Analysis of Construction Material Procurement Retardation on Sepaku-Petung Rigid Pavement Improvement Project in East Kalimantan Province

Asia Pacific Journal of Multidisciplinary Research
Vol. 5 No.4, 165-175
November 2017
P-ISSN 2350-7756
E-ISSN 2350-8442
www.apjmr.com

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Date Received: August 9, 2017; Date Revised: November 13, 2017

Abstract *–This study aims to know the factors influencing the retardation in procurement of construction materials on Sepaku-Petung pavement improvement project in East Kalimantan Province;to know the most dominant factor affecting the retardation in procurement of construction materials on Sepaku-Petung pavement improvement project in East Kalimantan Province; to determine what strategies that minimize the waiting time of materials in the improvement of Sepaku-Petung pavement project in East Kalimantan Province. This study used quantitative research method. The data was collected through interview, questionnaire distribution, and discussion forum. Based on the results of research and data analysis conducted, it can be concluded thatsuppliers, contractors, field conditions, and unpredictable conditionswere affecting the retardation in procurement of materials in the pavement improvement project in East Kalimantan. Field condition was the most dominant factors in the realization of Sepaku-Petung pavement improvement project in East Kalimantan province. Type B (Retarding Admixtures) could be added to retard the time-binding of the concrete (setting time), therefore minimizing material procurement waiting time. The contractor should also build his own supplier close to the project site to reduce the distance between the concrete supplier location and the project site.*

Keywords *–construction, material procurement, project.*

INTRODUCTION

Construction project consists of various activities. The numbers of activities that exist affect the number of resources used. Such resources include manpower or workers, materials, and heavy equipment. Material is one of the most important resources. The use of materials is the most important part that has a large percentage of 50 - 70% of the total project cost [1]. If the parties involved in the construction project are not able to maintain the smooth flow of materials, it will disrupt the project realization process which eventually becomes the cause of the retardation of the project completion.

Material retardation is a common constraint on construction projects. Since the material is ordered until arriving at the project site, there is a waiting time interval. Order waiting time is the time between or the grace period since the order is made or when the order is sent to the warehouse [2]. Waiting time for construction materials can be affected by the distance between projects requiring material and material suppliers. When suppliers used are only local suppliers, the material waiting time is relatively short. Conversely, if the suppliers of the material used are suppliers outside the region, outside the island or supplier abroad, then the waiting time of the material becomes relatively longer. That is the case in East Kalimantan Province where some remote areas are very difficult to get the supply of material. It is also the cause of the retardation in many construction projects in East Kalimantan.

Similarly, the object of research that will be investigated is the improvement project of Sepaku-Petung rigid pavement located in North PanajamPaser Regency of East Kalimantan Province, Indonesia. In the construction of this Sepatu-Petung rigid pavement improvement project, the researcher sees that material procurement is often too late. Some of the assumptions obtained from several parties are the factors affecting the material procurement retardation are in the form of transportation factors, weather, and limited material ordered. The material retardation in this project causes the contractor to increase the workers' working time (overtime) to overcome the retardation in the work schedule. This causes an increase in labor costs to be incurred by the contractor.

One of the steps that can be taken to ensure the smoothness of material is managing the supply chain. Supply Chain Management as a network of suppliers, manufacturers, assemblers, distributors, and logistics facilities that form the purchasing function of materials, material transformation into semi-finished or finished products, and distribution processes from those products to the consumers [3]. Besides, supply Chain Management is as an action of activities management in order to obtain raw materials into goods in the process or intermediate goods and finished goods and then send the product to consumers through the distribution system [4]. These activities include traditional purchasing functions and other important activities that relate between suppliers and distributors. The supply chain of a construction project shows a relationship between the supplier and the construction agent in an attempt to bring construction materials. The supply chain can be local-national, or even international scale. If the required materials are widely available in the market, the supply chain is generally only local. Conversely, if the material is scarce in the market, it makes supply chain into a national and even international scale [5].

The objectives of this present research are: 1) to know the factors influencing the retardation in procurement of construction materials on Sepaku-Petung pavement improvement project in East Kalimantan Province, 2) to know the most dominant factor affecting the retardation in procurement of construction materials on Sepaku-Petung pavement improvement project of East Kalimantan Province, 3) to determine which strategies that minimize the waiting time of materials in the improvement of Sepaku-Petung pavement project in East Kalimantan Province.

MATERIALS AND METHODS

The method used in this research is quantitative research method which is done by collecting the required data. This study used questionnaires that were distributed to the respondents, so that the results obtained are in the form of responses toward the problems discussed in the present research. This study used closed questionnaire that contains questions about research variables, including suppliers (4 items), contractors (10 items), field conditions (3 items), and unpredictable conditions (12 items). The questionnaire used Likert Scale (1-5) for the respondent's response, where: 1 for very low, 2 for low, 3 for adequate, 4 for high, and 5 for very high.

