

THE CONSIDERATION FACTORS OF WHEEL LOADER PROVISION PROCESS FOR A CONSTRUCTION PROJECT

Mahmuddin Mahmuddin^{1*}, Mubarak Mubarak², Ricky Reja Pahlevie³

^{1,2,3}) Jurusan Teknik Sipil, Fakultas Teknik, Universitas Syiah Kuala
Jl. Tgk. Syeh Abdul Rauf No. 7, Darussalam-Banda Aceh 23111

^{*})email: mahmuddin@unsyiah.ac.id

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Abstract: *The completion of a construction project is determined by various factors. One of these factors is related to the adequate availability of equipment resources both in terms of quantity, type, and function. The process for construction heavy equipment provision is generally carried out through the process of purchasing, renting, or leasing. The factors that are considered in the supply of equipment are one of the problems that need to be studied further so that the target of effective project implementation can be achieved. Based on these problems, this study was conducted to identify the factors that are considered by contractors in the process of providing equipment in a construction project. This research is focused on the supply of wheel loader heavy equipment by a contractor company in Banda Aceh City. Data collection was carried out using a questionnaire as a research instrument and involved the participation of 36 contractors with Medium (M1 and M2) and Large (B1) qualifications. The questionnaire instrument is structured into 6 factors consisting of cost, operation and maintenance factors, heavy equipment investment value, risk, equipment specifications and project conditions, and strategy. The process of data analysis applies descriptive statistical methods. The results of the analysis of the contractor's perception data indicate that the strategic factor is the most considered factor by the contractor in the provision of wheel loader heavy equipment. This condition is known from the indication of the average score of 3.11 as the highest value compared to other factors. The strategic factor becomes a top priority for contracting companies in supporting the improvement of the company's image or bona fide, especially when the company offers its services to the construction owner through a tender process.*

Keywords: *provision, heavy equipment, wheel loader, construction project, Banda Aceh City*

Abstrak: *Penyelesaian pekerjaan suatu proyek konstruksi ditentukan oleh berbagai faktor. Salah satu faktor tersebut berkaitan dengan tersedianya sumber daya peralatan memadai baik dari sisi jumlah maupun dari jenis dan fungsinya. Proses pengadaan alat-alat mekanis maupun alat berat konstruksi umumnya diperoleh dari proses pembelian, penyewaan, atau leasing. Faktor-faktor yang menjadi pertimbangan pada pengadaan peralatan menjadi salah satu permasalahan yang perlu dikaji lebih jauh agar sasaran pelaksanaan proyek yang efektif dapat dicapai. Berpijak pada permasalahan tersebut, penelitian ini dilakukan untuk mengidentifikasi faktor-faktor yang menjadi pertimbangan kontraktor pada proses penyediaan peralatan di suatu proyek konstruksi. Penelitian ini difokuskan pada pengadaan jenis alat berat *wheel loader* oleh perusahaan kontraktor di Kota Banda Aceh. Pengumpulan data dilaksanakan menggunakan kuesioner sebagai instrumen penelitian, dan melibatkan partisipasi 36 kontraktor berkualifikasi Menengah (M1 dan M2) dan Besar (B1). Instrumen kuesioner disusun dalam 6 faktor yang terdiri dari faktor biaya, operasional dan pemeliharaan, nilai investasi alat berat, risiko, spesifikasi alat dan kondisi proyek, dan strategi. Proses analisis data mengaplikasikan metode statistik deskriptif. Hasil analisis data persepsi kontraktor mengindikasikan bahwa faktor strategi merupakan faktor yang paling dipertimbangkan kontraktor pada penyediaan alat berat *wheel loader*. Kondisi ini diketahui dari indikasi nilai rata-rata skor 3,11 sebagai nilai tertinggi dibandingkan faktor-faktor lainnya. Faktor strategi menjadi prioritas utama bagi perusahaan kontraktor dalam menunjang peningkatan citra atau bonafiditas perusahaan, khususnya ketika perusahaan menawarkan jasanya pada penawaran pekerjaan melalui proses tender.*

Kata kunci: *pengadaan, alat berat, wheel loader, proyek konstruksi, Kota Banda Aceh*

1. INTRODUCTION

A project is generally defined as a temporary endeavor undertaken to create a unique product, service, or result [1]. A construction project is defined as a series of development activities that are limited by time with the allocation of resources to produce a form of construction. Construction projects are complex and time-consuming work and vary widely in type, size, duration, and cost, leading to several alternatives for project life cycle modeling and project delivery methods. [2]. Of the various resources needed to complete a project, equipment is one of the main components that must be met. The use of these resources is directly related to the work implementation process to simplify and speed up the process of completing construction projects [3], [4].

