The Identification of Material Management Risk Factors Affecting The Time Performance in Fly Over Project Construction

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Abstract

Material is everything and all requirement needed during the project construction to support the project activities so that the project can produce the goal achievement. Material management includes the planning and control related to the material viewed from various sectors including procurement, supply, purchase, delivery, acceptance, warehousing and distribution. One of the problems often faced is the material procurement delay. The material is not available when it is required and this condition causes the reduction of the workers' productivities. In addition, the workers' productivities reduction also affects the time performance of the project construction. The project manager needs to control the various activities in the project location. One of the importing factors is the time performance. This research aims to identify the most dominant factor in the material management affecting the time performance and to analyze the material management risk effect to the time performance in fly over project construction in Banda Aceh. The observation done to construction implementation teams (stakeholders) in Fly Over Project in Banda Aceh, they are the owner, supervision consultants and contractors. The statistical analysis used is validity test, reliability test, descriptive analysis and multiple linear regression. The most affecting material management risk factor to the time performance in the fly over project construction is quality control factor. It means that if quality control factor can be well handled, the time performance of the project construction will improve.

Keywords
Risk, Material management, Time performance

1. Introduction

In the construction project, there are various problem must be faced in the project completion (Pérez et al., 2010; Rani et al., 2013a; Qazi at al., 2016). One of the problems often faced is the material procurement delay (Marzouk and El-Rasas, 2014; Brahm and Tarziján, 2015; Aziz and Abdel-Hakam, 2016; Gebrehiwet and Luo, 2017). The material is not available when it is required and this condition causes the reduction of the workers' productivities (Ng et al., 2004; Abdel-Razak et al., 2007; Nasirzadeh and Nojedehi, 2013). The productivity reduction gives the contribution to cost swelling caused by the extension of workers' salary. In addition, the workers' productivities reduction also affects the time performance of the project construction (Brown et al., 2007; Lei et al., 2017, Rani et al. 2018). The project delay will be penalized or sanctioned by the owner to the contractor (Sambasivan and Soon, 2007; Doloi et al., 2012; Aziz, 2013; Senouci et al., 2016). The sanction is 1 per mile per day multiplied by the contract value. It will impact to the financial loss not only for small scale project but also for medium and large scale projects (Toor and Ogulana, 2008; Söderlund, 2010; Maier and Branzei, 2014; Lu et al., 2015; Patanakul et al., 2016; Liu et al, 2017).

The project runs well if the project can meet all requirements of the cost, time and quality (Atkinson, 1999; Khang and Myint, 1999; Gardiner and Stewart, 2000; Abdelsalam and Gad, 2009; Kim et al., 2012; Rani et al., 2013b; Rani, 2017). These three targets affect each other. The material procurement delay problem will cause the addition

of the time and the cost (Kaliba et al., 2009; Chan, 2001; Aliverdi et al.. 2013; Rani, 2015; Senouci et al., 2016; Sanchez et al., 2017) . The most important is we realize that the knowledge and skill of good material management become important matter in running the project (Zhang et al., 2018). For example is how to establish the relationship and good communication to the vendor/supplier in order to avoid the material delivery delay (Aibinu and Jagboro, 2002; Müller and Turner, 2005; Mesa et al., 2016; Wu et al., 2017). Because the vendor often prefers giving the priority and delivering the material ordered in the many quantities (Mahmoud-Jouini et al., 2004). The good understanding of this risk factor will become knowledge base to establish effective and efficient material management system (Edwards and Browen, 1998; Ward, 1999; Mohanty and Deshmukh, 2001; Ibn-Homaid, 2002; Perera et al., 2009; Xia et al., 2018; Yang et al., 2018).

There are many studies conduct around the world to improve risk management in construction projects (del Caño and de la Cruz, 2002; Thevendran and Mawdesley, 2004; Wakshull, 2004; Pavlak, 2005; Luu et al., 2009; Green and Fontaine, 2016; Olechowski et al., 2016; Wang et al., 2016; Domingues et al., 2017; Muriana and Vizzini, 2017; Szymariski, 2017; Hernández , et al., 2018).

