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Research Article

Risk Assessment of Resources Factor in Affecting Project Time

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Some risk factors contribute to various adverse effects on project implementation, especially the construction project. Risk needs to be recognized by analyzing the relationship between frequency of risks occurrence and impacts that may arise regarding construction time completion. The superposition of frequency and impact will indicate the risk importance of various risk factors. This research, therefore, aimed to assess the risk importance in time aspects of construction implementation to the contractor as the project executor is associated with the project resource factors. The resource factors reviewed are related to construction labor, materials, and equipment. The object of the study observed is a large qualified contractor company in Aceh Province with experience in the construction field for more than 15 years. The selection of time constraints is linked to the conditions of the company under various situations in Aceh during this period, both during the period of political and military conflicts, in the postdisaster rehabilitation and reconstruction period, and in the post-rehabilitation and reconstruction period. Characteristics of contractors and risks emerging are observed from the results of questionnaires distributed as instrument of data collection. The three resource factors studied each consists of several risk variables. The use of variables in the questionnaire is determined from the test results related to the validity and reliability of these variables. Risk assessment results of the three factors in the research indicate that the frequency of events and the level of impact of each variable determine the magnitude of the risk importance value. The labor is a factor with higher frequency and intensity of impact than the other two factors of study. Therefore, these factors contribute significantly to the project's completion time.

1. Introduction

Implementing the construction projects is vulnerable to risks that affect project objectives. Some internal or external risk factors may affect project targets. Project risk can be sourced from resource factors, which includes labor, materials, and equipment.

Risks are likely or no and, if they occur, will have an impact on the project [1–5]. In the opportunity theory, the risk is the probability of unexpected conditions and all of consequences possibility for project delays or project failures [6–11]. Risks are the variable of activities or factors and, if they occur, will decrease the achievement level of project objectives, i.e., cost and performance [12–15]. From the above definition, it can be concluded that the risk is an occurrence of uncertainty with an absolute chance of a condition that leads to unfavorable consequences of project objectives. Furthermore, risks in the project are a result in unfavorable physical, schedule, and financial consequences for the achievement of project objectives, i.e., cost, time, and project quality [12, 13]. Therefore, the risk is essential to manage risk project that can survive or perhaps optimize risk [12, 16–18].

The construction project implementers in Aceh Province face various risks over the past 15 years, such as the military and political conflicts of 2000–2004, postearthquake and tsunami rehabilitation and reconstruction in 2005–2009, and postrehabilitation and reconstruction in 2010–present [19]. These three periods provide different risk characteristics, both concerning the probability of the occurrence [20–24] and the impact [25, 26] for the project implementer. The first period was the period when there was a conflict of interest between GAM (Free Aceh Movement) and the central government. In that period, many armed conflicts

affected the security and safety [19]. Most contractors tend to refuse project work for security reasons. This condition could cause many projects, for both public and private sector investment running improperly. The second period is the period of rehabilitation and reconstruction, where the political conflict has decreased dramatically, and this was marked after signing peace memorandum on 15 August 2005 [19]. The number of construction works increased very high in this second period if compared to the previous period. The increase in employment is not proportional to the number of contractors and labors available in Aceh Province. The third period is the period in which the political and military conflicts have decreased, and the number of jobs declines drastically, or this condition is called as a normal condition until the current condition.

Risk assessment can be attributed to some factors and targets of a construction project consisting of cost, time, and performance. Previous research has indicated that various risk factors including factors related to project resources [20], external factors [21], managerial and operational factors [22], contracting and design factors [23], and financial and construction methods [24]. The potential for risk occurrence tends to be seen in the project resource factors associated with labors, and external factors related to government policy.

While associated with the impacts assigned to the project objectives, the studies that have been conducted are likely to see the impact on the cost aspects [25, 26]. The assessment of risks to project completion time has not been explained. The risk assessment of time is required given that this element is one of the success indicators of a project achieving its objectives. Analyzing the time risk impact on a construction project is required related to our previous risk factors as in paper [20–26]. Considering the abovementioned conditions, this study is aimed at assessing potential risks that may arise from the timing of completion of a construction project. The risk assessment focuses on project resource factors comprising labor, material, and equipment factors.