The equipment used in a project can be in the form of tools or heavy equipment. Construction heavy equipment today is specially designed by the manufacturer to perform certain mechanical operations in the completion of a job. In general, construction implementers use heavy equipment obtained from sources such as purchasing, renting, or leasing [5].

Equipment management is an effort to manage equipment resources to get optimal work results. Equipment management is a process that is delivered in stages of a cycle. The stages are initiated by the planning process, and followed by equipment provision, operations, and maintenance, and ended by the equipment removal process [6]. In the pre-construction phase, the availability of equipment is one of the factors considered by the job owner when the tender process takes place [7]. Availability of equipment is a measure of the bona fide of a construction company. In the cost estimation process, equipment resources are also one of the cost components that have a significant portion of the total cost as a whole [8]. Thus, the magnitude of the need for equipment costs will directly affect the overall project cost.

The usage of heavy equipment has a direct effect on the progress of project completion. Construction projects that are supported by the availability and adequacy of equipment will result in a higher level of work productivity [9], [10]. It shows that the increase in work productivity is directly proportional to the increase in the number of equipment used. The condition explains that the equipment factor is one of the key factors for the success of a project meeting the specified completion time target or even achieving project goals as a whole [11], [12].

The provision of heavy equipment for a construction project is defined by the type of work and function of the equipment. Heavy equipment is generally utilized in the construction works for earthmoving,

excavation, and lifting. The process of providing equipment by project implementers is carried out by considering various factors. In earthmoving work, several types of equipment are the most used and popular equipment, such as excavators and wheel loaders [13]. Both types of equipment are used for the excavation and loading process. The results of previous studies indicate that for excavators, the factor of specification and project conditions are the most considered factors by contractors [14]. The difference in equipment characteristics potentially causes the different considerations given for other types of equipment.

Referring to the previous considerations, this research is intended to identify and determine the dominant factors considered by the contractor in the provision of the wheel loader. This heavy equipment was used in earthworks and functioned to load excavated material [15]. This study focuses on medium and large qualified contractor companies in Banda Aceh City. There are six factors to be studied, namely, cost factors, operation/maintenance, the investment value of heavy equipment, risks, equipment specifications, and project conditions, and strategy.

2. RESEARCH METHODS

Object and Data

This study focuses on determining factors in the provision of wheel loader construction equipment. This study involved 36 respondents from medium (M1 and M2) and large (B1) classifications contractors in Banda Aceh City. This study applied a random sampling method to justify the participants required [16]. The number of participants was 36 representative of contractors who were positioned at the company managerial level.

The questionnaire was developed as an instrument for data collecting, as adopted from the previous study [14]. For this study, it was set up into two parts, namely Part A which included questions about the characteristics of the respondents such as the respondent's domicile, company experience, respondent's experience, ownership of heavy equipment, and projects carried out by the company. Meanwhile, Part B includes questions related to the factors considered in the provision of heavy wheel loaders. There are 6 factors with a total of 18 variables in this study, namely:

1. Cost (B)
 - i. Heavy equipment ownership tax (B1)
 - ii. Availability of capital cost (B2)
 - iii. Operational cost (B3)
 - iv. Heavy equipment maintenance cost (B4)
 - v. Heavy equipment insurance fee (B5)

2. Operations/Maintenance (OM)
 - i. Heavy equipment operator (OM1)
 - ii. Availability of spare parts (OM2)
 - iii. Heavy equipment warehouse (OM3)
3. Heavy Equipment Investment Value (I)
 - i. Asset salvage value (I1)
 - ii. Return on investment (I2)
4. Risk (R)
 - i. Inflation (R1)
 - ii. Risk of heavy equipment availability (R2)
 - iii. Heavy equipment condition (R3)
5. Equipment specifications and project conditions (SK)
 - i. The volume of work (SK1)
 - ii. Equipment capacity (SK2)
 - iii. Distance from home-based to project location (SK3)
6. Strategy (S)
 - i. Increase tender winning chances (S1)
 - ii. Increasing the company's investment value (S2)

Respondents' perceptions were measured using an instrument measurement scale that referred to the Likert scale. This study applies the following 5 perceptual measurement scales:

1. Strongly agree (4)
2. Agree (3)
3. Disagree (2)
4. Strongly disagree (1)
5. Don't know (0)

Instruments Test and Data Analysis

The process of testing the instrument was carried out before the questionnaires were distributed entirely through validity and reliability tests [17]. The validity test was conducted to measure the validity or validity of the questionnaire as a data collection instrument. The validity test is carried out by finding the correlation value using **Equation (1)** between parts of the measuring instrument as a whole with a total score and then comparing the correlation value (*r-value*) with *r-table*, that is, if *r-value* > *r-table* is declared valid and otherwise declared invalid.

$$r - value = \frac{n \sum XY - (\sum X)(\sum Y)}{\sqrt{\{n \sum X^2 - (\sum X)^2\} \{n \sum Y^2 - (\sum Y)^2\}}} \quad (1)$$

Where *r-value* is the correlation coefficient; *X* is the response value of each question; *Y* is the total response of all questions, and *n* is the number of respondents.

