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Construction Design Consultant Selection Using The Analytic Network Process Method

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ABSTRACT

This research aims to analyze what criteria and subcriteria are important to use in assessing prospective Construction Design Consultant in the procurement process using the ANP method. This research departs from the problem that the Toll Road Planning Division, which is responsible for technical and financial planning for the Trans Sumatra Toll Road project, is not spared from vendor performance problems, where in recent years several Construction Design Consultant have not managed to complete their work with the right quality and time. The results showed that the priority criteria for selecting the best construction design consultant are Quality of Service (23.31%), Relationship with Job Owner (22.36%), Company Certification (20.87%), Quality of Personnel (20.55%), and Company Reputation (12.91%). The subcriteria that has the highest weight is the Personality of personnel (14.90%) and the lowest is the Availability of software (0.75%). The sensitivity analysis of alternative priority weights shows that there is no change in the priority order of alternatives if the subcriteria weights are changed by amounts ranging from -50% to +40%.

INTRODUCTION

Companies use consultants primarily to reduce the cost of hiring internal planning staff and to provide technical expertise as needed (Loh & Norton, 2013). A procurement process is required to select and decide which consultants to work with. The procurement decision is one of the strategic decisions as it allows the company to reduce costs and ultimately increase profit figures (Parthiban et al., 2013). Procurement is one of the processes in construction management is the process by which companies plan, source, purchase, and pay for goods and services. Procurement decisions have a major impact on the company, with the cost of goods and services purchased accounting for more than 60% of the cost of goods sold (Gencer & Gürpinar, 2007). Procurement in construction management includes the purchase of materials,

appointment of consultants both Construction Design Consultant and work supervision consultants, appointment of contractors, recruitment of labor, and also logistics and inventory arrangements. The purpose of the procurement process is to purchase the required products or services at the most favorable price (Kelley, 2012). The company's success factor is influenced by the selection of the right vendor for the company (Sembiring et al., 2019). However, one of the challenges faced by project owners is the delay in completion and lack of quality work by planning consultants, which can be detrimental to the overall project. A survey shows that 60% of companies that have used consultants are not satisfied with the results, and 40% of them try to terminate the contract (Lacity & Willcocks, 1998). Improper selection is allegedly the main reason for the failure of cooperation between the work owner and the consultant (Huang & Liao, 2008).

PT Hutama Karya (Persero) is a State-Owned Enterprise (SOE) that obtained a mandate from the Government of Indonesia to build and operate the 2,776 km Trans Sumatra Toll Road (JTTS) (Hutama Karya, 2024). To succeed in the mandate, the company established the Toll Road Planning Division (RJT) to prepare the necessary technical and financial documents. In carrying out its main tasks and functions, the RJT Division works closely with toll road Construction Design Consultant. The RJT Division is not spared from these problems where in recent years there have been several Construction Design Consultant who have been unable to complete their work with the right quality and time so that amendments to extend the work period must be carried out. Based on partner assessment data from consultants who carried out work on the preparation of readiness criteria documents, preparation of financial studies, and preparation of traffic volume studies for various JTTS sections in the last 3 (three) years, namely 2021 to 2023, out of 39 (thirty-nine) contracts, there were 15 (fifteen) or around 38% of contracts that experienced time delays, and 8 (eight) or around 21% of contracts that received unsatisfactory assessments regarding the quality of work.

Based on observations and discussions with several employees in the RJT Division, factors such as ineffective time management, unclear communication, and lack of adequate resources from Construction Design Consultant are the main causes of these problems. Traditionally, the process of determining the winner in procurement activities tends to prioritize price as the main criterion for selecting the winning bidder (Parthiban et al., 2013). This is in line with the finding that service fee is the subcriteria that has the most weight in selecting Architect/Engineering (A/E) consultants for project owners in the public sector (Assaf et al., 2017).

Some similar studies include the identification of design consultant selection criteria in construction projects using the Delphi method by applying Principal Components Analysis (PCA) stating that the efficiency criteria and the company's/consultant's experience in previous work are the most important (Alkaabi & Mahjoob, 2022). This is in line with research analyzing the criteria and subcriteria of project management consultants (PMC) using the Fuzzy AHP method which states that the management resource criteria which include experience get the highest weight (Ha et al., 2015). There is also an analysis of the criteria for selecting Construction Design Consultant that affect client satisfaction using the Relative Importance Index (RII), Factor Analysis, and Multiple Regression Analysis (MRA) analysis methods where service quality is the criteria with the highest weight (Ogbu & Imafidon, 2022). The AHP method is also used in the analysis of Architect/Engineering (A/E) consultant selection (Assaf et al., 2017) and construction consultants (Razi et al., 2020).

