing productivity (Almashhadani et al., 2023; Pham et al., 2023; Tessema et al., 2022).

This research is also relevant to the issues of sustainability and eco-friendliness that are increasingly becoming a significant focus in the modern construction industry. The Weight Product method can be used to assess projects that prioritize sustainability, such as using environmentally friendly materials or more sustainable construction practices (Aulawi et al., 2023; Hamidah et al., 2022; Hidayat et al., 2023). The WP decision-making method can assign a relative value to a predetermined number of criteria. In the construction industry context, different projects have complex and diverse characteristics, including cost, execution time, construction quality, and risk. Therefore, applying the WP method becomes relevant to assist construction companies in identifying and prioritizing projects more systematically (Goodarzi et al., 2022; Ratnayake et al., 2022; Shojaeimehr & Rahmani, 2022).

Given the company's limited financial resources, project cost is a critical aspect to consider. In addition, efficient implementation time is a determining factor in winning tenders and maintaining customer confidence. Construction quality is also essential to ensure business sustainability and company reputation. Meanwhile, project risk is a factor that can affect both positively and negatively and, therefore, needs to be carefully assessed.

This research is expected to develop a systematic framework using the WP method to determine project priorities in construction companies. Thus, companies can optimize resource allocation and improve efficiency in various construction projects. This research is also expected to contribute to the literature and practice of the construction industry and serve as a basis for developing more advanced decision-making methods in this context. This research is a preliminary study for developing priority project selection applications in construction companies.

METODE PENELITIAN
This research provides a systematic and structured approach for construction companies to prioritize projects. Using the Weight Product method, this research facilitates informational
decision-making and enables companies to optimize their resource allocation per their strategic objectives. This research has four main stages, as shown in Figure 1: data collection, analysis, modeling, and ranking.

**Figure 1: Stages of Research**

1. **Data Collection**
   This stage collects the data needed to assess construction projects. This data includes information on cost, execution time, construction quality, and risk. This approach requires the acquisition of representative and relevant data so that the analysis reflects the actual conditions in the field. Careful and thorough data collection is fundamental to ensuring the validity and accuracy of the subsequent analysis results.

2. **Analysis**
   After the data is collected, the next step is to analyze each project based on the criteria that have been determined. At this stage, the Weight Product method will assign weights to each criterion and produce a weighted score for each project. This analysis provides a deep insight into the relative contribution of each project to the company's prioritized goals.

3. **Modeling**
   Modeling is the next step after data analysis. Researchers will use the analysis results in this stage to create a model representing the relationship between criteria and construction projects. This model makes it better to understand the patterns and dynamics underlying project prioritization. Modeling helps to recognize critical factors that influence prioritization decisions.

4. **Ranking**
   Ranking is the final stage that involves prioritizing projects based on the final score obtained from the Weight Product analysis. The project with the highest final score will be placed at the top of the ranking, signifying a higher priority. This process provides a
RESULTS AND DISCUSSION

Data Collection

In the data collection stage, relevant data related to construction projects in one of the construction companies in North Sumatra. The information collected includes aspects of project costs, estimated implementation time, measured construction quality criteria, and risk factors that can affect the course of the project. The data acquisition approach aims to ensure that the dataset used in the analysis reflects the actual conditions in the field. Information on various construction projects was carefully collected in the data collection stage. The data collected includes:

1. Project costs: The estimated cost of the entire project, including materials, labor, and equipment. Data related to the budget that has been prepared for each project.
2. Implementation time: The project implementation schedule details, including milestones and critical stages. Information on the target completion time and deadlines that must be met.
3. Construction Quality: Quality standards applied to each project. Inspection and measurement results related to construction quality have been carried out.
4. Project Risk: Identification and analysis of potential risks associated with each project. Risk mitigation strategies have been developed to overcome potential obstacles.

