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Subcontractor Selection Strategy to Minimize Subcontractor Performance Problems Using Analytical Hierarchy Process Method: Case Study at PT. Hutama Karya Infrastruktur

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Abstract

The construction industry shares about 13,4% of the world output in the business field. Subcontractor selection process will have a major effect on the performance results of a construction project. This study will focus on the subcontractor selection strategy to minimize subcontractor performance problems using the Analytical Hierarchy Process (AHP) method assisted by expert choice software in PT. Hutama Karya Infrastruktur. AHP is widely used in construction management research because its permanent ability to deal with many types of decisions. There are five criteria used as research variables, namely price, administration, resources, performance and quality, and partnership strategy. The results showed that price is not the top priority in choosing subcontractors, but the top priorities are performance and Quality, Health, Safety, Security, and Environment (QHSSE). The main sub-criteria on performance and QHSSE are work method and production capacity, this shows that the way of completion or work method and production capacity of equipment or supporting equipment of subcontractors in working on a project were the main priorities.

Keywords: Analytical Hierarchy Process, expert choice, subcontractor.

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1. Introduction

The construction industry shares about 13,4% of the world output in the business field. There are many factors that determine the success of a construction project such as site topography, weather, environment, specialized contractors, manpower and available technology (Clough, Sears, & Sears, 2000). Most construction contractors prefer to outsource construction project activities to subcontractors, and they only carry out managerial activities such as, project financing, contract administration with clients, equipment and material procurement processes, and monitoring project progress (El-khalek, Aziz, & Morgan, 2019). There are many factors that contribute not necessarily due to subcontractor factors, but it is important to understand that the subcontractor selection process will have a major effect on the performance results of a construction project. These quality issues can lead to results on project performance, such as cost overruns, delivery delays, and organizational reputation (Love et al., 2018).

This study will focus on the subcontractor selection strategy to minimize subcontractor performance problems using the Analytical Hierarchy Process (AHP) method. Case study at PT. Hutama Karya Infrastruktur (HKI) was chosen as the object of study because this company is one of the largest construction companies in Indonesia that has worked on many infrastructure projects throughout Indonesia.

The purpose of this study is to find out the most important criteria in selecting subcontractors and the performance of subcontractors that need to be considered in the selection of subcontractors. In addition, this study also aims to determine the right subcontractor selection strategy to minimize subcontractor performance problems at PT. HKI.

AHP method is one method that can be used to select the right subcontractor by considering several important criteria. Therefore, this study will use the AHP method to select the right subcontractor and determine the right subcontractor selection strategy to minimize subcontractor performance problems at PT. HKI.

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This study is expected to provide benefits for PT. HKI in choosing the right subcontractor and minimizing subcontractor performance problems. In addition, this study is also expected to contribute to the development of knowledge about subcontractor selection and AHP methods in the context of construction projects.

The objectives of this study are to determine important criteria in the selection of subcontractors at PT. HKI, the relative weight of each subcontractor selection criteria at PT. HKI using the Analytical Hierarchy Process (AHP) method, the right subcontractor based on predetermined criteria and relative weights using the AHP method, the right subcontractor selection strategy to minimize subcontractor performance problems at PT. HKI and also to provide recommendations to PT. HKI regarding the selection of the right subcontractor and effective subcontractor selection strategy to minimize subcontractor performance problems in the future.

2. Literature Review

Subcontractor is the party appointed by the main contractor to carry out part or all of the work in a construction project. Subcontractors have a very important role in a construction project. Subcontractors are responsible for part or all of the work in a construction project and can affect the overall smooth and successful running of the project. Control and selection of subcontractors needs to be conducted because 80 to 90% of the project budget is in the management of subcontractors (Choudhry, Hinze, Arshad, & Gabriel, 2012). Subcontractor selection is a critical part of subcontractor management. A key challenge for the project management team is that there are many criteria that must be evaluated in the subcontractor selection process. Decision making is more effective when the project management team develops and prioritizes criteria. Categorization of criteria is influential in subcontractor selection decisions (Abbasianjahromi, Sepehri, & Abbasi, 2018). In practice, the selection of the right subcontractor and having good performance is very important to ensure the smooth and successful construction project. There are often subcontractor performance problems such as delays in completing work, poor quality of work that can affect the course of the construction project as a whole.