Based on Jack R. Fraenkel's instrument validity analysis, validity test of the instrument in this study was done by comparing Product Moment Pearson's correlation index with the significance level of 0.05 (5%) as its critical value. The equation can be seen in Eq. (1).

$$r = \frac{n.(\sum XY) - \sum X.\sum Y}{\sqrt{\left[\left\{n.\sum X^2 - (\sum X)^2\right\}.\left\{n.\sum Y^2 - (\sum Y)^2\right\}\right]}} \quad (1)$$

Where:
r= correlation coefficient between items and total
X = Score of items
Y = Total score
n = number of respondents

The respondents of this study were 30 workers and those who related to the implementation of Sepaku-Petung project in East Kalimantan Province, Indonesia. This sample was selected through *accidental sampling technique*, with the basis that they were accidentally present at the project's location.

Determination of variables and indicators is done in several ways, such as: 1) seeking information by asking/interviewing directly the people relating to the problems in the reviewed project; searching for information from literature/previous researches in accordance with the present research's questions, 2) creating discussion forums with experts in the field of construction management to determine which indicators fit into this research and categorize them into several variables [6].

The data was gathered through collection of questionnaire responses, interviews, and discussion forum with experts in the field. With the questionnaire, the response of each respondent was collected and analysed. The statistical tests used to analyse and interpret the result of data gathering were F-test (simultaneous hypothesis testing), t-test (partial hypothesis testing), and factor analysis. F test and t-test used 5% significance level. To test the precision of factor's model, the statistical test used was Bartlett's Test Sphericity and Kiser-Mayer-Olkin (KMO), where:
KMO value 0.9 = very good
KMO value 0.8 = good
KMO value 0.7 = moderate
KMO value 0.6 = adequate
KMO value 0.5 = inadequate
KMO value < 0.5 = rejected.

RESULTS AND DISCUSSION

Simultaneous Hypothesis Testing (F-Test)

To know the significant influence of independent variables simultaneously on a dependent variable, F test is used, [7]. The results of simultaneous hypothesis testing using IBM SPSS Statistics 20 can be seen in Table 1.

Table 1. Simultaneous Hypothesis Testing

	Model	Sum of Squares	Df	Mean Square	F0113031	Sig.
	Regression	81.776	4	20.444	17.813	.000b
1	Residual	33.283	29	1.148		
	TOTAL	115.059	33			

Based on the output, it can be known that the F-count value is 17.813. The F-table value at the 5% level and degree of freedom (df) is k = 2-1 and the degrees of free denominator (df2) of n - k (34 - 1 = 33) is 4.14. If these two values are compared, then the value of F-count is higher than F-table (17.813> 4.14), so Ho is rejected. Hence, it can be concluded that simultaneously the four independent variables (suppliers, contractors, field conditions, and unexpected conditions) have a very significant influence on the dependent variable (waiting time retardation).

Partial Hypothesis Testing

To know the variables that have significant partial influence, the regression coefficient test is done by using t test statistics [8]. Determination of test result (acceptance/rejection of H0) can be done by comparing t-count with t-table or it also can be seen from its significance value, [9]. The result of partial hypothesis testing using IBM SPSS Statistics 20 can be seen in Table 2.

Table 2. Partial Hypothesis Testing

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	3.074	1.536		2.002	.055		
X1	.234	.096	.470	2.428	.022	.266	3.762
X2	.131	.040	.442	3.299	.003	.555	1.802
X3	.444	.194	.451	2.290	.030	.257	3.893
X4	.115	.054	.403	2.125	.042	.278	3.602

a. Dependent Variable: Y

Based on the output, the values of t-table obtained by each variable can be known. To make a conclusion whether it accepts or rejects Ho, it must first specify the t-table values that will be used. This value depends on the degree of free of charge (df) and the level of significance used. Using a significance level of 5% and a df value of n - k - 1 (34 - 6 - 1 = 29) obtained a t-table value as much 1.699. The test results of the influence of each independent variable (X1, X2, X3, X4) to the dependent variable (Y) are as follows:

a. Influence of Supplier (X1) on Waiting Time Retardation (Y)

Based on the output, it can be known that the t-count value is 2.428. If it is compared to the t-table value which is as much 1.699, then the t-count obtained is much higher than the value of t-table. So, Ho is rejected. Therefore, it can be concluded that the supplier variable significantly influences the retardation of waiting time. It can also be seen from the significance value of X1 smaller than 0.05 which is 0.022 <0.05.

b. Influence of Contractor (X2) on Waiting Time Retardation (Y)

Based on the output, the value of t-count is known as much 3.299. If it is compared to the t-table value which is as much 1.699, then the t-count obtained is much higher than the t-table value. So, Ho is rejected. Thus, it can be concluded that contractor variable significantly influences the retardation of waiting time. It can also be seen from the significance value of X2 smaller than 0.05 which is 0.003 <0.05.