The development of Banda Aceh in the various sectors affects transportation problems such as the traffic jams in several roads. Simpang Surabaya is one of the intersections which has very high traffic density and one of the important points in Banda Aceh Road Network System because it serves the primary road network system. Therefore fly over construction becomes absolute that must be constructed to solve the traffic jam problem in the area (Rani et al., 2017). This bridge has been being constructed during 710 days since 21 December 2015 to 29 November 2017. This project is funded by the State Budged (APBN) which is IDR 250,124,483,000.00 (Two Hundred Fifty Billion One Hundred Twenty Four Million four Hundred Eighty Three Thousand Rupiah).

Related to the above background, the problem of this research is what the dominant risk factor in the material management affecting the time performance of the project construction is and how the effect of material management risk to the time performance in Simpang Surabaya Fly Over Project Construction in Banda Aceh. This research aims to identify the most dominant factor in the material management affecting the time performance and to analyze the material management risk effect to the time performance in Simpang Surabaya Fly over Project construction in Banda Aceh. The observation done to construction implementation teams (stakeholders) directly involved in the field of Simpang Surabaya Fly Over Project in Banda Aceh including the owner, supervision consultants and constructors. The independent variables used in this research are material management risk factors including planning and scheduling, contracting, coordination and core personnel, purchasing, delivering, quality control, storage and warehouse, field mobilization, consumption, supervision and controlling, budgeting, external factors, while the dependent variable is time performance. The statistical analysis used is validity test, reliability test, descriptive analysis and multiple linear regression using *Statistical Product and Service Solution* (SPSS). This research benefit is expected to be good knowledge for the researcher, and can be input to the contractor constructing Simpang Surabaya Fly over Project in Banda Aceh in handling material management.

2. Literature Review

2.1. Risk

Alijoyo (2006) stated that the risk can be defined from various view points. From the result of output view, it can be defined as the results or outputs which cannot be certainty predicted, dislike, and contra productive. While form the process view, it can be defined as the factors affecting the objective achievement and resulting undesirable consequences.

Fisk (1997) mentioned that the risk is the variation may occur naturally in any situation. No one can predict when the risk can occur. Therefore, the risk can also be interpreted as the probability of events occurring in the certain period.

2.2. Material Management

Asiyanto (2009) mentioned that the material is everything and all requirement needed during the project construction to support the project activities so that the project can produce the goal achievement. According to the process, the project materials can be divided into 4 categories as follows:

1. Raw materials are the materials delivered to the project location. They are still in the raw type for processing. The raw materials include stone, sand, cement, steel, and wood.
2. Finished materials are the material delivered to the project location and can be directly installed. The finished materials include tile, roof tile, glass, ceramic, and light.
3. Fixed materials are the material delivered to the project location as the fixed materials. They include ready mix concrete and hot mix asphalt.
4. Prefabricated materials are the materials casted or installed outside the project location by the other parties. When delivering to the project location, it is only installed. The prefabricated materials include precast concrete, steel frame, door and window sills.

Material management includes the planning and control related to the material viewed from various sectors including procurement, supply, purchase, delivery, acceptance, warehousing and distribution.

2.3. Material Management Risk Affecting the Time Performance

Andani (2011) mentioned that the material management risk affecting the time performance of the project is divided into some factors. The risk factors can be mentioned in Table 1.

Table 1. Material management risk factors affecting the time performance

Variable	Indicator
Planning and scheduling	The difficulty in material procurement (imported material)
	Material Specification which is less explicit/ less completed
	The mistake in forecasting the field condition, weather, and future condition
	Mistake in planning the working scope
	Less accurate and careful in material scheduling planning
	Mistake in developing and applying the working method Mistake in determining the transportation production capacity so that the transportation tool available is not enough for material mobilization
	Less planning for alternative material
	Management planning for material transportation is less good
	Lacking of knowledge about where and when the best material available
Contracting	The sub clauses of the contract which are not completed
	The misperception in understanding the clauses of the sub contract/material specification
	The weaknesses in solving the disagreement among involved parties
	The Mistake in writing the contract clauses
	The difference of the language used in the contract
Coordination and core personnel	The communication/coordination system among the personnel which is less effective
	The procedure and bureaucracy systems which are complicated
	The delay of decision making process
	The mistake in delegating the task and authority
	The project personnel located are less competence in the organization structure
Purchasing	The material scarcity of on the market which is not anticipated by the contractor
	The material source condition change to the project location
	The change of policy and company rules in the research
	Lest quality of the supplier
	The materials are purchased using the traditional method (ordering many at once but rarely needed)
Delivering	The delay in material delivering to the location