AHP is a method to obtain the best alternative criteria from several criteria based on the given ranking. (Kurniawan, Hasibuan, & Nugroho, 2017) stated that the AHP method is a hierarchy that represents complex problems in a multi-level structure where the first level is goals and then followed by criteria, subcriteria, and alternatives that make it easier to solve complex problems and are broken down into more structured hierarchical groups and systematic. AHP is widely used in construction management research because its permanent ability to deal with many types of decisions. There are three steps in AHP method, namely: hierarchy formation, pairwise comparisons, and verification of consistency. In the hierarchy formation, the first level contains decision goal and the lower level consists of progressive breakdown of the decision criteria, sub criteria and options for reaching decision goal. Pairwise comparisons are made between the relative importance of every two criteria at the second level of the hierarchy. Pairwise comparisons are often based on a nine-point scale. Verification of consistency is important to ensure optimal outcome (Darko et al., 2019). AHP method is a convenient tool, particularly given the relatively complex process it is applied, its built-in facility to force the user into orderly, methodical thinking, and its inherent capacity to unveil the tacit knowledge of the competent, experienced user. This method consists effective means for formalization of knowledge, which may itself be considered to be one of the current study's primary contributions. AHP method is perfect to train new engineer, particularly given its transparency with regard to the evolution of the selection process and the considerations made (Shapira & Goldenberg, 2005).

Other methods used includes the Analytic Network Process (ANP) and Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) methods. ANP is an expansion of AHP and it is more complicated than the AHP method. The ANP method requires interaction and dependency by using the network. ANP allows interaction and feedback from elements within the cluster (inner dependence) and between clusters (outer dependence) (H Muhendra, Hasibuan, & Buana, 2018). The TOPSIS method considering both positive and negative solution is one of the widespread methods in multi-criteria decision-making problem. TOPSIS method combined with intuitionistic fuzzy set allows chance of success for supplier selection process (Boran, Gen, Kurt, & Akay, 2009). Based on TOPSIS method, the best alternative is the nearest to the positive ideal solution (PIS) and farthest from the negative ideal solution (NIS). The PIS describes solution that maximizes the advantage criteria and minimizes the cost criteria (Shemshadi, Toreihi, & Shirazi, 2011). (Hery Muhendra & Hasibuan, 2018) used the ANP method to choose overpass construction project subcontractor. Differences in the use of methods in the subcontractor selection process cause different assessments in each project undertaken.

In this study, AHP was chosen because AHP Method has advantages in the analysis system, which is a hierarchical structure, as a consequence of the selected criteria, up to the deepest subcriteria, and take into account the validity up

to the tolerance limit of inconsistencies of various criteria and alternatives chosen by decision makers and can take into account the durability or resilience of the output of decision-making sensitivity analysis (Mahendra & Hasibuan, 2018). The AHP method was presented with the software tool Expert Choice.

The Expert Choice 11 program is a software for processing data based on the AHP method that helps decide the best results. The steps of the AHP method with the Expert Choice 11 program can be summarized into three stages, namely creating a structure of goals or criteria, measuring goals and alternatives, and synthesizing and calculate results to show priority alternatives in achieving goals such as Figure 1.

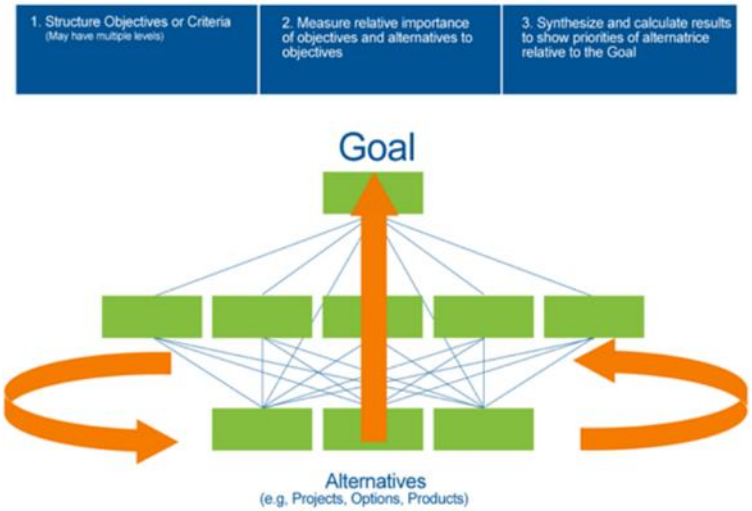

Figure 1. AHP hierarchy with Expert Choice 11

The results showed that the speed of work is strongly influenced by job productivity which is influenced by labor qualifications such as: level of education/expertise, age, time, income and job location (Harris, Alam, & Wibowo, 2017).

The selection of subcontractors is the initial stage of running a project. The selected subcontractor can influence the performance of a project. The right selection of subcontractors will provide selected subcontractors with good performance and will result on the good project performance as described in Figure 2.