The reliability test was carried out to analyze the feasibility of the questionnaire as a research tool. The reliability values (r_{11}) are determined by correlation coef-

ficient (*r*) and calculated using **Equation (2)**. The acceptance of reliability value (*c-alpha*) is more than 0.6 and the category of the values describe in **Table 1**.

$$r_{11} = \left(\frac{2r}{1+r} \right) \quad (2)$$

Table 1. Category of reliability values

No.	Value Range	Level
1.	>0.8	Very high
2.	>0.6 to 0.8	High
3.	>0.4 to 0.6	Medium
4.	>0.2 to 0.4	Low
5.	<0.2	Very low

A descriptive statistical method was used to analyze the data in this study using frequency distribution analysis, mean, and ranking analysis [17]. The frequency distribution was used to identify the variation of respondents' answers based on the value of each variable. The mean was used to determine the average level of influence of variables and factors. The standard deviation was used to describe the distribution range of data. After the average value for each factor is sorted from the largest to the smallest, the highest factor or determining factor for the provision of wheel loader construction equipment is obtained. Respondents' perception criteria were stated based on the average score of each variable (**Table 2**).

Table 2. Criteria for the average perception of respondents

No	Mean Score Range	Criteria
1	> 3.5 to 4	Strongly agree
2	> 2.5 to 3.5	Agree
3	> 1.5 to 2.5	Do not agree
4	> 0.5 to 1.5	Strongly Disagree
5	0 to 0.5	Do not know

3. DISCUSSION RESULT

Instrument Test Results

The validity test was carried out on 12 samples used to ensure the feasibility of the questionnaire. For the number of samples (*n*) = 12, the degrees of freedom (*df*) = 10, and the error rate (α) = 10%, then the *r-table* value is 0.4973. The results of the validity test for all variables are declared valid so that they can be used as a measuring tool of research (**Table 3**).

The reliability test resulted in a reliability value of 0.981, and greater than the minimum limit of *c-alpha*. This "very high" level of reliability corresponds to the

category of reliability values greater than 0.80 (Table 4). These results indicate that the instrument can be trusted to produce reliable data.

Table 3. Validity test results

Factor	Variable	r-value	r-table	Validity
B	B1-B5	0.5624 - 0.8693	0.4973	Valid
OM	OM1-OM3	0.6121 - 0.8397	0.4973	Valid
I	I1-I2	0.5825 - 0.6491	0.4973	Valid
R	R1-R3	0.6451 - 0.7886	0.4973	Valid
SK	SK1-SK3	0.6053 - 0.8053	0.4973	Valid
S	S1-S2	0.5220 - 0.6006	0.4973	Valid

Table 4. Reliability test results

Equipment	r_{11}	c-alpha	Category	Level
Wheel loaders	0.981	> 0.60	> 0.80	Very high

Characteristics of Respondents

The results of the research for questionnaire part A are the characteristics of respondents who are grouped based on the respondent's domicile, company experience, respondent's work experience, wheel loader ownership status, and projects handled by the company in the last 10 years. The results of the research on the characteristics of the respondents can be seen in Table 5.

Based on the results for the characteristics of the respondents, it can be explained that the largest respondent's domicile is Banda Aceh with a frequency of 35 respondents and a percentage of 97%. The experience of the largest company is 5-10 years with a frequency of 18 companies and a percentage of 50%. As for the work experience, the largest respondent is 5-10 years with a frequency of 12 respondents and a percentage of 33%. For wheel loader ownership, there are 18 construction companies in the city of Banda Aceh that have wheel loaders with a frequency of 50%. Meanwhile, the most frequently handled projects by companies in the last 10 years are construction projects with a frequency value of 33 companies and a percentage of 92%.

Factors to consider in the provision of wheel loader

Identification of factors considered in the provision of heavy equipment wheel loaders obtained from data

analysis Questionnaire B. The analysis was carried out on 6 factors, namely cost factor (B), operation/maintenance (OM), heavy equipment investment value (I), risk (R), specification of project equipment and conditions (SK), and strategy (S). The analysis was carried out in 2 reviews, namely a review of the variables and a review of the factors. The value of respondents' perceptions of each study variable is shown in Table 6.