Analysis

Once the data was collected, the construction project analysis was carried out using the Weight Product (WP) method. The following analysis results provide an in-depth insight into the relative contribution of each project to the company's prioritized goals:

1. Criteria Weights: Weights have been successfully assigned to each criterion, such as cost, execution time, construction quality, and risk, according to their importance.
2. Weighted Score: The WP method is applied to each project to calculate a weighted score based on the criteria weights. The weighted score provides each project's relative value, calculating each project's contribution to the predefined criteria.
3. Ranking of projects: The projects are scored based on the weighted scores, and the ranking of the projects is determined. The project with the highest final score gets a higher rank, signifying a higher priority in the company context.
4. Identification of Priority Projects: The analysis results help identify the projects that significantly contribute to the company's priority goals. Projects that rank higher are considered priority projects for greater resource allocation.

Through this analysis stage, the research successfully identified the projects most aligned with the construction company's prioritized goals. These results will be the basis for ranking and determining the next steps in efficient construction project management.

Modeling

Object/Alternative Identification

The results of object identification are shown in Table 1.

Table 1. List of Project Alternatives

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1840</td>
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</table>
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Criteria Determination
Based on the results of the analysis stage, the criteria used in this research consist of the following:
- C1: Cost,
- C2: Time,
- C3: Quality, and
- C4: Risk.

Calculating the Weight Value
The next step is calculating each criterion's initial relative weight value using Equation 1.

\[
W_j = \frac{w_j}{\sum w_j}
\]  

Total weight value = 16, then obtained

W1 = 5/16 = 0.312
W2 = 4/16 = 0.250
W3 = 4/16 = 0.250
W4 = 3/16 = 0.187

Creating a Comparison Matrix of Alternatives and Criteria
The next stage is to determine the alternative value of each criterion after weighting, then write in the form of a comparison matrix of alternatives and criteria. The values in the matrix are obtained through questionnaires filled out by decision-makers in the company.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 2</td>
<td>P2</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Project 3</td>
<td>P3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project 4</td>
<td>P4</td>
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<td>Project 8</td>
<td>P8</td>
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<td>P9</td>
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<tr>
<td>Project 10</td>
<td>P10</td>
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<tr>
<td>Project 11</td>
<td>P11</td>
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<tr>
<td>Project 15</td>
<td>P15</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Calculating Alternative Preference Value (S Vector)

The calculation of the S vector value aims to normalize the numbers used. The S vector value is obtained by equation 2.

\[
S_i = \prod_{j=1}^{n} X_{ij}^{w_j}
\]  

...(2)

With \( S_i \) being the alternative preference value analogous to the S vector, \( X_{ij} \) is the alternative value of each criterion, \( W_j \) is the weight value of each criterion, and \( n \) is the number of criteria. Then, the S value for each alternative is obtained, as shown in Table 3.

Table 3. S Vector Value of each alternative

<table>
<thead>
<tr>
<th>Alternative</th>
<th>S value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
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<tr>
<td>P2</td>
<td>4,00738881</td>
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<tr>
<td>P3</td>
<td>3,93597934</td>
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<td>P4</td>
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<tr>
<td>P5</td>
<td>1,85515716</td>
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<tr>
<td>P6</td>
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<tr>
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<td>P9</td>
<td>3,52694993</td>
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<td>P10</td>
<td>3,6628415</td>
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<td>P11</td>
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<td>3,6628415</td>
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<td>P13</td>
<td>3,00299718</td>
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<tr>
<td>P14</td>
<td>2,71351426</td>
</tr>
<tr>
<td>P15</td>
<td>3,40237322</td>
</tr>
</tbody>
</table>

Calculating Relative Preference Value (Vector V)
The last calculation stage is to calculate the relative preference value, also called the V vector, using equation 3; the results of this stage are shown in Table 4.

\[ V_i = \frac{\prod_{j=1}^{n} x_{ij} w_j}{\prod_{j=1}^{n} x_{ij} w_j} \]  