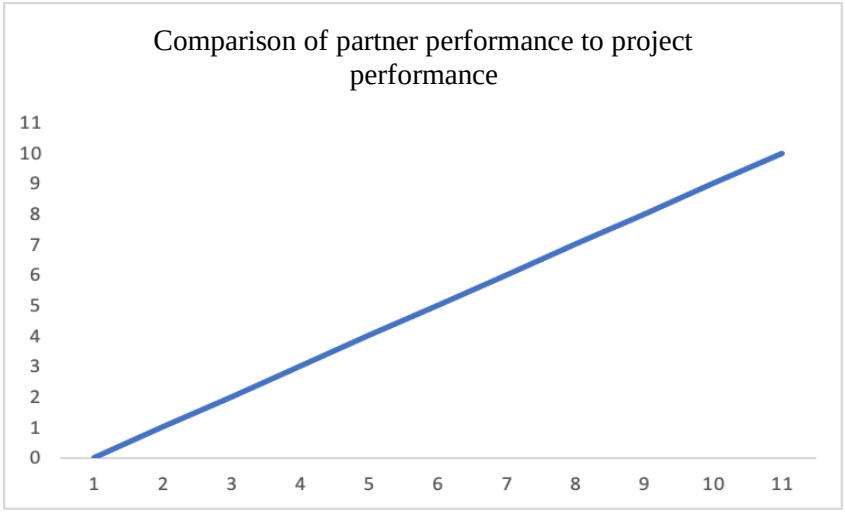

Figure 2. Effect of subcontractor selection on project performance

3. Research Method and Materials

This research was quantitative descriptive research with a case study approach. The research lasted for 6 months, starting from April to June 2023. The population in this study was infrastructure projects carried out by PT. HKI. The sample used in this study was ongoing infrastructure project at PT. HKI. The project was selected based on certain predefined criteria, such as the complexity of the project, the number of subcontractors involved, and the level of performance of subcontractors that have been recorded. The sample was selected based on purposive sampling techniques carried out by considering these criteria, so as to represent the population appropriately. There are five criteria used as research variables, namely: price, administration, resources, performance and quality, and partnership strategy.

The research was conducted through 2 stages of survey. The first survey was conducted with 6 respondents consisting of directors and department heads of PT. HKI. The second survey carried out with 70 respondents from PT. HKI with the following specification:

a. Respondent should have at least bachelor degree with minimum 5 years work experience in infrastructure project.
b. Respondent should have position as procurement, engineering or field supervisor.

The survey techniques used in this study were interviews and documentation. The validity of the data in this study were maintained by conducting interviews with competent sources and collecting data from trusted sources. Data reliability were maintained by cross-checking data from different sources and avoiding errors in data collection.

The collected data were analyzed using the AHP method to determine the criteria and relative weight of each subcontractor selection criteria at PT. HKI of subcontractors in the project under study. The priority and weight of criteria and sub criteria were used to recommend improvement strategies in the selection of subcontractors. Statistical analysis such as validity and reliability tests were used to ensure the reliability and validity of the data obtained. The results of the analysis were presented in the form of tables, graphs, and narratives to facilitate understanding and interpretation.

4. Results and Discussion

Research variables were determined by making criteria and sub criteria that will be used as assessment variables. Criteria were based on secondary data from the company data and other references. There are 5 criteria namely: price; administration; resources; performance and Quality, Health, Safety, Security, and Environment (QHSSE); and partnership strategy. The criteria were then divided into several sub-criteria as follows:

4.1 Price

The price is an important factor because the value of the contract will be closely related to the ability to complete the work and each company expect profit from the contract. The sub criteria for price are as follows: competitive offer, work items and prices, payment methods, financial capability/balance sheet, and warranties.

4.2 Administration

The administrative completeness is the initial part in the subcontractor clarification process that must be completed as part of the requirements for service provider partners. Administration criteria are divided into the following sub criteria: completeness of documents, business license, company registration certificate, company profile, letter of commitment to implement anti-bribery.

4.3 Resources

Resources are the potential and support that must be possessed by subcontractor to be able to complete the work based on the contract. It is divided into the following sub criteria: list of owned equipment, existing specialist experts, completeness of organizational structure.

4.4 Performance and Quality, Health, Safety, Security, and Environment (QHSSE)

Performance and QHSSE are very important to ensure the performance of the selected subcontractor. This criteria is divided into the following sub criteria: QHSSE eligibility, working methods, execution time, and production capacity.

4.5 *Partnership Strategy*

Partnership strategy is a long-term cooperation between employers and partners because of mutual trust and commitment. This criteria is divided into the following sub criteria: list of selected partners, work experience, track record and reputation, and recommendations.

Based on the first survey there is one sub criteria that should be deleted, namely sub criteria letter of commitment to the application of anti-bribery. Meanwhile, based on the input of respondents, the following sub criteria were added: actual remaining capacity as part of administration criteria, e-procurement as part resources criteria and action plan as part of QSHSSE criteria.