2. Materials and Methods

2.1. Data Collection. This research uses primary data collected by using questionnaire instrument. The questionnaire contains some questions prepared to obtain information related to the characteristics of the respondent, the occurrence frequency rating, and the impact on the timing of completion of the construction. Risk factors associated with project resources include 7 variables of labor factor, 10 variables of material factors, and 17 variables of equipment factor (Table 1).

The selection of respondents is based on a contractor company that has been involved in construction work for the last more than 15 years. The number of companies involved in the questionnaire survey counted 15 companies out of a total population of 20 contracting companies with large qualifications. These data are based on the membership of the company at the Construction Services Development Agency 2016. The minimum respondent is the personnel of the company at the middle managerial level, such as the director, manager, and senior engineer.

Table 1: List of factors and variables of project resources [20, 25].

Resources factors	Variable code	Variables
Labor	A1	Low labor availability
	A2	The ability of the labor is lacking
	A3	The discipline of unfavorable labor
	A4	Low labor productivity
	A5	Less solid teamwork
	A6	Labor squabble
	A7	Strike the labor
Material	B1	Increase in material prices
	B2	Delay in material delivery
	B3	Theft of material
	B4	Material quality is below standard
	B5	The type and quantity of material are not correct
	B6	Damage of material on delivery and storage
	B7	Limited material shelter
	B8	The supplier cannot fulfill the material order
	B9	Planning and management of good materials
	B10	Material handling
Equipment	C1	Low capacity of equipment
	C2	Displacement of equipment
	C3	Late mobilization of equipment
	C4	Equipment is incomplete
	C5	Device damage
	C6	Unqualified of equipment inspection
	C7	Productivity and efficiency decreased
	C8	The additional cost of equipment rental
	C9	Fuel scarcity
	C10	Difficult to access for heavy equipment
	C11	Planning and equipment management is not good
	C12	Equipment maintenance costs are high
	C13	Do not understand the procedure of using equipment
	C14	Not suitable equipment for working conditions/field
	C15	Ownership of rental equipment
	C16	Ownership of rental-purchase equipment
	C17	Ownership of proprietary tools

2.2. Questionnaire Testing. This questionnaire testing is conducted to ensure the data collection is valid and reliable to answer the research objectives. The instrument testing uses the validity test and the reliability test. The need for the validity test is to show the validity levels of an instrument by using the Pearson product moment correlation [27]. Pearson product moment correlation (r) measures the linearity of two paired variables x and y for n number of respondents. To determine whether or not a valid variable item uses the criteria, the following conditions were assumed:

(1) If $t \geq t_{sig}$, then the variables are declared as valid

(2) If $t < t_{sig}$, then the variables are declared as invalid

The correlation was analyzed by using the formula in the following equations:

$$r = \frac{n\left(\sum xy\right) - \left(\sum x\right) - \left(\sum y\right)}{\sqrt{\left\{n\sum x^2 - \left(\sum x\right)^2\right\}\left\{n\sum y^2 - \left(\sum y\right)^2\right\}}}, \quad (1)$$

$$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}. \quad (2)$$

The reliability test (r) is performed to ensure the reliability of instrument as the data collection tool by using Cronbach's Alpha (*C-Alpha*) analysis. An indicator of questionnaire feasibility is measured by the *C-Alpha* coefficient ≥0.6. The significance level for the statistical test used is 5%. The reliability test is performed using Equations (3)–(5) [28]:

$$r = \frac{k}{(k-1)}\left[1 - \frac{\sigma_b^2}{\sigma_1^2}\right], \quad (3)$$

where r = reliability of the instrument, k = the total of question items, σ_b^2 = the variance of items, and σ_1^2 = the total score variance. The variance of items and the total variance are calculated by using Equations (4) and (5):

$$\sigma_b^2 = \frac{Jk_{\mathrm{i}}}{n} - \frac{Jk_{\mathrm{s}}}{n^2}, \quad (4)$$

$$\sigma_1^2 = \frac{\sum xt^2}{n} - \frac{\left(\sum xt^2\right)}{n^2}, \quad (5)$$

where $\sum xt^2$ = the total response of the respondents, $\sum xt^2$ = the square of total response, Jk_{i} = the sum of squares of whole items, and Jk_{s} = the total square of response.