	The change of material condition (broken/loss) during delivering process
	Accessibility during delivery process is less good
Quality control	The material quality purchased does not match to the order
	The material quality does not match the specification
Storage and warehouse	The material loss in the warehouse
	The delay in storage system
	The material is broken in the storage (due to the type of warehouse which does not match the requirement)
	The material storage is not grouped per material type Less monitoring in the warehouse
Field mobilization	Damage to material transportation during material distribution
	The traffic management application does not run well
	The congestion in the loading area
Consumption	The material use wastefulness in the location
	Frequent material transfer
	Less understanding to the characteristic of the project location
Supervision and controlling	Less coordination meeting in the field
	Report system (recording) of the material flow is less good
	Decision making system is less good
	Less good inventories control of the material stocks
Budgeting	Payment system selection is less appropriate
	Payment media selection is less appropriate
External	Economic condition change
	Frequent change of the law regulations
	The unpredictable conditions are often happened during the project construction (natural disaster, politic, and others)
	The weather and climate conditions are less supported

Source: Andani (2011)

2.4. Time Performance

Halpin (1998) mentioned that the project manager needs to control the various activities in the project location. One of the importing factors is the time performance. The time performance is the process comparing the field work and planned schedule. The project construction time criterias can be divided into 3 indicators such as slow, normal and fast durations.

3. Methodology

3.1. Data Collection

The data used in this research is primary and secondary data. The primary data is questionnaire. The data collection done is by distributing written document to the respondents to be answered. While the secondary data used is Aceh Province Map, Banda Aceh Map, Research Location Map, Rigid Pavement Layout, and Stakeholder Data obtained from PT. Jaya Konstruksi.

3.2. Population Determination

The population is stakeholder involved in Simpang Surabaya Fly over Project in Banda Aceh consisting of owner, supervision consultant, and contractor based on the data received from PT. Jaya Konstruksi on 2016. The stakeholder is 73 people. The total sampel from this research taken is total of the population.

3.3. Research Variable Determination

These research variables consist of independent variables (X) which are material management risk factors and dependent variable (Y) which are time performance.

3.4. Measurement Scale

The respondents‘ answers of the questionnaire use Likert Scale which every answer of the respondents can be explained in Table 2.

Table 2. Answering category of related variable

No.	Answering Category	Performance	Score
1	Not Very Good (STB)	Delay than the schedule > 2 weeks	1
2	Not Good (TB)	Delay than the schedule between 1-2 weeks	2
3	Less Good (KB)	Delay than the schedule < 1 week	3
4	Good (B)	On time or faster between 1-2 weeks	4
5	Very good (SB)	Faster than the schedule > 2 weeks	5

4. Result

4.1. Validity Test

The result of validity test of every question has been processed and it can be explained in Table 3.

Table 3. Validity test

Variable	Factors	Statement	R_{count}	R_{table}
X1	Planning & scheduling	$X_{1.1} – X_{1.10}$	0.433 – 0.806	0.230
X2	Contracting	$X_{2.1} – X_{2.5}$	0.580 – 0.737	0.230
X3	Coordination & core personnel	$X_{3.1} – X_{3.5}$	0.715 – 0.875	0.230
X4	Purchasing	$X_{4.1} – X_{4.5}$	0.674 – 0.897	0.230
X5	Delivering	$X_{5.1} – X_{5.3}$	0.946 – 0.982	0.230
X6	Quality control	$X_{6.1} – X_{6.2}$	0.921 – 0.923	0.230
X7	Storage & warehouse	$X_{7.1} – X_{7.5}$	0.866 – 0.954	0.230
X8	Field mobilization	$X_{8.1} – X_{8.3}$	0.910 – 0.949	0.230
X9	Consumption	$X_{9.1} – X_{9.3}$	0.637 – 0.862	0.230
X10	Supervision & controlling	$X_{10.1} – X_{10.4}$	0.604 – 0.779	0.230
X11	Budgeting	$X_{11.1} – X_{11.2}$	0.854 – 0.885	0.230
X12	External	$X_{12.1} – X_{12.4}$	0.735 – 0.906	0.230

Table 3 shows that all statements given to the respondents has $R_{count} > R_{table}$. It means that all statements are valid.

4.2. Reliability Test

The result of reliability test for each variable has been processed and it can be explained in Table 4.

