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Cost Risk Analysis of High-Rise Building Construction Project in DKI Jakarta

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ABSTRACT: Construction industry is one of the developing sectors of today. It is where the more careful planning is needed, especially in terms of risk planning that the management of construction business is thoroughly able to compete in this era of globalization. Risk is the aspect that should be considered in the construction project planning. Many factors of uncertainty in construction projects, making risk analysis desperately need to be considered in project planning. 1st research problem will identify and classify factors and variables on preliminary cost with high risk level. 2nd research problem will discover the result of risk analysis based on previous problem. Preliminary cost will be analyzed in considering the uncertainty factors. The research instruments used include 5 factors, 35 independent variables and 1 dependent variable in connection with the level of risk to project cost performance. Risk identification and risk classification on 1st research problem determined by using qualitative analysis on literature review. Risk analysis on 2nd research problem used quantitative method with statistical analysis with the help of SPSS program (Statistical Package for the Social Sciences) version 23. The research object studied is limited to preliminary cost which has high risk to the change of cost performance in high-rise building project in DKI Jakarta. The data will be analyzed by correlation, linear regression method, model test and R^2 test as statistical analysis. The results of statistical analysis will be continued with Monte Carlo simulations and conditional variance based analysis to determine the contingency costs that can be considered by observing the variables of risk that may occur. The purpose of this study is to analyze the variables in preliminary costs that have risks of cost increases in high-rise building projects in DKI Jakarta. The variable of risk cost is expected to be consideration for contractor in organizing project cost planning in the future. Based on risk identification and risk classification results, 35 variables and 5 factors of preliminary cost have been determined. Based on risk analysis results, 85.2 % of cost performance can be explained by 4 main variables such as site management cost, main contractor's site office cost, additional structure cost and protection of works and project area cost. Due to Monte Carlo simulation and conditional variance based analysis method, the highest contingency allocation for site management cost is 38.976 % from total contingency and the lowest contingency allocation for additional structure cost is 0.394 % from total contingency.

KEYWORDS: High-Rise Building, Risk Analysis, Project Cost Management, Preliminary Cost, Contingency Cost

I. INTRODUCTION

The construction industry at the present time has become one of the most developed industries better in all aspects. The effort of the Government of the Republic of Indonesia to develop the economy by building infrastructure becomes one of the preferred work programs. This causes the growth sector of the construction industry to increase significantly and will sustain development in Indonesia at this time. Therefore the construction industry in Indonesia should be seen as one of the growing sectors for the better. A healthy and efficient industrial sector shall have a two-way effect of supporting the competitiveness of other industries and also improving the competitiveness of the construction industry itself. As a matter of fact, the construction sector takes the third position as a driver of economic growth in Indonesia throughout 2016, with a contribution of 0.51 percent according to Kompas News [8]. Service business competition / construction industry in the era of globalization will be very tight, where foreign contractors present and compete in Indonesia. Competition in all aspects that becomes the characteristic of globalization era will be getting stronger. The

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Vol. 7, Issue 6, June 2018

participation of the construction industry in Indonesia in this globalization must be addressed properly that positive opportunities can be developed while the negative effects can be minimized so that the local construction industry is not less competitive according to Asiyanto [1]. The involvement and participation of Indonesia in free trade and globalization is an unavoidable necessity. However, this can be addressed properly and planned that the construction industry in Indonesia is able to take advantage of all positive aspects and opportunities exist and minimize the harm to the national construction sector in Indonesia. This is where more careful planning is needed, especially in terms of risk planning in order that the management of construction business is thoroughly able to compete in this era of globalization.

According to Wibowo [14], the fact that construction cost can rise higher than the estimated ones is always happen on construction projects. This research will present an approach method for analyzing risks on construction costs that may arise in project execution. There is an understanding of the most critical risks to influence consideration in decision-making in construction projects. This analysis shall be a consideration for predicting the various possible uncertainties that are used as risk analysis methods in construction projects. The analysis to be used in this research is qualitative analysis (literature review), statistical analysis and contingency analysis with Monte Carlo simulation and conditional variance based analysis.