2.3. Analysis

2.3.1. Analysis of Frequency Index (FI). Frequency index (FI) is used to assess the frequency of risk occurrences. The index is used as an indicator to explain the frequency of risk factors reviewed. The FI analysis is as follows [29]:

$$\text{Frequency index (FI)} = \frac{\sum_{I=1}^{5} a_i n_i}{5N}, \quad (6)$$

where i = the index of the category, a_i = the weight of the i-th response, n_i = the total of respondent response for item i-th, and N = the total number of respondents. The frequency index scale was made using a Likert scale with the criteria shown in Table 2.

2.3.2. Analysis of the Severity Index (SI). The assessment results of risk impact on project completion time are presented in the form of the severity index (SI). The severity index shows the impact index of the emergence of internal risk factors [29]. The index is an indicator of the magnitude of the impact of resources risk factors reviewed. The classification of the risk impacts of the severity index scales used in this study can be seen in Table 3. The severity index analysis [29] is done by using the following calculation formula:

Table 2: Criteria and rating scale FI [30].

Qualification	Likert scale	Scoring scale
Very rarely	1	0.000 ≤ FI ≤ 0.125
Rarely	2	0.125 < FI ≤ 0.375
Often enough	3	0.375 < FI ≤ 0.625
Often	4	0.625 < FI ≤ 0.875
Very often	5	0.875 < FI ≤ 1.000

Table 3: Criteria and rating scale SI [30].

Qualification	Likert scale	Scoring scale
Very low	1	0.000 ≤ SI ≤ 0.125
Low	2	0.125 < SI ≤ 0.375
Medium	3	0.375 < SI ≤ 0.625
High	4	0.625 < SI ≤ 0.875
Very high	5	0.875 < SI ≤ 1.000

$$\text{Severity index (SI)} = \frac{\sum_{I=1}^{5} a_i n_i}{5N}, \quad (7)$$

where i = the index of the category, a_i = the weight of the i-th response, n_i = the total of respondent response for item i-th, and N = the total number of respondents. The severity index scale was made using the Likert scale with the criteria shown in Table 3.

2.3.3. Analysis of Risk Importance Index (RII). The risk analysis is completed by using the risk importance index (RII) analysis, as it is formulated in Equation (8). Risk importance is one method to measure the importance of risk based on the amount of occurrence (frequency) and impact (severity) that can be caused. This risk importance will be analyzed against per variable of the resource risk factors:

$$\text{RII} = \text{FI} \times \text{SI}, \quad (8)$$

where FI = frequency index of each risk variable and SI = severity index of each risk variable.

3. Results and Discussion

3.1. Respondents' Characteristics. Respondents' characteristics are divided into two, namely, the characteristics of personality and characteristics of the contractor, as shown in Tables 4 and 5.

Data are collected from 15 respondents who were working in a contractor firm with great qualification domiciled in Aceh Province. Respondents of this study generally have a position as manager and director of the company with work experience between 2 and 4 years. Typically, the contractor has more than 15 years of experience in the field of construction and has handled a number of projects during the political conflict period, the rehabilitation and reconstruction period, and post-rehabilitation and reconstruction period, so it can be concluded that the contractors who are the respondents of this research understand project risks at all three periods.

Table 4: Characteristic of respondents.

Category of characteristic	Characteristic description	Frequency	Frequency relative (%)
Position in contractor firm	Director	5	33.3
	Manager	7	36.67
	Other	3	20.00
Personal experience	>2–4 years	1	6.67
	>4–7 years	1	6.67
	>7 years	13	86.67

Table 5: Contractor firms characteristic of respondents.

Category of characteristic	Characteristic description	Frequency	Frequency relative (%)
Total of contractor's projects handled	Period of conflict		
	1–3 projects	3	20.00
	>3–6 projects	5	33.33
	>6–10 projects	4	30.00
	>10 projects	3	40.00
	Period of rehabilitation reconstruction		
	1–3 projects	1	6.67
	>3–6 projects	5	33.33
	>6–10 projects	3	20.00
	>10 projects	6	40.00
	Period of post-rehabilitation reconstruction		
	1–3 projects	2	13.33
	>3–6 projects	2	13.33
	>6–10 projects	5	33.33
	>10 projects	6	40.00
Types of projects ever handled	Building	11	73.33
	Roads and bridges	14	93.33
	Water constructions	9	60.00
Average of contract price yearly	<10 billion	2	13.33
	10 billion–50 billion	8	53.33
	>50 billion	2	13.33

3.2. Result of the Validity Test and the Reliability Test. The validity test in this paper uses a confident level of 95% (5% significant level) by t_{sig} obtained equal to 0.514. The test criterion is that if $t \geq t_{sig}$, then the instrument is declared valid, and vice versa. The results of the validity test for data of frequency index and severity index of each question are summarized in Tables 6 and 7.