Table 4. Reliability test

Variable	Factors	Cronbach Alpha
X1	Planning & scheduling	0.866
X2	Contracting	0.734
X3	Coordination & core personnel	0.853
X4	Purchasing	0.870
X5	Delivering	0.963
X6	Quality control	0.824
X7	Storage & warehouse	0.936
X8	Field mobilization	0.916
X9	Consumption	0.672
X10	Supervision & controlling	0.684
X11	Budgeting	0.676
X12	External	0.842

The above table shows that all variables in the questionnaire has *Cronbach Alpha* > 0.6. It means based on the reliability test done to all variables results that all variables are reliable.

4.3. Descriptive Analysis

Descriptive analysis is used to detect the frequency of respondents' characteristic, frequency of questionnaire answer in problem solving. The problem is the most dominant risk factor of material management affecting the project time performance. It can be explained as below.

These respondents' characteristics are the stakeholders' characteristics consisting of owner, supervision consultants, contractors which are 73 respondents. The distribution of the respondents' characteristics can be shown in the column chart of 1 to 4.

The characteristic based on gender shows that almost all are males which are 70 respondents (95.89%). Only small part are females which are 3 respondents (4.11%). The respondents' distribution based on the gender can be shown in Figure 1.

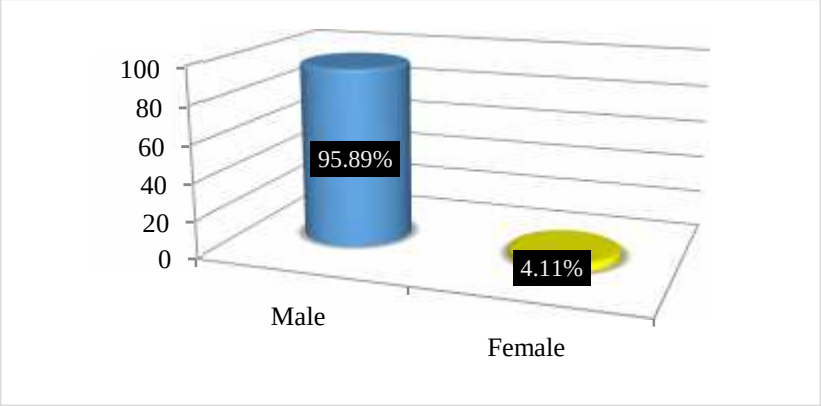

Figure 1. Gender of respondents

The characteristic based on age shows that most respondent have 31-40 years old which are 39 respondents (53.42%). Almost half respondents have 20-30 years old which are 34 respondents (46.58%).The respondents' distribution based on the age can be shown in Figure 2.

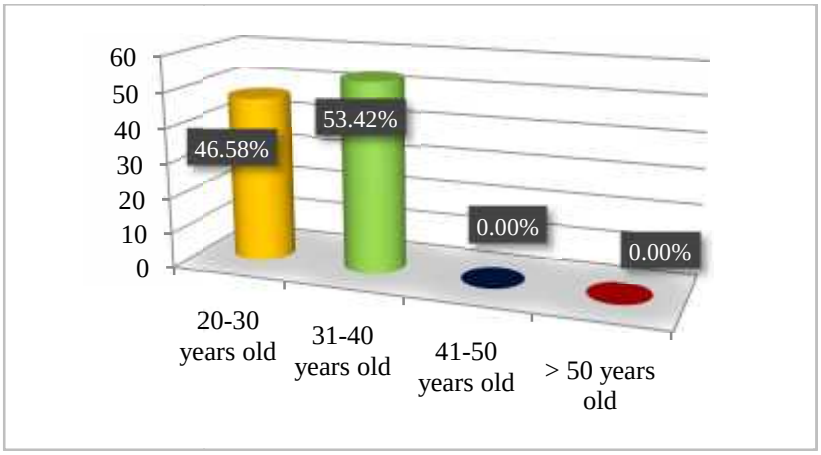

Figure 2. Age of respondents

The characteristic based on the last education shows that most respondent have bachelor degree backgrounds which are 53 respondents (72.60%). Only small parts have diploma degree backgrounds which are14 respondents (19.18%) following by the senior high school backgrounds which are 6 respondents (8.22%). The respondents' distribution based on the last education can be shown in Figure 3.