The former stated that technical resource is the most important criterion, while the latter stated that the most important criterion is financial capability. The use of the AHP method has the disadvantage that the method tends to ignore the vagueness, fuzziness, and human behavior inherent in construction projects, therefore the Fuzzy AHP approach is used to overcome these weaknesses (Ha et al., 2015). However, both AHP and Fuzzy AHP methods are known to assume that the factors used in hierarchical structure analysis are independent of each

other, which is not entirely true. The dependency that occurs between one factor and another can only be known through internal and external analysis (Yüksel & Dagdeviren, 2007).

Therefore, this research aims to analyze what criteria and subcriteria along with their weighting rankings are important to use to assess prospective Construction Design Consultant using the ANP method. The ANP approach was chosen because it could accommodate dependencies between elements in its network model, where based on observations of the assessment of prospective Construction Design Consultant running in the RJT Division, there is the potential for dependencies that may occur between the various factors used.

One example is the relationship between the perception of professional competence subcriteria and quality of previous work subcriteria, where generally consultants with good quality of work in previous collaborations mean that they will also produce good performance in future collaborations that will be carried out. This can be equivalent to the assumption that the brand of an electronic item will determine the quality and technological superiority of the item (Chen, 2010)

LITERATURE REVIEW

Multi-Criterion Decision-Making

In a complex decision-making, it is necessary to consider simultaneously the various factors underlying the decision. A method that can be used to solve these decision-making problems is Multi-Criteria Decision-Making (MCDM) or also known as Multi-Criteria Decision-Analysis (MCDA). MCDM is one of the decision-making problems that aims to determine the best alternative by considering more than one criterion in the selection process, which has various tools and methodologies that can be applied in various fields, ranging from finance to engineering design (Taherdoost & Madanchian, 2023). Methodologies in MCDM that are commonly used in vendor selection problems are Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP). Both methods accommodate the determination of the best vendor based on criteria that influence decision making.

Analytic Network Process

Analytic Network Process (ANP) is a decision-making methodology that is a development of AHP. Both were developed by Thomas L. Saaty but have different development years, where AHP was developed in 1980, while ANP in 1996. ANP is an approach used to address complex problems through network modeling.

This method accommodates interdependencies and feedback between elements in a decision, something that is not accommodated by AHP. By using ANP, decision makers can identify and assess various elements that influence the decision, including criteria, alternatives, and stakeholders (Saaty & Vargas, 2006). The main objective of ANP is to provide a comprehensive and flexible framework for decision-making. It helps in dealing with problems that have many interconnected factors and cannot be parsed by traditional linear methods. ANP is particularly useful in situations where decisions must be made amidst complexity and uncertainty.

METHODS

The research method used in this research is the descriptive quantitative method. Descriptive quantitative research focuses on analyzing numerical data processed by statistical methods and the resulting conclusions are not general in nature (Priadana & Sunarsi, 2021). The subject of this research is the RJT Division of PT Hutama Karya (Persero). Data collection and analysis were carried out using the ANP method with steps based on previous research by (Gencer & Gürpinar, 2007).

Determination of respondents was carried out by purposive sampling method, where the selected samples were considered to know best what factors should be considered to choose a construction design consultant in the RJT Division. The steps of implementing this research include: (1) Analyzing the problems of selecting Construction Design Consultant that occur in the RJT Division; (2) Determining the objectives and collecting the initial criteria and subcriteria for evaluating Construction Design Consultant during the procurement process based on research conducted by (Ogbu & Imafidon, 2022) as shown in Table 1; (3) Validating the criteria and subcriteria to respondents using a Likert scale questionnaire. Respondents can also add other criteria and subcriteria that are considered important that are not included in the initial criteria and subcriteria; (4) Identifying the relationship between elements using a questionnaire; (5) Constructing a network model in Super Decision software and distributing pairwise comparison questionnaires with an importance scale of 1-9; (6) Calculating the consistency ratio (CR).