Based on the second survey, there were several sub criteria that have values below 4, namely sub-criteria business license, company registration certificate and recommendations. Based on the results of the analysis with expert choice 11, the performance and QHSSE criteria has the highest weight of 0.457 followed by resources (0.210) and price (0.617), partnership strategy (0.112) and the administration (0.054). The value of consistency in weighing criteria is 0.04, so that the respondent's assessment is considered as consistent. The detail of the result can be seen in table 1. It can be seen that price is not the top priority in choosing subcontractors. This result is in line with research conducted on the supplier competition in Ngawi-Kertosono Toll Road Project which showed that price is not the Critical Success Factor (CSF) in determining a subcontractor. CSF that has the highest priority is quality of work (Vega, Negoro, & Ardiantono, 2018).

Table 1. Criteria weighting using AHP method with Expert Choice 11

Criteria	Weighting Value
Performance and QHSSE	0,457
Resources	0,210
Price	0,167
Partnership Strategy	0,112
Administration	0,054
Consistency Value	0,040

The result of sub criteria that has the highest priority of each criteria are:

a. Work method in criteria performance and QHSSE criteria with weight of 0.359.
b. List of owned equipment in resources criteria with weight of 0.505.
c. Competitive offer in price factor criteria with weight of 0.415.
d. Work experience in partnership strategy criteria with weight of 0.466.
e. Actual remaining capacity in administrative criteria with weight of 0.634.

Figure 3 presents a performance sensitivity analysis of the five criteria used in research with the highest priority criteria starting from performance and QHSSE criteria, resources, price, partnership strategy, and administration. It can be seen from the figure 3 that the work method sub criteria is the top priority compared to other sub criteria.

5. Conclusion

Based on this study, there are three criteria that have highest value, namely performance and QHSSE criteria (0.457), resource criteria (0.210) and price criteria (0.167). In this research, the main sub criteria on performance and QHSSE are work method and production capacity. Resources as the second highest criteria showed that resources are important factors that must be taken into account in the selection of subcontractors. This criteria showed the ability of subcontractors to prepare its resources for the completion of a project. the third highest criteria is price with the competitive offer as the highest sub criteria. This sub criteria showed that subcontractor should submit a price bid that is acceptable to the main contractor so that main contractor can estimate profit and loss.

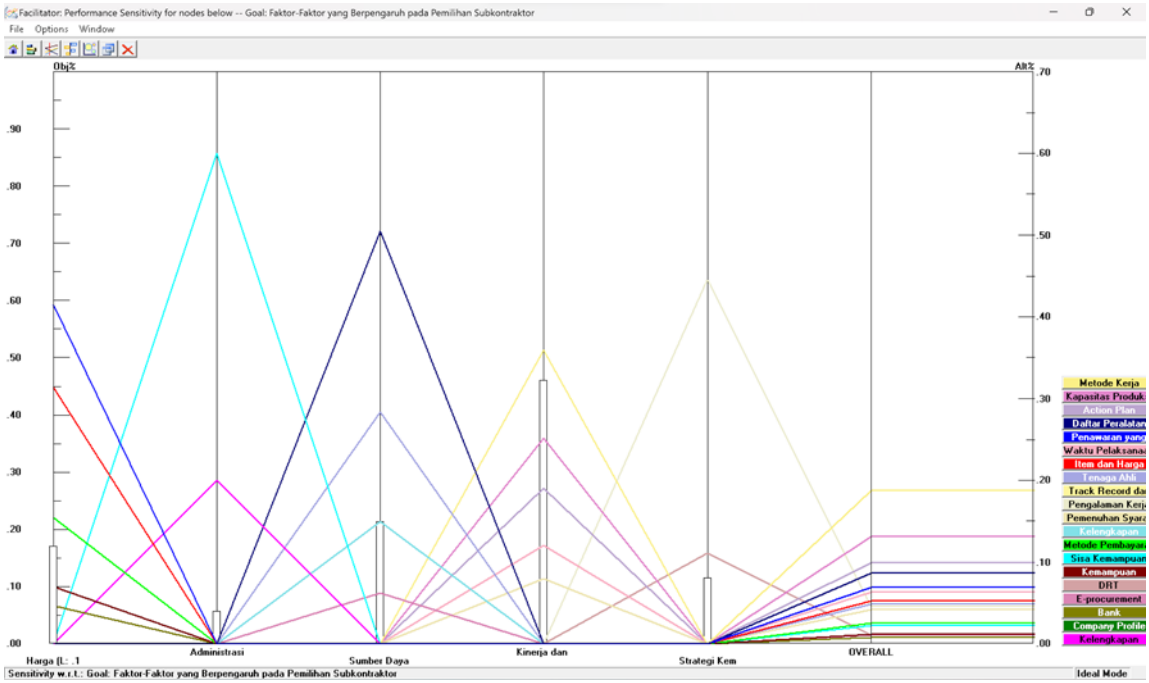

Figure 3. Performance sensitivity graph

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