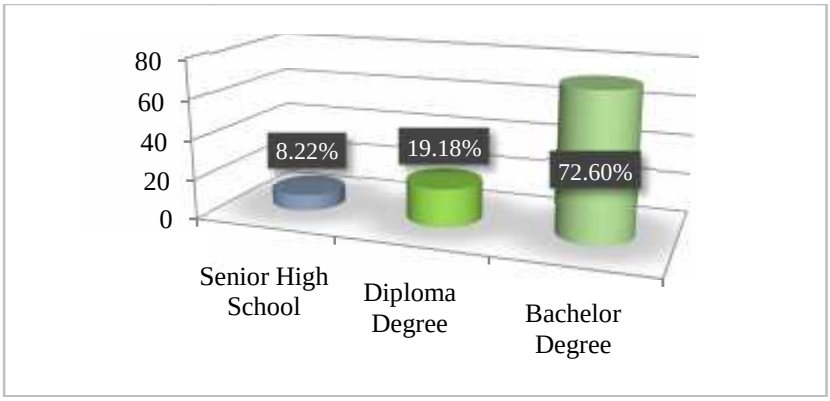

Figure 3. Last education of respondents

The characteristic based on the stakeholder shows that most respondent are constructors which are 62 respondents (84.93%). Small parts are supervision consultants which are 7 respondents (9.59%) following by the owners which are 4 respondents (5.48%). The respondents' distribution based on the stakeholder can be shown in Figure 4.

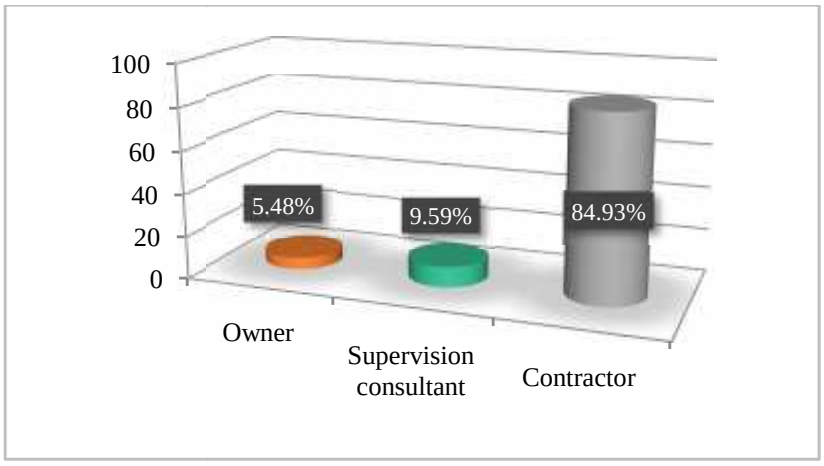

Figure 4. Stakeholder of respondents

4.4. Material Dominant Risk Factor Affecting to the Time Performance in the Fly Over Project Construction

This analysis is intended to know perception of the owners, supervision consultants, and contractors about the most dominant of material management risk factors affecting the time performance in Banda Aceh Fly over Project Construction.

Based on Table 5, the indicator mean of each factor shows the interpretation of score percentage for each indicator. Most of stakeholders are very affected and the other are affected. It means that all material management risk indicators affect time performance in the fly over project.

Table 5. Mean of material management risk factors affecting the time performance

Variable	Factors	Mean	Ratings
X1	Planning & scheduling	4.082	8
X2	Contracting	3.663	10
X3	Coordination & core personnel	3.592	12
X4	Purchasing	4.277	6
X5	Delivering	4.110	7
X6	Quality control	4.390	3
X7	Storage & warehouse	4.310	5
X8	Field mobilization	4.393	2
X9	Consumption	4.374	4
X10	Supervision & controlling	4.397	1
X11	Budgeting	4.075	9
X12	External	3.599	11

Based on the table 5 above shows that the highest mean is obtained from the supervision and controlling factor which value is 4.397. It means that based on stakeholders' perceptions, the most dominant of material management risk factors affecting the time performance in fly over project construction is the supervision and controlling factor.

4.5. Multiple Linear Regression Analysis

Multiple linear regression analysis is used to determine the effect of material management risk factors to the time performance in fly over project construction in Banda Aceh by looking at the regression coefficient. The multiple regression coefficients that have been analyzed are summarized in Table 6.