The consistency is considered acceptable if the CR value is smaller than 10% ((Saaty & Vargas, 2006); (7) Building a supermatrix to determine the importance weight of criteria and subcriteria. The supermatrix includes unweighted supermatrix, weighted supermatrix, and limit supermatrix; (8) Determine the best construction design consultant alternatives based on the weight of each criterion and subcriteria that have been obtained; (9) Conduct sensitivity analysis to observe the behavior of subcriteria by changing the weight of the criteria.

Table 1 Initial Criteria And Subcriteria

Code	Criteria	No	Subcriteria
QP	Quality of Personnel	1	Experience of personnel
		2	Education level of personnel
		3	Personality of personnel
CC	Company Certification	4	Quality of previous work
		5	Company legality
RO	Relationship with Job Owner	6	Consultancy fee
		7	Responsiveness
		8	Acquaintance
QS	Quality of Service	9	Perceived professional competence
		10	Proximity of office location
		11	Work commitment
		12	Availability of software
		13	Offers a wide range of services
CR	Company Reputation	14	Company age
		15	Company size
		16	Formal presentation / written proposal
		17	Prior cooperation

Source: Processed data (2024)

RESULTS

Based on the results of the validation of criteria and subcriteria from respondents using a Likert scale questionnaire, and because there were no respondents who provided additional criteria and/or subcriteria, Table 2 is the final result of the validation of criteria and subcriteria.

Table 2 Validated Criteria And Subcriteria

Code	Criteria	No	Subcriteria
QP	Quality of Personnel	1	Experience of personnel
		2	Personality of personnel
CC	Company Certification	3	Quality of previous work
		4	Company legality
RO	Relationship with Job Owner	5	Responsiveness
		6	Acquaintance
QS	Quality of Service	7	Perceived professional competence
		8	Work commitment
		9	Availability of software
CR	Company Reputation	10	Formal presentation / written proposal
		11	Prior cooperation

Source: Processed data (2024)

The next step is to identify the relationship between subcriteria using a questionnaire to respondents to provide an assessment of whether there is a relationship between one subcriteria and another, both within the same criteria (inner dependence) and different criteria (outer dependence). In this questionnaire, the determination of the relationship follows research by (Kasirian, 2009), where a subcriteria is stated to affect other subcriteria if a block (row i - column j) has the number of respondents choosing (Vij) which is more than half of the total respondents (> N/2).

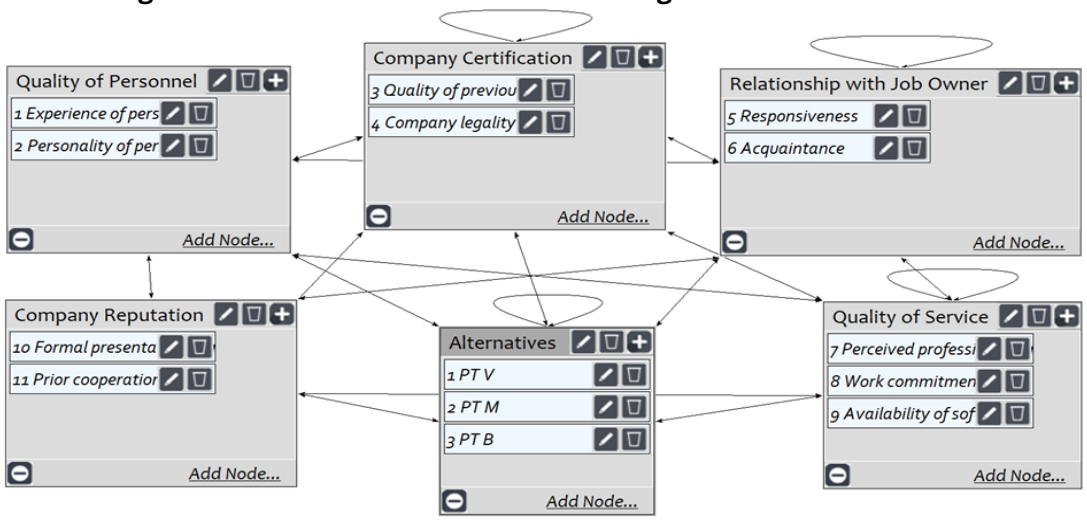
In this case, it takes at least 4 (four) out of a total of 7 (seven) respondents who state that a subcriteria affects the other subcriteria. After the relationship between subcriteria is identified, the ANP model can be constructed. The result of this step is shown in Table 3 and the construction of the network model is shown in Figure 1.