The reliability test result for the frequency index and the severity index analyses indicate that the *C-Alpha* value for all risk factors (labor, materials, and equipment) is higher than 0.6, as summarized in Tables 8 and 9.

3.3. Risk Assessment. In the case of frequency analysis of labor risk factors, there are no "often" variables with consistent occurrence in the three study periods, and only 4 (four) "often" variables appear consistently in Period I and Period II. These variables are A1 (poor labor availability), A2 (inadequate labor capacity), A3 (poor worker discipline), and A4 (low work productivity). Although consistently appearing in the first two periods, the variables A1, A3, and A4 show a declining pattern from the initial period to the next period, except A2. This condition is reasonable, while from the Period I to the next period, the threat to the lives of labors is more secure.

Table 6: Result of the validity test of FI data.

Variable code	Range of t			Information
	Period I	Period II	Period III	
A1-A7	0.590–0.934	0.590–0.934	0.729–1.176	Valid
B1-B10	0.579–0.870	1.489–2.258	0.556–0.913	Valid
C1-C17	0.544–0.946	0.544–0.947	0.139–0.939	Valid

Table 7: Result of the validity test of SI data.

Variable code	Range of t			Information
	Period I	Period II	Period III	
A1-A7	0.536–0.831	0.566–0.950	0.775–0.951	Valid
B1-B10	0.558–0.879	0.529–0.863	0.573–1.000	Valid
C1-C17	0.517–0.919	0.535–0.880	0.578–0.948	Valid

Table 8: Result of the reliability test of data frequency.

Factors	Reliability test results			Information
	Period I	Period II	Period III	
Labor	0.89	1.14	1.15	Reliable
Material	0.93	5.97	0.83	Reliable
Equipment	1.08	0.98	0.87	Reliable

Table 9: Result of the reliability test of data severity.

Factors	Reliability test results			Information
	Period I	Period II	Period III	
Labor	0.74	0.81	0.87	Reliable
Material	0.88	0.86	0.89	Reliable
Equipment	0.96	0.96	0.98	Reliable

In the material risk factor, there are 2 (two) "often" variables such as variable of B1 (material price increase) and B2 (material delivery delay). Only B1 variable consistently appears on all three periods, except B2 variable. Although B1 is consistent, B1 is not a variable that affects the time risk compared to B2, as its variable name.

In the equipment risk factor, 3 (three) "often" variables appear in Period I, namely, C3 (delayed mobilization of equipment), C9 (fuel shortages), and C10 (difficult to access for heavy equipment). Variable B9 often occurs in Period I because of wars between parties (characteristics of conflict areas) that hinder the mobilization of heavy equipment. The results of FI analysis for three factors can be seen in Table 10.

In case of the severity analysis for labor risk factors, only 1 (one) "high" variable and variable A1 appear only in Period I (poor workforce availability). In the case of the severity analysis for material risk factors, only 1 (one) "high" variable and variable B2 appear only in Period I (material delivery delay). While for the equipment risk factors, there is no "high" variable giving impact toward time severity. The results of SI analysis for three factors can be seen in Table 11.

In the case of risk importance index, the analysis for three risk factors in all three periods analyzed is in the next section.

Table 10: Result of frequency index (FI).