c. Influence of Field Condition (X3) on Waiting Time Retardation (Y)

Based on the output, it can be known that the value of t-count is 2.290. If it is compared to the t-table value which is as much 1.699, then the t-count obtained is much higher than the t-table value. So, Ho is rejected. Hence, it can be concluded that the field condition variable significantly influences the retardation of waiting time. It can also be seen from the significance value of X3 smaller than 0.05 which is 0.030 <0.05.

d. Influence of Unpredictable Condition (X4) on Waiting Time Retardation (Y)

Based on the output, the t-count value is as much 2.125. If it is compared to the t-table value which is 1.699, then the t-count obtained is much higher than the t-table value. So, Ho is rejected. Thus, it can be concluded that the unexpected conditions variable significantly influence the retardation of waiting time. It can also be seen from the significance value of X4 smaller than 0.05 which is 0.045 <0.05.

Analysis of Supplier Variable Factor on Variable of Waiting Time Retardation

To know the influence of each factor, then factor analysis test is conducted. Determination of test results can be done by looking at the value of KMO and *Bartlett*'s test and by seeing the value of Communalities. The result of factor testing using IBM SPSS Statistics 20 can be seen in Table 3.

Table 3. Table of KMO and *Bartlett*'s Test Result

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.803**
Bartlett's Test of Sphericity	Approx. Chi-Square	65.837
	Df	6
	Sig.	.000

Based on the output, it can be seen that the value of KMO is 0.803 with a significance of 0.00. Since the value of significance is far below 0.05, then the existing variables and samples are quite able to be further analyzed. Each of these factors can be grouped into risk categories. Risk Categorization is a way to define risk categories into groups based on the level of risk. Factors that exist in supplier variables can be grouped into risk categories based on Extraction values on Communalities as in Table 4.

Table 4. Table of Each Factor Influence

	Initial	**Extraction**	**Percentage**	**Category**
Material Stock	1.000	.763	76,3%	ResikoTinggi
Type of Conveyance	1.000	.730	73%	ResikoTinggi
Availability of Conveyance	1.000	.726	72,6%	ResikoTinggi
Production Process Equipment	1.000	.726	72,6%	ResikoTinggi

Extraction Method: Principal Component Analysis.

Communalities are the values that indicate the contribution of these variables to the factors formed. The percentage orders of each factors starting from the highest are as follows:

1. Factor of stock material has value of extraction equal to 0,763, this means that 76,3% of stock material factor variance can be explained by factors formed.
2. Factor of supplier and conveyance type have an extraction value of 0.730, this means that 73% of conveyance type factor variance can be explained by the factors formed.
3. Factor of conveyance availability has an extraction value of 0.726, this means that 72.6% of the conveyance availability factor variance can be explained by the factors that formed.
4. Factor of production process equipment has value of extraction equal to 0,726, this means that 72,6% of production process equipment factor variance can be explained by factors formed.

From those factors' values, they will be eliminated based on the values from *eigen*velues. The results of *eigen* values can be seen from Table 5.

Table 5. Table of *Eigen* Values Results

Compo-nent	**Initial *Eigen*values**			**Extraction Sums of Squared Loadings**		
	TOTAL	**% Of Variance**	**Cumulative %**	**Total**	**% Of Variance**	**Cumulative %**
1	2.945	73.620	73.620	2.945	73.620	73.620
2	.445	11.118	84.739			
3	.359	8.977	93.716			
4	.251	6.284	100.000			

Based on the result of *eigen* values, it can be seen that the remaining factor with the value of *eigen* values below 1 consists of 3 remaining factors in the order according to Table 6.

Table 6. Component Matrix

	Component 1
Material Stock	.873
Type of Conveyance	.855
Availability of Conveyance	.852
Production Process Equipment	.852

Analysis of Contractor Variable Factors on Waiting Time Retardation Variable

To know the influence of each factor, then factor analysis test is used. Determination of test results can be done by looking at the value of KMO and *Bartlett*'s test and by seeing the value of Communalities. The results of factor testing using IBM SPSS Statistics 20 can be seen in Table 7.

Table 7. Table of KMO and *Bartlett*'s Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.803**
Bartlett's Test of Sphericity	Approx. Chi-Square	65.837
	Df	6
	Sig.	.000

Based on the output, it can be known that the value of KMO is 0.803 with a significance of 0.00. Since the value of significance is far below 0.05, then the existing variables and samples are quite able to be further analyzed. Each of these factors can be grouped into risk categories. Risk Categorization is a way to define risk categories into groups based on the level of risk. Factors that exist in supplier variables can be grouped into risk categories based on Extraction values on Communalities as in Table 8.