Research Problem

1. Identify and classify factors and variables on preliminary cost with high risk level on high-rise building construction in DKI Jakarta (1st research problem)
2. Discover result of risk analysis on preliminary cost management on high-rise building construction in DKI Jakarta (2nd research problem)

II. LITERATURE REVIEW

Risks Management

Uncertainty events that have negative impact on project can be determined as a risk according to Kountur [9]. Risks have many types of approach and definition based on different point of stakeholder's view by Baloi and Price [3]. Project risk management is a process for implementing risk management planning, identification, analysis, response planning and supervision and risk control of a project according to Project Management Institute [11]. The following is a general framework of how to conduct risk management in a construction project in Figure 1 according to Flanagan and Norman [5]:

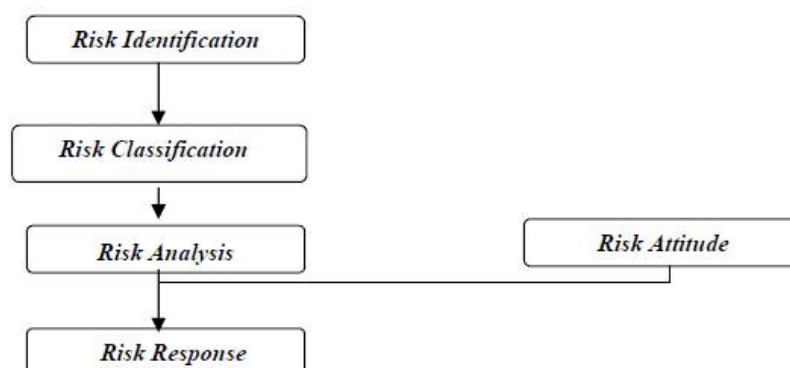


Figure.1 Risk Management Process (Flanagan and Norman, 1993)

This study will use Flanagan and Norman risk management systems as the research reference. The focus of this research is on the phase of risk identification, risk classification and risk analysis.

Project Cost Management

More complex and larger high-rise building construction will need planning on cost management precisely according to Hoai [6]. Project Cost Management is a method that uses technology to measure cost and productivity throughout the

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Visit: www.ijirset.com

Vol. 7, Issue 6, June 2018

project life cycle. Cost is all the resources shall be sacrificed to achieve the goal according to Schawalbe [13]. This will be supported where project cost management is included to ensure that the project is able to be completed as per the agreed plan. According to the Project Management Institute [11], project cost management includes several phases; including cost estimating, cost budgeting and cost control. This phase is described in Figure 2.

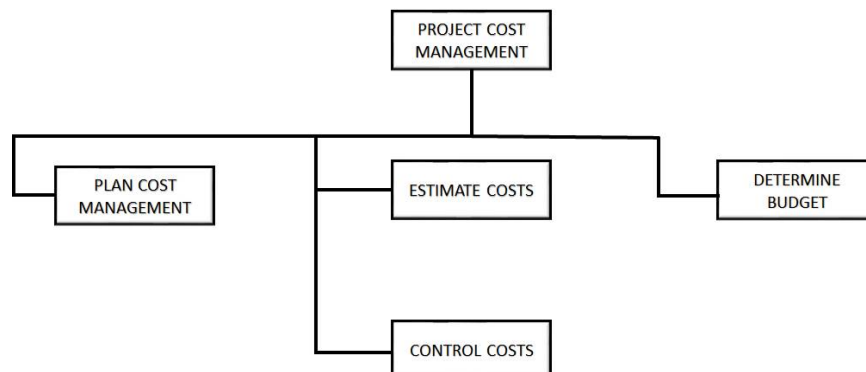


Figure. 2 Project Cost Management Hierarchy (PMBOK, 2017)

Cost estimating involve a forecast development, and required and planned resources to complete a project. Cost engineer who will set the cost estimates with precision and precisely in accordance with the planned budget specifications. Cost estimating is one of the main outcomes in project cost management. The phase of project cost management that is the focus of this research is at the cost estimating phase.

Project Management Body of Knowledge - PMBOK (2017) outlines key aspects of project cost management. Project cost management focuses on managing the resource costs required to complete the entire project. Project cost management needs to be considered as an impact on overall project planning whether it is in the construction phase up to the operation and maintenance phase. For example, when the number of review designs is limited to project planning, it may indeed reduce the construction cost of the project. But this may increase the operating costs of the planned building. So it is expected that project cost management, not only focusing on the construction phase, but also throughout the entire project life cycle. This research will be focused on project cost management, due the fact that cost is one of the main objective of successful projects according to Baccarini [2]. The focus process on project cost management hierarchy on this research is on cost estimating process.