Resources factors	Variable code	Period I		Period II		Period III	
		FI	Scale	FI	Scale	FI	Scale
Labor	A1	0.667	**Often**	0.640	**Often**	0.547	Often enough
	A2	0.667	**Often**	0.667	**Often**	0.547	Often enough
	A3	0.653	**Often**	0.627	**Often**	0.573	Often enough
	A4	0.640	**Often**	0.640	**Often**	0.560	Often enough
	A5	0.493	Often enough	0.480	Often enough	0.480	Often enough
	A6	0.427	Often enough	0.467	Often enough	0.453	Often enough
	A7	0.387	Often enough	0.387	Often enough	0.360	Often enough
Material	B1	0.667	**Often**	0.693	**Often**	0.653	**Often**
	B2	0.653	**Often**	0.493	Often enough	0.507	Often enough
	B3	0.613	Often enough	0.493	Often enough	0.493	Often enough
	B4	0.387	Often enough	0.387	Often enough	0.36	Rarely
	B5	0.507	Often enough	0.427	Often enough	0.44	Often enough
	B6	0.467	Often enough	0.467	Often enough	0.427	Often enough
	B7	0.440	Often enough	0.373	Rarely	0.387	Often enough
	B8	0.453	Often enough	0.413	Often enough	0.373	Rarely
	B9	0.493	Often enough	0.453	Often enough	0.387	Often enough
	B10	0.347	Rarely	0.32	Rarely	0.293	Rarely
Equipment	C1	0.413	Often enough	0.373	Rarely	0.373	Rarely
	C2	0.427	Often enough	0.413	Often enough	0.347	Rarely
	C3	0.640	**Often**	0.56	Often enough	0.413	Often enough
	C4	0.480	Often enough	0.44	Often enough	0.387	Often enough
	C5	0.573	Often enough	0.587	Often enough	0.56	Often enough
	C6	0.480	Often enough	0.467	Often enough	0.4	Often enough
	C7	0.493	Often enough	0.467	Often enough	0.427	Often enough
	C8	0.480	Often enough	0.52	Often enough	0.453	Often enough
	C9	0.627	**Often**	0.52	Often enough	0.52	Often enough
	C10	0.680	**Often**	0.533	Often enough	0.533	Often enough
	C11	0.453	Often enough	0.493	Often enough	0.427	Often enough
	C12	0.493	Often enough	0.467	Often enough	0.427	Often enough
	C13	0.467	Often enough	0.467	Often enough	0.467	Often enough
	C14	0.480	Often enough	0.453	Often enough	0.48	Often enough
	C15	0.480	Often enough	0.413	Often enough	0.373	Rarely
	C16	0.440	Often enough	0.453	Often enough	0.387	Often enough
	C17	0.427	Often enough	0.32	Rarely	0.373	Rarely

3.3.1. Risk Importance Index for Labor Factor. Based on the calculation of the average RII (Table 12) in each period, the highest rank of variable is A1 (low availability of labor) in Period I, variable A2 (the ability of labor is less) in Period II, and variable A3 (the discipline of unfavorable workers) in Period III. The risk of A1 variable tends to decrease over the three periods.

Generally, there are 3 (three) high-score variables of RII in the labor factors. This RII of the three variables is obtained of the relative frequencies of occurrences (FI) and impact of severity (SI). The RII of high-score variables is used to analyze time risk to achieve the completion of the contract time. The problem of A1 (low availability of labor) is commonly experienced in Period I (military and political conflict), in which laborers from outside Aceh do not dare to come to work in this area. When the conflict situation decreases, the problem of labor availability can be resolved, otherwise to A2 (the ability of labor is less).

3.3.2. Risk Importance Index for Material Factor. Based on the calculation of the average RII (Table 13), the highest rank of the variable is B2 (material delivery delay) in Period I, variable B1 (material price increase) in Period II, and variable B2 (material delivery delay) in Period III. The risk of B2 variable tends to decrease over the three periods.

The material factors also contribute to the completion of the project according to the time target. From the three periods of the study, the risks to completion times are determined by B1 (material price increase) and B2 (material delivery delays). B1 variable (the problem of price increase) in Aceh is determined by the supply and demand aspects influencing the time transportation. During the Period II (rehabilitation and reconstruction period), there is a high increase in material demand without the availability of adequate supply. Delivery delays are also a problem considering the distribution of separate project sites and not in the economic center of a region.

3.3.3. Risk Importance Index for Equipment Factor. Based on the equipment risk factor, the variable with the highest RII in Period I is C3 (delayed mobilization of equipment), while in Periods II and III, the C5 variable (tool breakdown). The risk

Table 11: Result of the severity index (SI).