Table 8. The Influence of Each Factor

Communalities

	Initial	Extraction	Percentage	Category
Payment Smoothness	1.000	.804	80.4%	High risk
Contractor and Supplier Relations	1.000	.796	79.6%	High risk
Material Type	1.000	.796	79.6%	High risk
Staff Quality	1.000	.716	71.6%	High risk
Material Procurement System	1.000	.669	66.9%	Medium Risk
Material Procurement Schedule	1.000	.653	65.3%	Medium Risk
Number of Staff	1.000	.649	64.9%	Medium Risk
Material specification	1.000	.637	63.7%	Medium Risk
Space Availability	1.000	.633	63.3%	Medium Risk
Coordination	1.000	.619	61.9%	Medium Risk
Number of Materials	1.000	.599	59.9%	Medium Risk

Extraction Method: Principal Component Analysis.

Communalities are the values that indicate the contribution of these variables to the factors formed. The percentage orders of each factors starting from the highest are as follows:

1. Factor of payment smoothness has an extraction value of 0.804, this means that 80.4% of the payment smoothness factor variance can be explained by the factors formed.
2. Factor of contractor and supplier relations has an extraction value of 0.796, this means that 79.6% of contractors and suppliers relations factor variance can be explained by the factors formed.
3. Factor of material type has an extraction value of 0.796, this means that 79.6% of the material type factor variance can be explained by the factors formed.
4. Factor of staff quality has an extraction value of 0.716, this means that 71.6% of the staff quality factor variance can be explained by the factors formed.
5. Factor of material procurement system has an extraction value of 0.669, this means that 66.9% of the material procurement system factor variance can be explained by the factors formed.
6. Factor of material procurement schedule has the value of extraction of 0.653, this means that 65.3% of the material procurement schedule factor variance can be explained by the factors formed.
7. Factor of the number of staff has an extraction value of 0.649, this means that 64.9% of the number of staff factor variance can be explained by the factors formed.
8. Factor of material specification has an extraction value of 0.637, this means that 63.7% of the material specification factor variance can be explained by the factors formed.
9. Factor of space availability has an extraction value of 0.633, this means that 63.3% of the space availability factor variance can be explained by the factors formed.
10. Factor of coordination has an extraction value of 0.619, this means that 61.9% of the coordination factor variance can be explained by the factors formed.
11. Factor of the number of material has extraction value of 0,599, this means that 59,9% of the number of material factor variance can be explained by the factors formed.

From the factors' values above, they will be eliminated based on the value of *eigen* values. The result of *eigen* values can be seen from Table 9.

Table 9. Result of *Eigen* Values

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.609	41.900	41.900	4.609	41.900	41.900
2	1.906	17.329	59.229	1.906	17.329	59.229
3	1.054	9.585	68.814	1.054	9.585	68.814
4	.905	8.225	77.039			
5	.716	6.505	83.544			
6	.646	5.875	89.419			
7	.509	4.630	94.049			
8	.355	3.229	97.278			
9	.162	1.470	98.748			
10	.138	1.252	100.000			
11	-2.699E-017	-2.454E-016	100.000			

After extraction, it appears in the table above that there are three factors whose *eigen* values are above 1, then component number 1, 2, and 3 are declared invalid. Therefore, it must be re-tested by eliminating the three factors until forming one factor which has *eigen* values above 1. From variable X2, three repetitions are done to obtain data with the result of one factor having *eigen* value above 1. Shown in Table 10, 11, 12 are the order of *eigen* values retest results.

Table 10. The First X2 *Eigen* Values Re-Test Results

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.174	39.681	39.681	3.174	39.681	39.681
2	1.493	18.660	58.341	1.493	18.660	58.341
3	1.034	12.922	71.263	1.034	12.922	71.263
4	.692	8.647	79.910			
5	.637	7.960	87.871			
6	.479	5.986	93.857			
7	.317	3.965	97.822			
8	.174	2.178	100.000			

Table 11. The Second X2 *Eigen* Values Re-Test Results

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.493	49.854	49.854	2.493	49.854	49.854
2	1.123	22.455	72.309	1.123	22.455	72.309
3	.627	12.543	84.852			
4	.450	9.010	93.861			
5	.307	6.139	100.000			

Table 12. The Third X2 *Eigen* Values Re-Test Results

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.455	48.486	48.486	1.455	48.486	48.486
2	.933	31.097	79.583			
3	.613	20.417	100.000			

Based on the result of *eigen* values, it can be seen that the remaining factors with the value of *eigen* values below 1 are two remaining factors in the order according to the component matrix Table 13 as follows.

Table 13. Component Matrix Table

	Component 1
Procurement of materials set by the project owner	.815
Relationships between contractors and suppliers	.738
Material Procurement System	.497

Analysis of Field Condition Variable Factor on Waiting Time Retardation Variable

To comprehend the influence of each factor, then factor analysis test is employed. Determination of test results can be done by looking at the value of KMO and *Bartlett*'s test and see the value of Communalities. The results of factor testing using IBM SPSS Statistics 20 can be seen in Table 14.