High-rise Building Construction Project in DKI Jakarta

According to the Provincial Regulation of DKI Jakarta No.7 year 2010 on Building [12], the building is defined as a physical form of construction work which is integrated with its place of position, partly or entirely above and inside the ground or water, which functions as a place for human to do their activities, whether it is for shelter or residence, religious activities, business activities, social and cultural activities, and many more. The high-rise building itself is a building which has a height of more than 8 layers. Meanwhile, according to Law No.28 year 2002 on Building [10], defines the organization of buildings is a building activity that includes the process of technical planning and construction execution, as well as activities of utilization, preservation and demolition.

The classification of buildings based on height is explained in Provincial Decree of DKI Jakarta No.7 year 2010 [12] on Building Article; they are:

- a. High-rise building
The definition of high-rise buildings is a building that has more than 8 (eight) storeys of building.
- b. Medium-rise building
The meaning of a medium-rise building is a building that has a number of 5 (five) up to 8 (eight) storeys of building
- c. Low-rise buildings

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Vol. 7, Issue 6, June 2018

The meaning of low-rise building is a building that has a number of up to 4 (four) storey of building. The object of the construction project which becomes the study of research is a high-rise building with height is above 8 storeys. DKI Jakarta became the object area of this research.

This research will focus on high-rise building projects which have at least 8 level floor of building.

III. RESEARCH METHODOLOGY

Research Process

Research is a critical investigation in searching for facts to find out and obtain things in a particular purpose. Many of the problems in this world may be solved because of innovative discoveries of researchers in accordance with various fields of science. This research starts from an interesting phenomenon to find out how risk analysis can be implemented in project cost planning of high-rise building in DKI Jakarta. After the research problem is done, the early stage is conducted, where the instrument to achieve the purpose of research in the end is planned. Research methods should be taken in accordance with the research problem.

After that, the literature review obtained on the basis of literature is done; such as books and journals that support the available facts and data. The journals used are prioritized over the last 10 years whether they are local journals or international journals. The literature review will help in determining the exact type of method that can be used in research. The literature review is also helpful in the process of analyzing research results. Furthermore, in the analysis phase, an analysis will be used in accordance with the analysis method of data collection which is questionnaire data collection method as the primary data. At the end, this result of research will determine and solve 2 main research problem those have been said.

Qualitative analysis with literature review used to solve 1st research problem. Identification and classification will determine factors and variables on preliminary cost with high-risk level. Furthermore, 2nd research problem is about how to discover risk analysis on this research. Statistical analysis used to analyze the result of questionnaire. Monte Carlo simulation and conditional variance based analysis method will continue the result of statistical analysis to determine the budget of contingency cost on each preliminary item.

Method of 1st research problem

Literature review

Identification and classification will be the first step on risk management process based on Flanagan and Norman's type of risk management. Qualitative method used to identify and classify with objectives such as:

1. To determine preliminary cost with high risk level from books, researchs, and papers previously
2. To analyze facts, datas, and tendency of risk management on preliminary cost that happen in DKI Jakarta
3. To establish factors and variables of preliminary cost to answer the next research problem

Method of 2nd research problem

Research Respondend

Research respondents are persons or parties who are required to provide explanation/ information about a fact or opinion. In this study the respondents were selected to assist in answering the questions of the research questionnaire. Respondents in this study are the parties who are considered competent by the writer in answering research variables in the questionnaire. The selection of respondents is limited by several conditions, such as the minimum number of respondents targeted is 35 respondents. Respondents are also parties as contractors involved in the work of high-rise building construction project in DKI Jakarta. Respondents who were selected to answer the questionnaire were limited by several criteria; they are, working in a high-rise building construction contractor company in DKI Jakarta, having a minimum education level of bachelor degree, and having minimum occupancy in working on high-rise building project for 2 years.

Research Instruments

This research will use secondary data and primary data. The existing secondary data is the preliminary cost of the high-rise building project in DKI Jakarta. While it is continued with the primary data used in the form of the results of expert

International Journal of Innovative Research in Science, Engineering and Technology

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Visit: www.ijirset.com

Vol. 7, Issue 6, June 2018

validation and questionnaires obtained from respondent. In order to answer the research objectives is to determine preliminary costs that have a high risk. To obtain a preliminary hypothesis of costs that have high potential risk obtained from literature studies and expert validation to ensure the preparation of variables to be used in the study. This process will get a description of the variables that are suspected to have a high potential risk impact. Data on costs obtained and validation of experts, will be followed by the preparation of research factors, independent variables and dependent variables that will be distributed to the respondents

Statistical Analysis and Contingency Analysis

The first research problem is to find out what factors and variables related to high risk cost in high-rise building project in DKI Jakarta. The method of solving the 1st problem is a method with primer data collection started and expert interviews, questionnaire distribution for respondents and result analysis in the form of tests to be able to prove and answer the problems. After all questionnaire results data are collected, the data will be further processed in statistic. The questionnaire analysis in this study will be assisted by SPSS (Statistical Package for the Social Sciences). Futhermore, contingency analysis used Monte Carlo simulation and conditional variance based analysis method. Monte Carlo simulation can be defined as statistical sampling method to solve quantitative problems on risk aspect according to Holton [7]. Due the fact that lot of attention to estimate the cost based on probabilistic method according to Diekmann [4], these methods will determine contingency cost precisely based on each preliminary item at the end of this research.