Factors	Variable code	Period I		Period II		Period III	
		SI	Scale	SI	Scale	SI	Scale
Labor	A1	0.650	**High**	0.570	Medium	0.490	Medium
	A2	0.610	Medium	0.610	Medium	0.510	Medium
	A3	0.560	Medium	0.530	Medium	0.510	Medium
	A4	0.510	Medium	0.490	Medium	0.450	Medium
	A5	0.490	Medium	0.450	Medium	0.450	Medium
	A6	0.510	Medium	0.450	Medium	0.440	Medium
	A7	0.430	Medium	0.400	Medium	0.350	Medium
Material	B1	0.440	Medium	0.410	Medium	0.410	Medium
	B2	0.650	**High**	0.560	Medium	0.570	Medium
	B3	0.470	Medium	0.450	Medium	0.450	Medium
	B4	0.350	Low	0.370	Low	0.360	Low
	B5	0.360	Low	0.350	Low	0.370	Low
	B6	0.360	Low	0.400	Medium	0.390	Medium
	B7	0.410	Medium	0.370	Low	0.360	Low
	B8	0.440	Medium	0.410	Medium	0.400	Medium
	B9	0.470	Medium	0.440	Medium	0.390	Medium
	B10	0.310	Low	0.280	Low	0.370	Low
Equipment	C1	0.370	Low	0.370	Low	0.370	Low
	C2	0.370	Low	0.330	Low	0.370	Low
	C3	0.610	Medium	0.480	Medium	0.520	Medium
	C4	0.400	Medium	0.370	Low	0.440	Medium
	C5	0.530	Medium	0.530	Medium	0.490	Medium
	C6	0.410	Medium	0.430	Medium	0.400	Medium
	C7	0.470	Medium	0.430	Medium	0.400	Medium
	C8	0.470	Medium	0.410	Medium	0.360	Low
	C9	0.530	Medium	0.480	Medium	0.450	Medium
	C10	0.490	Medium	0.450	Medium	0.470	Medium
	C11	0.400	Medium	0.440	Medium	0.390	Medium
	C12	0.470	Medium	0.400	Medium	0.390	Medium
	C13	0.440	Medium	0.450	Medium	0.370	Low
	C14	0.480	Medium	0.450	Medium	0.400	Medium
	C15	0.350	Low	0.290	Low	0.350	Low
	C16	0.370	Low	0.330	Low	0.330	Low
	C17	0.330	Low	0.310	Low	0.310	Low

Table 12: Result of the risk importance index (RII) for labor factor.

Variable code	Period I		Period II		Period III	
	RII	Rank	RII	Rank	RII	Rank
A1	0.434	**1**	0.365	2	0.268	3
A2	0.407	2	0.407	**1**	0.279	2
A3	0.366	3	0.332	3	0.297	**1**
A4	0.326	4	0.314	4	0.252	4
A5	0.242	5	0.216	5	0.216	5
A6	0.218	6	0.210	6	0.199	6
A7	0.167	7	0.155	7	0.126	7

Table 13: Result of the risk importance index (RII) for material factor.

Variable code	Period I		Period II		Period III	
	RII	Rank	RII	Rank	RII	Rank
B1	0.294	2	0.284	**1**	0.268	2
B2	0.425	**1**	0.276	2	0.290	**1**
B3	0.288	4	0.222	3	0.222	3
B4	0.136	10	0.143	9	0.130	10
B5	0.183	7	0.150	7	0.163	5
B6	0.168	9	0.187	5	0.167	4
B7	0.180	8	0.138	10	0.140	9
B8	0.199	6	0.169	6	0.150	8
B9	0.232	5	0.200	4	0.151	7
B10	0.108	11	0.090	11	0.108	11
B11	0.294	2	0.150	7	0.163	5

of C3 variables tends to decrease from Period 1 (0.390) to the next periods (Period 2 (0.269) and Period 3 (0.215)). Based on this condition, it can be seen that these variables give an essential role in the delay of construction project work in the three phases of study in Aceh Province. The results of RII analysis can be seen in Table 14.

The delay problems in the project completion in this factor arise due to the variables of C3 (delayed mobilization of equipment) and C5 (tool breakdown). This delay mobilization due to limited access of contractor companies to project sites during this period is emerged during Period I (military and political conflict periods). In the two subsequent periods, the problems, generally, arise due to the inability of firms to overcome the equipment damage along with the increasing and workload of equipment need.

Table 14: Result of the risk importance index (RII) for equipment factor.