Table 14. Results of KMO and *Bartlett*'s Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.357
Bartlett's Test of Sphericity	Approx. Chi-Square	16.460
	df	3
	Sig.	.001

Based on the output, it can be known that the value of KMO is 0.357 with a significance of 0.01. Since the value of significance is far below 0.05, then the existing variables and samples are quite able to be further analysed. Each of these factors can be grouped into risk categories. Risk Categorization is a way to define risk categories into groups based on the level of risk. Factors that exist in supplier variables can be grouped into risk categories based on Extraction values on Communalities as in Table 15.

Table 14. The Influence of Each Factor

Communalities

	Initial	Extraction	Prosentase	Kategori
Distance Location	1.000	.940	94%	High Risk
Access to Project	1.000	.864	86,4%	High Risk
Topographic Conditions	1.000	.855	85,5%	High Risk

Extraction Method: Principal Component Analysis.

Communalities are the values that indicate the contribution of these variables to the factors formed. The percentage orders of each factors starting from the highest are as follows:

1. Factor of the location distance has an extraction value of 0.94, this means that 94% of the location distance factor variance can be explained by the factors formed.
2. Factor of the access to the project has an extraction value of 0.864, this means that 86.4% of the access to the project factor variance can be explained by the factors formed.
3. Factor of topographic conditions has an extraction value of 0.855, this means that 85.5% of the topographic condition factor variance can be explained by the factors formed.

From the factors' values above, elimination will be done based on the values of *eigen*velues. The result of *eigen*values can be seen from Table 16.

Table 16. Results of *Eigen* Values

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.524	50.803	50.803	1.524	50.803	50.803
2	1.135	37.834	88.637	1.135	37.834	88.637
3	.341	11.363	100.000			

Based on the result of *eigen* values, it can be seen that the remaining factor with the value of *eigen* values below 1 is one remaining factor in sequence according to the component matrix Table 17 as follows.

Table 17. Component Matrix

	Component 1
Distance of Location	.962
Access to Project	.893
Topographic Conditions	.843

Analysis of Unpredictable Condition Variable on Waiting Time Retardation Variable

To know the influence of each factor, then factor analysis test is done. Determination of test results can be done by looking at the value of KMO and *Bartlett*'s test and see the value of Communalities. The results of factor testing using IBM SPSS Statistics 20 can be seen in Table 18.

Table 18.Results of KMO and *Bartlett*'s Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.650
Bartlett's Test of Sphericity	Approx. Chi-Square	155.942
	df	36
	Sig.	.000

Table 19. The Influence of Each Factor

	Initial	Extraction	Percentage	Category
Coinciding with the month of Fasting	1.000	.863	86,3%	High risk
Material Price	1.000	.846	84,6%	High risk
Illegal Charges	1.000	.830	83%	High risk
Demand	1.000	.802	80,2%	High risk
Security	1.000	.784	78,4%	High risk
Bad weather	1.000	.771	77,1%	High risk
Natural disasters	1.000	.647	64,7%	Medium Risk
Material specification	1.000	.606	60,6%	Medium Risk
Fuel price	1.000	.584	58,4%	Medium Risk

Extraction Method: Principal Component Analysis.

Based on the shown output, it can be known that the value of KMO is 0.650 with a significance of 0.00. Since the value of significance is far below 0.05, then the existing variables and samples are quite able to be further analyzed. Each of these factors can be grouped into risk categories. Risk Categorization is a way to define risk categories into groups based on the level of risk. Factors that exist in supplier variables can be grouped into risk categories based on Extraction values on Communalities as in Table 19.

Communalities are the values that indicate the contribution of these variables to the factors formed. The percentage orders of each factors starting from the highest are explained as follows:

1. Factor of coinciding with the fasting month has an extraction value of 0.863, this means that 86.3% of coinciding with fasting month factor variance can be explained by the factors formed.
2. Factor of material price has an extraction value of 0.846, this means that 84.6% of the material price factor variance can be explained by the factors formed.
3. Factor of illegal charges has an extraction value of 0.830, this means that 83% of the illegal charges factor variance can be explained by the factors formed.
4. Factor of demand has an extraction value of 0.802, this means that 80.2% of the demand factor variance can be explained by the factors formed.
5. Factor of Security has an extraction value of 0.784, this means that 78.4% of the security factor variance can be explained by the factors formed.
6. Factor of bad weather has an extraction value of 0.771, this means that 77.1% of bad weather factor variance can be explained by the factors formed.
7. Factor of natural disaster has an extraction value of 0.647, this means that 64.7% of natural disaster factor variance can be explained by the factors that formed.
8. Factor of material specification has an extraction value of 0.606, this means that 60.6% of the material specification factor variance can be explained by the factors formed.
9. Factor of fuel price has an extraction value of 0.584, this means that 58.4% of fuel price variance can be explained by the factors formed.