IV. ANALYSIS AND RESULTS

Analysis on 1st Research Problem

Based on the result of literature review on qualitative analysis about preliminary cost with high risk level, 35 variables of preliminary item have been determined. Those variables have been identified and classified to 5 main factors. The result of identification and classification on preliminary cost described on Table 1. Those variables will be used for statistical analysis to solve next research problem.

Table.1 Factors and Preliminary Cost Variables

Factors	Preliminary Cost Variables
General Condition	Insurance of the works, project meeting, contractor's equipment, workmen living place, project security and permissions, site management, settlement monitoring and soil investigation, sample and prototypes, testing of materials, identification badges for staffs and workers, checking verticality of the works
Temporary Facilities	Temporary building such as sub-contractor's office, warehouse, barrack and other supporting building, telephones, main contractor's site office, water, lighting and power, general scaffolding and staging
Document - Administration	Shop drawings, as-built drawing, contract document such as form of tender, letter of agreement, terms of contract, contract drawing, material listing, bill of quantities, letter of assignment and other document
Environmental Condition	Noise control, temporary diversion of traffic, pest control, temporary drainage, removal of rubbish, cleaning up and maintenance on project area
Protection	Personal protective equipment for staffs, workers and visitors, additional structure for method of works and protection of public and private service-property, lightning protection, fire protection, protection of works and project area

Analysis on 2nd Research Problem

Based on the results of the correlation test results, it is obtained some independent variables that have a sufficient correlation with the dependent variable Y (risk analysis on cost performance), which are X6 (Increase in the the cost of

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 6, June 2018

site management), X14 (Increase in the cost of manufacture and the need of contractors' site office, including all kinds of accommodation and sanitation facilities during project execution), X22 (Increase in the cost of road and temporary road diversion under conditions which are required during construction), X23 (Increase in pest control costs such as rat, mosquitoes, and so on which may disturb human health during the work period. Disinfectant shall recommended as safe by the relevant agencies), X25 (Increase in waste cleaning costs and maintenance of the project area should be carried out periodically to facilitate access to roads when inspection is performed, facilitate access of workers in the construction process and create clean, neat project areas regularly), X27 (Increase in additional structural costs for implementation and environmental protection), X28 (Increase in protection cost / protection methods from electricity to keep project location safe from danger of short-circuit), X29 (Increase of protection cost / fire protection method to keep location of the projects are safe from fire hazards) and X30 (Increase in protection cost during construction and protection of project area in accordance with local regulatory safety standard and contractor standard respectively).

Multiple linear regressions

Based on the results of statistical analysis with the assistance of SPSS, the regression equation constant value is 0.325, coefficient of variable X6 is 0.202, coefficient of variable X14 is 0.350, coefficient of variable X30 is 0.279 and coefficient of variable X27 is 0.267. From the values of the variable coefficient above, it can be obtained the regression equation as follows:

$$Y = 0.325 + 0.202 X6 + 0.350X14 + 0.279 X30 + 0.267 X27$$

The expression of the equation is Y as the cost performance due to the risk analysis of high rise building in DKI Jakarta, X6 is the increase of the cost of site management purposes, X14 is the increase of manufacture cost and the need of the contractor's site office, X30 is the increase of protection cost of construction work and the protection of the project area, and X27 is an increase in the cost of additional structures and environmental protection.

Hypothesis testing

The hypothesis of this study is:

Ho = preliminary cost variable does not significantly have a risk to the cost performance

Ha = preliminary cost variables significantly have a risk to the cost performance

Based on the hypothesis, it will be followed by the analysis of models t, F and D

t Test

Based on t test result, it is obtained a value from result of analysis with help of SPSS program seen in Table 2. The value of t obtained by t table = 2.0595. By observing at the result of t each variable, accordingly it has a conclusion that Ho is rejected, and Ha is accepted. The conclusion that can be drawn is that preliminary cost variables are significantly has a risk to the cost performance. The results of t test analysis with the help of SPSS program can be seen in Table.2.