...(3)

Table 4. Vector V value of each alternative

<table>
<thead>
<tr>
<th>Alternative</th>
<th>S Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>0.08771846</td>
</tr>
<tr>
<td>P2</td>
<td>0.07751408</td>
</tr>
<tr>
<td>P3</td>
<td>0.07613282</td>
</tr>
<tr>
<td>P4</td>
<td>0.05802837</td>
</tr>
<tr>
<td>P5</td>
<td>0.03588391</td>
</tr>
<tr>
<td>P6</td>
<td>0.06587714</td>
</tr>
<tr>
<td>P7</td>
<td>0.05112247</td>
</tr>
<tr>
<td>P8</td>
<td>0.08650358</td>
</tr>
<tr>
<td>P9</td>
<td>0.06822105</td>
</tr>
<tr>
<td>P10</td>
<td>0.07084957</td>
</tr>
<tr>
<td>P11</td>
<td>0.0749143</td>
</tr>
<tr>
<td>P12</td>
<td>0.07084957</td>
</tr>
<tr>
<td>P13</td>
<td>0.05808634</td>
</tr>
<tr>
<td>P14</td>
<td>0.05248694</td>
</tr>
<tr>
<td>P15</td>
<td>0.06581139</td>
</tr>
</tbody>
</table>

**Ranking**

The last stage is to sort the rating or ranking based on the value of the V vector result obtained from the previous stage. Ranking results:

Table 3. Ranking Results

<table>
<thead>
<tr>
<th>Alternative</th>
<th>S Value</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>0.08771846</td>
<td>1</td>
</tr>
<tr>
<td>P8</td>
<td>0.08650358</td>
<td>2</td>
</tr>
<tr>
<td>P2</td>
<td>0.07751408</td>
<td>3</td>
</tr>
<tr>
<td>P3</td>
<td>0.07613282</td>
<td>4</td>
</tr>
<tr>
<td>P11</td>
<td>0.0749143</td>
<td>5</td>
</tr>
<tr>
<td>P10</td>
<td>0.07084957</td>
<td>6</td>
</tr>
<tr>
<td>P12</td>
<td>0.07084957</td>
<td>7</td>
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<tr>
<td>P9</td>
<td>0.06822105</td>
<td>8</td>
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<td>P6</td>
<td>0.06587714</td>
<td>9</td>
</tr>
<tr>
<td>P15</td>
<td>0.06581139</td>
<td>10</td>
</tr>
<tr>
<td>P13</td>
<td>0.05808634</td>
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<tr>
<td>P4</td>
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<td>P14</td>
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<td>P7</td>
<td>0.05112247</td>
<td>14</td>
</tr>
<tr>
<td>P5</td>
<td>0.03588391</td>
<td>15</td>
</tr>
</tbody>
</table>
The priority scale is divided into three priority areas: priority 1 is ranked 1-5, priority 2 is ranked 6-10, and priority 3 is ranked 11-15. This prioritization will be a reference in the development of further software development.

CONCLUSION
This research explores the application of the Weight Product (WP) method in prioritizing construction projects. In the dynamic construction industry context, the WP method has proven to be a practical framework for addressing the complexity of diverse projects. From the analysis and ranking, this research successfully identifies the projects that are most in line with the prioritization goals of the construction company, providing a foundation for more informed and structured decision-making. The WP method becomes relevant in the face of various challenges, such as project cost, execution time, construction quality, and risk, all critical aspects of construction project management. In addition to practical benefits, this research also contributes to the literature and practice of the construction industry. Developing a systematic framework using the WP method can guide construction companies in optimizing their resource allocation. This research also opens up opportunities for further research, especially in developing its concrete application for prioritized project selection. Overall, this research not only provides deep insights into construction project prioritization but also confirms the importance of adaptation to technology and structured decision-making methods to improve the performance of construction companies in the face of ever-changing market challenges.

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