Table 3 Relationship Between Criteria And Subcriteria

		QP		CC		RO		QS			CR	
		1	2	3	4	5	6	7	8	9	10	11
QP	1			ü	ü	ü		ü	ü			ü
	2			ü	ü	ü	ü	ü	ü			ü
CC	3		ü		ü	ü	ü	ü	ü			
	4	ü	ü					ü	ü			
RO	5		ü	ü	ü		ü	ü				ü
	6		ü			ü						ü
QS	7	ü	ü	ü	ü	ü	ü		ü			
	8	ü	ü	ü	ü		ü	ü				
	9			ü		ü		ü	ü		ü	
CR	10			ü				ü		ü		
	11		ü	ü		ü	ü	ü				

Source: Processed data (2024)

Figure 1 ANP Model Of Construction Design Consultant Selection



Decision software. The assessment in Super Decision uses an importance scale of 1-9. Due to the large number of questions and rating scales, filling out the assessment on Super Decision uses the "Questionnaire" option with direct assistance from the researcher. This was done to minimize the potential for confusion and saturation from respondents who could make the assessment inconsistent. The results of each respondent's assessment were then calculated as the geometric mean to become the final assessment of all respondents. The geometric mean value is then inputted back into Super Decision to be able to calculate the supermatrix. The weights of each criterion and subcriteria are presented in Table 4.

Table 4 Weight Recapitulation Of Criteria And Subcriteria

Code	Criteria	Criteria Weight	No	Subcriteria	Subcriteria Weight
QP	Quality of Personnel	0.1638	1	Experience of personnel	0.0450
			2	Personality of personnel	0.1189
CC	Company Certification	0.1664	3	Quality of previous work	0.1080
			4	Company legality	0.0584
RO	Relationship with Job Owner	0.1783	5	Responsiveness	0.1119
			6	Acquaintance	0.0664
QS	Quality of Service	0.1859	7	Perceived professional competence	0.0912
			8	Work commitment	0.0887
			9	Availability of software	0.0060
CR	Company Reputation	0.1030	10	Formal presentation / written proposal	0.0141
			11	Prior cooperation	0.0889

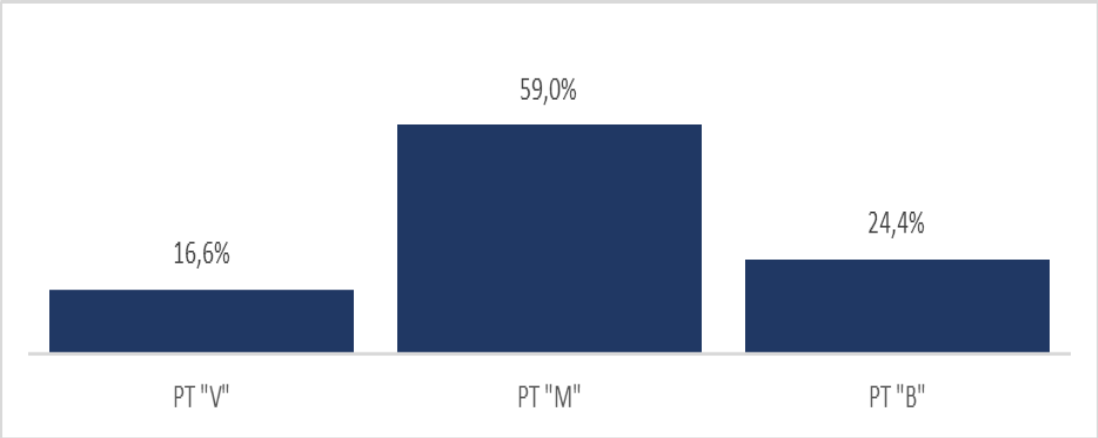
Source: Processed data (2024)

This study selected 3 (three) construction design consulting firms as alternatives. The reason for this selection is that all three are known as consulting firms with significant

reputations and experience in providing construction design consultancy services. The three companies are PT "V", PT "M", and PT "B". Based on the results of the respondents' assessment through Super Decision software, the weight results for each construction design consulting company were obtained as shown in Figure 2, where PT "M" obtained the highest weight with a value of 59.0%, followed by PT "B" with a value of 24.4%, and finally PT "V" with a value of 16.6%.

Sensitivity analysis is an analysis conducted to see how and how much the priority of alternatives changes if the weights of the criteria and subcriteria change. If there is a change in the priority of the alternative, then the change point is called the critical point of an alternative. Sensitivity analysis is carried out by decreasing and/or increasing the weight of subcriteria from -50% to +40%. The sensitivity analysis of alternative priority weights shows that there is no change in the priority order of alternatives if the subcriteria weights are changed by amounts ranging from -50% to +40%.