Table.2 Result of t Test
Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.759	.311		8.876	.000		
	X6	.382	.074	.671	5.199	.000	1.000	1.000
2	(Constant)	1.746	.361		4.834	.000		
	X6	.311	.063	.546	4.903	.000	.922	1.085
	X14	.318	.079	.446	4.003	.000	.922	1.085
3	(Constant)	1.035	.314		3.292	.002		
	X6	.211	.053	.370	3.975	.000	.780	1.283
	X14	.371	.062	.521	5.987	.000	.892	1.121
	X30	.334	.069	.431	4.815	.000	.843	1.187
4	(Constant)	.325	.336		.968	.341		
	X6	.202	.045	.355	4.446	.000	.777	1.287
	X14	.350	.053	.491	6.551	.000	.881	1.136
	X30	.279	.061	.360	4.545	.000	.788	1.270
	X27	.267	.076	.261	3.520	.001	.897	1.115

a. Dependent Variable: Y

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 6, June 2018

f test

From result of analysis with F test, it is obtained a result of F count = 7.886 and F table = 2.6 with significant level of 0.000. This shows that when F count > F table, Ho is rejected and Ha is accepted. It can also be seen that the significant level <0.05 which means Ho is rejected and Ha accepted. The results of the F test analysis can be seen in Table 3.

Table.3 Result of F Test

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.550	1	3.550	27.026	.000 ^b
	Residual	4.335	33	.131		
	Total	7.886	34			
2	Regression	4.997	2	2.499	27.678	.000 ^c
	Residual	2.889	32	.090		
	Total	7.886	34			
3	Regression	6.233	3	2.078	38.970	.000 ^d
	Residual	1.653	31	.053		
	Total	7.886	34			
4	Regression	6.716	4	1.679	43.061	.000 ^e
	Residual	1.170	30	.039		
	Total	7.886	34			

Coefficient of Determination test (R2 test)

The result of regression analysis using stepwise method, determination coefficient value from model forming variables selected in the case it is observed from the value of R square is 0.852, which means X6 variable (increase in cost of site management purposes), X14 (increase of manufacture cost and need of contractor' site office) , X30 (increase in protection cost of construction work and protection of project area) and X27 (increase in additional structure cost and environmental protection) simultaneously explain Y (increase in cost performance due to cost risk analysis) equal to 85.2%, while the remaining 14.8% is explained by factors outside the independent variables. SPSS output results of coefficient of determination test can be seen in Table 4.

Tabel.4 Model Summary Result of Regression Analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.671 ^a	.450	.434	.362	
2	.796 ^b	.634	.611	.300	
3	.889 ^c	.790	.770	.231	
4	.923 ^d	.852	.832	.197	1.971

a. Predictors: (Constant), X6

b. Predictors: (Constant), X6, X14

c. Predictors: (Constant), X6, X14, X30

d. Predictors: (Constant), X6, X14, X30, X27

e. Dependent Variable: Y

Monte Carlo Simulation

This research used 22 real data of preliminary cost from 22 different high-rise building projects in DKI Jakarta. From those 22 projects' data, standard deviation is Rp. 69.588.476.184,- with first absolute error is Rp. 2.215.173.432,-. The Monte Carlo simulation in this research required as many as 8,882 iterations to obtain results with a 2% error rate. From the Monte Carlo simulation results based on the overall iteration, the final deviation standard and the actual error can be found. The final standard deviation obtained is Rp. 36,933,490,962, while the actual error in this simulation is Rp. 1,145,162,071. The actual standard deviation represents the uncertainty calculated by Monte Carlo simulation with

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 6, June 2018

a total of 8,882 iterations. It can be seen with the simulation that the actual standard deviation is smaller; the simulation shows the uncertainty in the preliminary cost distribution is considerable.