Variable code	Period I		Period II		Period III	
	RII	Rank	RII	Rank	RII	Rank
C1	0.153	16	0.138	14	0.138	13
C2	0.158	15	0.136	15	0.128	15
C3	0.390	**1**	0.269	2	0.215	4
C4	0.192	11	0.163	12	0.170	8
C5	0.304	4	0.311	**1**	0.274	**1**
C6	0.197	10	0.201	9	0.160	12
C7	0.232	5	0.201	9	0.171	7
C8	0.226	8	0.213	6	0.163	11
C9	0.332	3	0.250	3	0.234	3
C10	0.333	2	0.240	4	0.251	2
C11	0.181	12	0.217	5	0.167	9
C12	0.232	5	0.187	11	0.167	9
C13	0.205	9	0.210	7	0.173	6
C14	0.230	7	0.204	8	0.192	5
C15	0.168	13	0.120	16	0.131	14
C16	0.163	14	0.150	13	0.128	15
C17	0.141	17	0.099	17	0.116	17

Table 15: Ten potential rankings in all three periods.

Risk factors	Variable code	Period I		Period II		Period III		Top ten variables in all periods
		RII	Rank	RII	Rank	RII	Rank	
Labor	A1	0.434	1	0.365	2	0.268	5	1
Material	B2	0.425	2	0.276	7	0.290	2	2
Labor	A2	0.407	3	0.407	1	0.279	3	3
Labor	A3	0.366	5	0.332	3	0.297	1	4
Equipment	C10	0.333	6	0.240	10	0.251	8	5
Equipment	C9	0.332	7	0.250	9	0.234	9	6
Labor	A4	0.326	8	0.314	4	0.252	7	7
Equipment	C5	0.304	9	0.311	5	0.274	4	8
Material	B1	0.294	10	0.284	6	0.268	6	9
Material	B3	0.288	12	0.222	11	0,222	10	10

3.3.4. Risk Assessment of Resources Factor for All Periods in Aceh. In this subsection, risk assessment analysis in the three periods in Aceh Province is based on the resources factor of a combination of labor, materials, and equipment. In Table 15, the top ten variables of 35 risk assessment variables are shown.

The top ten variables are A1, A2, A4, B2, B3 [31], B3 [32], A2, B1, B2 [33], and A1, A2, A4, B1, B2, B3, C5 [34]. Based on these top ten variables, seven variables are related to variables in other studies from other regions or countries. While the rest three variables become the contractor's risk characteristics from this research case study (A3, C9, and C10).

4. Conclusions

This study shows the result of assessment related to risk assessment by using the indicator of frequency, severity, and risk importance index. The project risk is the superposition of RII on all risk variables. Each variable is a function of frequency and severity. Both frequency and severity influence high and low risks. The RII analysis is used as an input to assess the most dominant risk of cost, time, and quality.

Based on the labor risk factors, the most dominant time risk variable occurring in Period I is the inadequate availability of labor; in Period II, the ability of the workforce is lacking; and in Period III, experience/expertise of the contractor is lacking. From the material risk factor, the most dominant time risk variable occurs in Period I, and Period III is the delay of material delivery, while in Period II, the material price increase. Based on RII analysis result from the equipment risk factor, it can be concluded that the most dominant time risk variable occurring in Period I is the delay in the mobilization of equipment, while in Period I and II, equipment malfunction.

We have analyzed 35 variables which were categorized into three factors of variables which are tested in three periods providing different risk characteristics, both concerning risk probability and risk impact. Based on the variable, it has been concluded that ten variables as the most dominant risks that arise simultaneously in all three periods. Four variables, namely, low labor availability (A1), the ability of the labor is lacking (A2), the discipline of unfavorable labor (A3), and low labor productivity (A4), are derived from labor factors. Three variables, namely, the increase in material prices (B1), delay in material delivery (B2), and

theft of material (B3), are derived from material factors. While the three variables are device damage (C5), fuel scarcity (C9), and the difference between difficulties to access heavy equipment (C10) come from the equipment factor. The ten dominant variables, three of which are A3, C9, and C10 are derived from the characteristics of the three periods in this study, while seven variables are also related to risk variables in other regions or countries, namely, A1, A2, A4, B1, B2, B3, and C5.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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