Table 5. Characteristics of respondents

No	Criteria	Frequency	%	
<u>Respondent's experience</u>				
1	<5 years	8	22%	
	5-10 years	12	33%	
	10-15 years	10	28%	
	>15 years	6	17%	
<u>Company experience</u>				
2	<5 years	2	6%	
	5-10 years	18	50%	
	10-15 years	9	25%	
	>15 years	7	19%	
<u>Wheel loader ownership</u>				
3	Yes	18	50%	
	No	18	50%	
<u>Last 10 years project experience</u>				
4	Building	Yes	33	92%
		No	3	8%
	Road and bridge	Yes	29	81%
		No	7	19%
	Water constr.	Yes	21	58%
		No	15	42%
	Ports	Yes	7	19%
		No	29	81%

Table 6. The variables analysis results

Factor	Variable	Mean Score	Perceptual interpretation
B	B1	2.64	Agree
	B2	3.03	Agree
	B3	2.64	Agree
	B4	2.83	Agree
	B5	2.72	Agree
OM	OM1	2.92	Agree
	OM2	2.81	Agree
	OM3	3.03	Agree
I	I1	2.72	Agree
	I2	2.47	Do not agree
R	R1	2.64	Agree
	R2	2.33	Do not agree
	R3	2.83	Agree
SK	SK1	3.17	Agree
	SK2	3.08	Agree
	SK3	2.72	Agree
S	S1	3.14	Agree
	S2	3.08	Agree

On the cost factor, the dominant variable considered in the supply of wheel loaders is the variable availability of capital costs (B2), which is ranked first with an average value of 3.03. In the operational/maintenance factor, the factor of heavy equipment storage (OM3) is the variable with the highest average of 3.03. In the investment value factor of heavy equipment, the variable residual value of assets (I1) has the highest value, namely 2.72. For the other three factors, the highest perceived score values appear on the variables of heavy equipment condition (R3), work volume (SK1), and increasing the chance of winning the tender (S1), respectively for the risk factor, equipment specification factor and project condition, and strategic factors.

Regarding the results of the perception analysis on the factor review, the highest order of contractor considerations appears in the strategic factor, followed by the equipment specification factor and project condition, operational/maintenance factor, cost factor, risk factor, and lastly the heavy equipment investment value factor. A description of the results of the analysis is shown in Table 7.

Table 7. The rank on the supply of wheel loader factors

Factor Code	Factor	Average	Rank
S	Strategy	3.11	1
SK	Equipment Specifications and Project Conditions	2.99	2
OM	Operation/Maintenance	2.92	3
B	Cost	2.77	4
R	Risk	2.60	5
I	Heavy Equipment Investment Value	2.60	6

The strategic factor is the factor with the highest order according to the indication of the average value of 3.11. The condition is slightly different from the results of other studies for the provision of heavy equipment excavators which are more concerned with the equipment specifications and project conditions [14]. This condition shows that construction companies in Banda Aceh City were provisioning wheel loaders for strategic purposes to increase the chances of winning tenders, in addition to considering the added value of investment from this equipment. Thus, this heavy equipment is needed by the company to complete the company profile when preparing bid documents for tendering a job and ensuring the success of infrastructure construction [18].

On the other hand, the procurement of equipment as part of the investment option (Factor I) has not become a priority in the consideration of contractors in Banda Aceh. This condition can be assumed as a consequence of the

company's financial capability profile which is still relatively limited to purchasing a variety of heavy equipment. The priority of investment choices should consider the aspect of investment returning and the residual value of the asset [10], [19].

4. CONCLUSIONS

This study identifies the determining factors in the supply of heavy equipment wheel loaders on construction projects. The survey was conducted using a questionnaire instrument on respondents from contractors with medium and large qualifications in Banda Aceh City. Descriptive analysis was applied to the perception data obtained from 36 respondents.

The results of this study indicate that the determining factor in the supply of heavy equipment wheel loaders comes from strategic factors, followed by equipment specifications and project conditions, as well as operational/maintenance factors. This shows that in procuring heavy equipment wheel loaders at contractor companies in Banda Aceh City, they pay close attention to these factors. In addition to being an investment and increasing the chances of winning a tender for the company, good and appropriate equipment specifications can also expedite the process of working on construction projects both operationally and in maintenance.

The conditions shown by the results of this study provide a general representation of the contractors in providing wheel loader heavy equipment. The development of further studies can be carried out by examining specifically the method of equipment provision, such as purchasing, renting, or leasing.

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