From the factors' values shown above, elimination will be done based on the values of *eigen*velues. The results of *eigen* values can be seen from Table 20.

Table 20. Table of *Eigen* Value Results

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.229	35.877	35.877	3.229	35.877	35.877
2	2.429	26.987	62.864	2.429	26.987	62.864
3	1.077	11.965	74.828	1.077	11.965	74.828
4	.687	7.628	82.457			
5	.608	6.761	89.218			
6	.478	5.309	94.527			
7	.288	3.198	97.725			
8	.128	1.423	99.148			
9	.077	.852	100.000			

After extraction, it appears in the table above that there are three factors whose *eigen*value are above 1, then component number 1, 2, and 3 are declared invalid. Therefore, it must be re-tested by eliminating the three factors until forming one factor which has *eigen* values above 1. From variable X1, two tests are done to obtain data with the result of one factor having *eigen* values above 1. Shown in Table 21and 22 are the order of *eigen* values retest results:

Table 21. The First X4 of *Eigen* Values Re-Test Results

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.244	37.402	37.402	2.244	37.402	37.402
2	1.420	23.674	61.076	1.420	23.674	61.076
3	1.065	17.753	78.829	1.065	17.753	78.829
4	.526	8.763	87.592			
5	.507	8.457	96.049			
6	.237	3.951	100.000			

Table 22. The Second X4 of *Eigen* Values Re-Test Results

Component	Initial *Eigen*values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.343	44.751	44.751	1.343	44.751	44.751
2	.955	31.824	76.575			
3	.703	23.425	100.000			

Based on the result of *eigen* values above, it can be seen that the remaining factors with the value of *eigen* values below 1 are two remaining factors in the order according to the component matrix Table 23.

Table 23. Component Matrix

	Component 1
Illegal Charges	.779
Coinciding with the month of fasting and Eid	.756
Material Price	.405

Discussion

Factors that Affect the Waiting Time Retardation of Construction Materials Procurement on Sepaku-Petung Pavement Improvement Project in East Kalimantan Province

Construction project is a series of activities performed only once and generally in a short duration [1]. Each project requires resources which include workers, money, machines, methods, and materials. One of the resources that must be fulfilled in a project is material because the material is one of the important aspects in the construction project. The material has a large percentage of 50-70% of the total project cost. It shows that construction materials require good management, so that the required materials can be obtained in accordance with the quantity, quality, and timing [1]. Good management can reduce the occurrence of excess material waste, material arrival retardation, late project completion, and swelling of the final project cost.

Material procurement retardation can be caused by several factors, including suppliers, contractors, field conditions, and unexpected conditions. If the material in the supplier is out of stock or the supplier does not have the stock of material ordered, it will certainly affect the retardation of material procurement waiting time in the project. Besides suppliers, the second factor is the contractor. The procurement system of materials used by contractors may also affect the retardation of material procurement waiting time. If the system used by the contractor is inefficient in ordering material goods, then it will hinder the procurement of materials within a project. On the other hand, the third factor is the field condition. It includes the distance from the supplier to the project that is too far and the condition of the road that is passed to deliver the goods from the supplier to the project. If the distance between the supplier and the project is too far and the road condition is not good, then the condition will affect the retardation of material procurement on Sepaku-Petung pavement improvement project in East Kalimantan province. The fourth factor is the unexpected condition. This condition refers to coinciding with the month of fasting. This leads to a condition where labors' working hours in the supplier sector were reduced. Such circumstances will result to retardation in material procurement waiting time on Sepaku-Petung pavement improvement project in East Kalimantan province.

Each of the factors causing retardation in material procurement in these four categories has almost same weight. This almost equal weight means that all factors can have the same impact and it does not close possibility that more than one factor causing retardation in procurement of goods in a single delivery process from the supplier to the project site. Based on simultaneous hypothesis test analysis (F test) from this research, it can be proven that the four factors give influences on the retardation of material procurement on Sepaku-Petung pavement improvement project in East Kalimantan province. This can be seen from the F-count value which is higher than F-table (17.813> 4.14). Besides seeing from the value of F count, it can also be seen from the value significance. From the result of the research, the significance value is <0,05, so that the four variables influence simultaneously to the retardation of material procurement on Sepaku-Petung pavement improvement project in East Kalimantan province. This is in line with Mickson's research which concludes that the retardation of waiting time in a project is caused by several factors.

Dominant Factors that Influence the Waiting Time Retardation of Construction Materials Procurement on Sepaku-Petung Pavement Improvement Project in East Kalimantan Province

The waiting time retardation of construction materials procurement is influenced by several factors. The factors are divided into four variables. These factors have different percentage weights in affecting the retardation of waiting time for the procurement of construction materials. Shown in Table 24 is the percentage of each factor to the retardation of the procurement of construction materials.