Table 6. Multiple linear regression coefficient

Variable	Regression Coefficient	Significant
Constant	3.567	
Planning & scheduling	0.002	0.000
Contracting	0.018	0.701
Coordination & core personnel	0.003	0.041
Purchasing	0.002	0.887
Delivering	0.002	0.740
Quality control	0.032	0.803
Storage & warehouse	0.001	0.029
Field mobilization	0.005	0.927
Consumption	0.002	0.721
Supervision & controlling	-0.016	0.851
Budgeting	0.020	0.240
External	-0.027	0.191

Based on the regression coefficient in Table 6, it is obtained the multiple linear regression analysis which can be shown in the below equations:
$Y = 3.567 + 0.002X_1 + 0.018X_2 + 0.003X_3 + 0.002X_4 + 0.002X_5 + 0.032X_6 + 0.001X_7 + 0.005X_8 + 0.002X_9 – 0.016X_{10} + 0.020X_{11} – 0.027X_{1.}$

The graph of multiple linear regression analysis which has been analyzed can be shown in Figure 5.

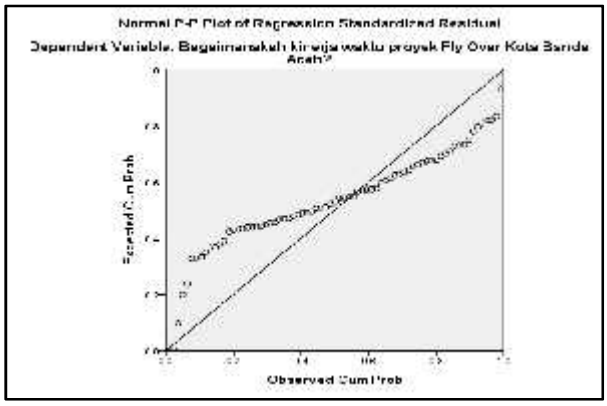

Figure 5. The graph of multiple linear regression

The graph shows that the points are located around the regression line. It means that the line represents all data taken so that the regression model can be accepted.

5. Discussion

In this research, there are 12 risk factors of material management affecting the time performance. From all the factors, it is obtained the most dominant risk factor of material management affecting time performance in the fly over project construction which is supervision and controlling factor.

Supervision and controlling factor is the part of management function which aims to effort the field implementation runs along with the schedule planned. Supervision and controlling factor consists of 4 indicators including less coordination meeting in the field, report system (recording) of the material flow is less good, and decision making system is less good, less good inventories control of the material stocks. The impact of material management risk from supervision and controlling factor is the work product and process become under control so that it affects the time performance of project construction. The action can be done to minimize or avoid the impact is by auditing the process and product; repairing the controlling system; creating the flow chart of the controlling completed with person in charge; and creating Standard Operating Procedures (SOP) and Job description.

Before the project activity starts, SOP and Job Description must be clear. SOP is a document relating to the procedure carried out chronologically to complete the work item in order to receive the most effective working product from the workers using the cheapest cost. Job description is the guide of the company to Personnel in performing the task for project controlling. These SOP and job descriptions are made by the company and project team, so that project authority and responsibility in the project controlling can adjust the implementation time.

The effect of the material management risk factors to the time performance in fly over project construction has been analyzed using multiple linear regression. This effect is the response between the action and the reaction. This means that when the risk factors of material management occur, the time performance in the flyover project will increase or decrease. Based on multiple linear regression coefficients analyzed, there are 10 risk factors of material management have positive affects and the rest of 2 factors have negative affects to the time performance in fly over project construction.

Positive effects imply that if one of material management the risk factors is well handled, the time performance of the fly over project will increase. The factors which have positive effects are quality control factor, budgeting factor, contracting factor, field mobilization factor, coordination and core personnel factor, planning and scheduling factor, purchasing factor, delivery factor, consumption factor and storage and warehouse factor. Negative effects imply that if one of material management the risk factor is well handled, the time performance of the fly over project will decrease. The factors which have negative effects are supervision and controlling factor and external factor.

Related to the above condition, the most dominant risk factor of material management affecting the time performance in the fly over project is quality control factor which have the highest regression coefficient as 0.032. It means that if quality control is well handled, the time performance in the project construction will increase. The handling can be done to the quality control is by reviewing the material in the plant before the material delivered, every material which does not meet the requirement must be returned, and the contract clause must clearly explain the material quantity, and the material used is based on the owner approval.

Acknowledgements

This research was supported by Universitas Muhammadiyah Aceh. We thank our colleagues from Universiti Malaysia Pahang who provided insight and expertise that assisted this research, although they may not agree with all of the interpretation and conclusion produced of this paper.

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