Figure 2 Graph Of Alternative Weighting Results



DISCUSSION

The results of the criteria weights show similarities in research previously conducted by (Ogbu & Imafidon, 2022), where Quality of Service is also the highest weighted criterion. This is because this criterion is a description of the ability and technical competence of the construction planning consultant to complete its work, where a toll road construction project generally has a construction structure, especially in the bridge construction section, which is complicated and complex so that it requires a good understanding of civil science to design the structure.

This criterion also contains the work commitment of the construction design consultant which includes thoroughness, commitment, social skills, initiative, and easy-to-accept directions from the work owner, where often the scope of work changes according to actual conditions in the field so that it requires a consultant's commitment to readjust the design according to the direction of the work owner for changes that occur in the field. In addition, the availability of software is also part of this criterion, where according to current regulations, a construction project planning is required to use BIM in the planning process, so construction planning consultants are required to own and master the operation of the software. In addition to complying with these regulations, the use of BIM also makes construction design work more effective and efficient as well as the right quality and time.

Then in terms of subcriteria weighting, the highest weight is on the personality of personnel subcriteria with a value of 14.9%, followed by responsiveness with a value of 14.0%. The respondents argue that the root of the quality and good work of a construction design consultant is the personality of its personnel. Companies with personnel who have good personalities will create good teamwork which ultimately avoids potential performance problems in the future. Then responsiveness enters the ranks of subcriteria with the highest

weight because responsive consultants show professionalism and dedication, can adapt to sudden changes, and increase efficiency in decision-making. This not only affects the satisfaction of the job owner but also the effectiveness of project management, especially in emergencies or crises, where quick responsiveness can greatly affect the outcome of the project.

On the other hand, the availability of software subcriteria is the subcriteria with the lowest weight with a value of 0.8%. Based on the results of the geometric mean calculation, this is because in comparison with other subcriteria in the same criteria, namely the perceived professional competence subcriteria and the work commitment subcriteria, respondents gave high scores to both subcriteria compared to the availability of software subcriteria. This is probably because the mandatory regulation on the use of BIM in construction design planning has been enforced recently, so respondents prefer to override these subcriteria as important in choosing a construction design consultant. This result also occurs in research by (Ogbu & Imafidon, 2022), which states that companies that have the capacity to use technology do not always adopt it to provide services.

CONCLUSION

This study shows that there are 5 (five) criteria and 11 (eleven) subcriteria that must be considered in order to select the best construction design consultant to minimize performance problems that may occur in the future. Based on data analysis of pairwise comparisons between criteria and subcriteria using the ANP method, the priority criteria for selecting the best construction design consultant are Quality of Service (23.31%), Relationship with Job Owner (22.36%), Company Certification (20.87%), Quality of Personnel (20.55%), and Company Reputation (12.91%).

Meanwhile, the priorities of the subcriteria for selecting the best construction design consultant are Personality of personnel (14.90%), Responsiveness (14.03%), Quality of previous work (13.55%), Perceived professional competence (11.43%), Prior cooperation (11.15%), Work commitment (11.12%), Acquaintance (8.33%), Company legality (7.32%), Experience of personnel (5.64%), Formal presentation/written proposal (1.76%), and Availability of software (0.75%). Of the 3 (three) alternative Construction Design Consultant selected, PT "M" obtained the highest weight with a value of 59.0%, followed by PT "B" with a value of 24.4%, and finally PT "V" with a value of 16.6%. Sensitivity analysis shows that there is no change in the priority order of alternatives, meaning that there's no critical point of an alternative and PT "M" is the most favorable construction design consultant in this case.

SUGGESTION

Because this research focuses on finding criteria and subcriteria that must be used in selecting toll road Construction Design Consultant, the results of this study can only be applied in the Toll Road Planning Division of PT Hutama Karya (Persero). For future research, the authors suggest expanding the scope of consultant selection in other fields, as well as increasing the quantity and expanding respondents from other work units who often work with consultants from various fields so that the research results can be applied on a larger scale, for example on a company scale. Then this research also only uses one of the MCDM methods, namely ANP. It is recommended that future research be able to use different methods and/or combine and/or compare several MCDM methods to create better decision-making results.

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