Table 24. Component Matrix which Affects the Waiting Time

Variables	Indicators	Component's Value
Supplier	Material Stock	0.873
	Type of Conveyance	0.855
	Availability of Conveyance	0.852
	Production Process Equipment	0.852
Contractor	Material Procurement set by project owner	0.815
	Relation between contractor and supplier	0.738
	Material Procurement System	0.497
Site Condition	Distance of Location	0.962
	Access to Project	0.893
Unexpected Conditions	Illegal Charges	0.779
	Coinciding with the month of fasting and Eid	0.756
	Material price	0.405

By seeing the table, it can be known that there is the most dominant factor in influencing the waiting time retardation of construction materials procurement. The dominant factor is the distance of location because this factor has the highest matrix component value compared to other factors that is worth 0.962. The dominant factor is included into the field condition variable.

Field condition is one of the variables that affect the retardation of material procurement waiting time on Sepaku-Petung pavement improvement project in East Kalimantan province. If the condition of the field is extremely bad, it will hamper the procurement of material goods in a project; but if the field condition is good, then it will accelerate the procurement of the material. The condition of this field has three factors where one of its factors is the dominant factor in influencing the waiting time retardation of material procurement on Sepaku-Petung pavement improvement project in East Kalimantan province. This factor includes the distance between the project site and the supplier. Based on the result of factor analysis, the value of the distance factor between the project site and the supplier has an influence of 0.962 on the waiting time retardation of the construction material procurement on Sepaku-Petung pavement improvement project in East Kalimantan province.

If the distance of the location is too far from the supplier, then the procurement time of the material is also longer due to the travel time passed by transportation. Besides, material delivery also becomes longer. This can be proven from the value of Communalities of the distance between the project site and the supplier factor which is 0.94.

Strategy to Minimize Waiting Time Retardation of Construction Material Procurement of on Sepaku-Petung Pavement Improvement Project in East Kalimantan Province

Project is a set of interconnected activities. There are certain starting points and endpoints and results as well. Project is usually cross-organizational function that requires a variety of skills from various professions and organizations. Each project is unique, and not even two projects are exactly alike. The project is a temporary activity of personnel, materials, and means to make/realize project targets within a certain period of time that eventually ends. If the realization of project targets faces obstacles or there are factors that inhibit or cause waiting time retardation of material procurement, a strategy should be made to minimize the inhibiting factors.

The most dominant factor in this research is the distance of location between supplier and project site. The distance between supplier and project location in this research is as far as 31.2 Km. It can be seen in the Figure 1, 2, and 3.

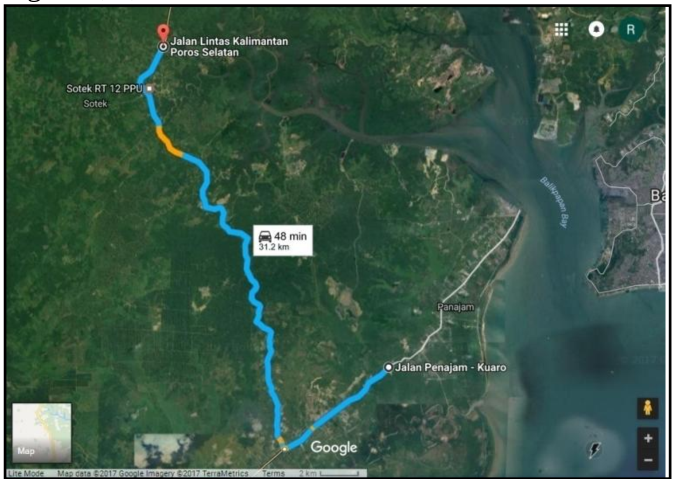

Fig. 1.The Distance between Concrete Suppliers and Project Site

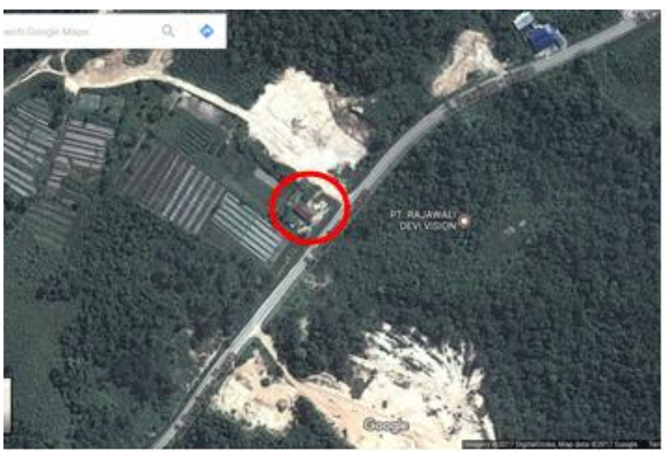

Fig.2.Location of Concrete Supplier

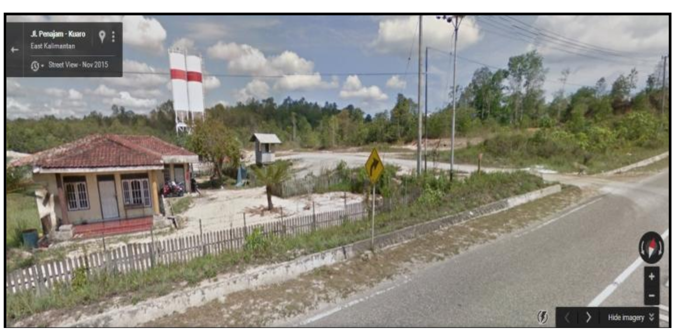

Fig.3.Picture of Concrete Suppliers Location

From the figures shown above, it can be seen that the location of suppliers are on Panajam-Kuaro Street. While the project location is on South-Center Kalimantan Cross Street. The distance between the supplier location and the project site is 31.2 Km. This is the main factor causing material procurement retardation on Sepaku-Petung Pavement Improvement Project in East Kalimantan Province. The project site and the picture of project site can be seen in Figure 4.

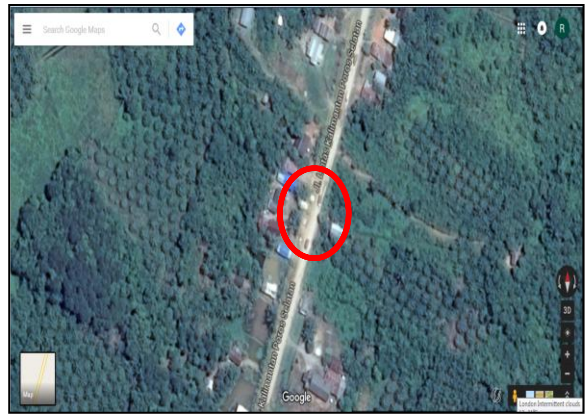

Fig.4.Project Location

Fig.5.Picture of Project Site

One of the strategies to minimize the factors that trigger the retardation in material procurement is by adding more materials to the concrete mix when it is in the ready mix. The additional material used is Type B (Retarding Admixtures) which functions to retard the time binding of concrete (setting time). Because in the case of concrete materials procurement, the distance which is far from the project site can affect the quality of the concrete. This is caused by further distance traveled by ready mix. This makes the concrete take longer time to stir. According to experts in the field of ready mix business, mixer trucks carrying cast concrete or ready mix trucks should not travel more than two hours. Concrete that stirred for too long will experience slumploss (loss of water) and decrease in compressive strength of concrete. The long-stirred concrete feature is that the concrete mixture turns into a clenched and round shape. Therefore, by adding more material type B (Retarding Admixtures), concrete that initially can only last for two hours in ready mix mixture, it can now last up to six hours.

The other strategy is by selecting supplier location which is closer to the project site. Since the distance between the concrete supplier and the project site is very far away, the contractor has to locate the concrete supplier close to the project site, but since there are no concrete suppliers close to the project site, the contractor must create a supplier of its own concrete close to the project site. It is by making a batching plant close to the project site, as well as piling material close to the project site long before the project is operated. Therefore, the waiting time of concrete material procurement that was initially late can be solved. It also can avoid the decrease of the concrete quality.

CONCLUSION

Based on the research results and data analysis conducted, it can be concluded as follows: 1) based on simultaneous hypothesis test analysis (F test), it can be concluded that there are four factors that influence the retardation in procurement of materials on Sepaku-Petung pavement improvement project in the province of East Kalimantan. This can be proven from the F-count value which is higher than F-table (17.813> 4.14). The four factors are the factors of suppliers, contractors, conditions, and unpredictable conditions, 2) the most dominant factor in the operation of Sepaku-Petung pavement improvement project in East Kalimantan province is the field conditions covering the distance between project sites and suppliers, access to project, and extreme topographic conditions. From the three indicators, the distance factor is the most influential. This is clearly seen from the percentage value of factor analysis in which this factor has the highest component matrix value compared to other factors; that is 0.962, 3) the strategy to minimize the factors that trigger the waiting time retardation of material procurement is by adding more material Type B (Retarding Admixtures) which functions to retard the time of concrete binding (setting time). Another strategy is that the contractor has to build his own supplier close to the project site, so that the distance between the concrete supplier location and the project site initially becomes much closer.

As the implication of this study, contractors of construction industries should prepare the inventory management long before the road improvement project starts. Therefore, retardations due to delays of material arrival can be avoided. The limitations of this study were inability to collect all the data from the entire projects in Sepaku-Petung area, as the sample used was only 30 respondents. Project cost surge due to material delays also still not revealed in this research. Therefore, future studies are suggested to collect the data with larger sample size and broader research area in Sepaku-Petung, Kalimantan Province. Future studies can also analyse the surge of project cost as the effect of material delays and project retardation.

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