By observing on the results of the changes from the Monte Carlo simulation, we will be able to generate new simulated data. The data formed in the form of all preliminary costs is 8,882 iterations. The total preliminary cost of the iterative results will be in the form of a normal distribution, since the random number of preliminary costs is also normal with Monte Carlo simulations. The normal distribution diagram of Monte Carlo simulation result is 8,882 iteration. It can be seen in Figure.3

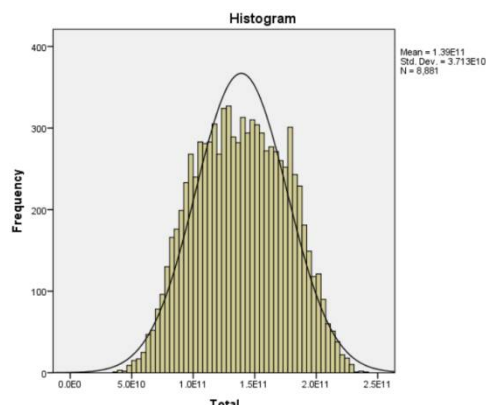


Figure.3 Normal Distribution on Result of Monte Carlo Simulation

Conditional Variance Based Analysis Method

The percentile results for preliminary cost distribution of Monte Carlo simulation results provides information on the amount of cost allocation that can be planned by Conditional Variance Based Analysis (CVBA) method. The value of the total preliminary cost that will be the reference/ base line is the average / mean value of 8,882 iterations that is Rp. 144,969,163,801. This value can also be referred to as the expected value. The expected value becomes the minimum value assumed to be prepared by management without considering the risks. Therefore the level of risk should also be considered in determining the additional cost. The level of risk can be determined based on the percentile level of the normal distribution of preliminary costs. The greater the level of risk planned to be covered, the greater the cost that must be budgeted for it. The results of the descriptive analysis obtained from the previous Monte Carlo simulations can be seen in Table 5.

With the 99th percentile, it shows the level of risk of 1% to be plan. Therefore, the value of contingency cost to cover the risk is Rp. 75,571,576,940 (Rp. 220.541.041.737 – Rp. 144.969.163.801). Meanwhile, with the 90th percentile, it shows the level of risk of 10% to be plan. The value of contingency cost to cover the risk is Rp. 49,314,711,690 (Rp. 194.283.875.490 – Rp. 144.969.163.801). The Contingency cost can be seen by distribution graph in Figure 4. This suggests that the greater the level of risk to be planned and willing to bear, the smaller the contingency costs needed to cover it.

$$\text{Value of contingency cost} = \text{the- percentile Value} - \text{expected Value (mean)}$$

Table.5 Result of Statistic Descriptive Analysis

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 6, June 2018

Statistics		
SUM		
N	Valid	8,882
	Missing	13
Mean		144,969,163,801
Std. Error of Mean		394,629,109
Median		145,188,941,502
Mode		40,473,629,737 ^a
Std. Deviation		37,191,569,108
Skewness		-.0072
Std. Error of Skewness		.0260
Kurtosis		-.7612
Std. Error of Kurtosis		.0520
Range		200,888,932,857
Minimum		40,473,629,737
Maximum		241,362,562,594
Percentiles	85	186,425,306,705
	90	194,283,875,490
	99	220,541,041,737

a. Multiple modes exist. The smallest value is shown.

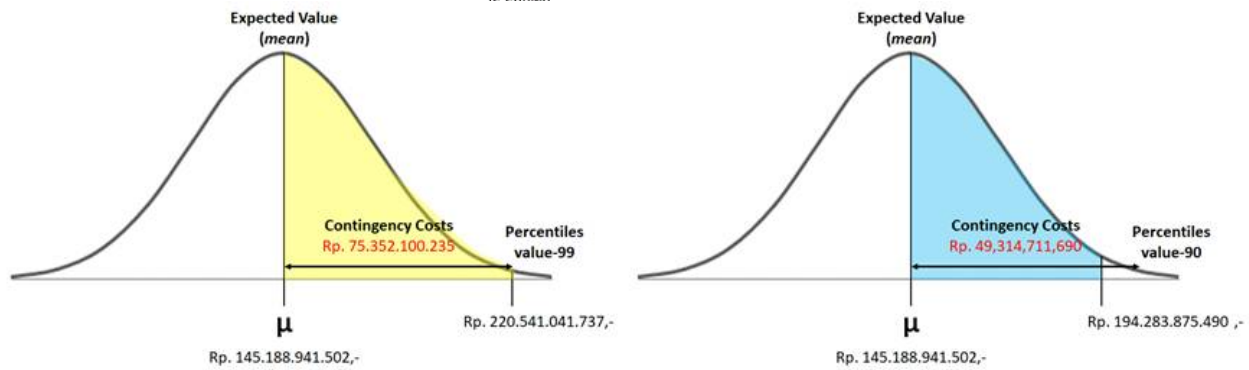


Figure. 4 Contingency Cost Based On Risk Analysis

By knowing the expected level of risk level and the required contingency cost, a graph can be drawn to describe the contingency cost curve in risk planning. At the risk level of 1% that is willing to be borne by the contractor, then the required contingency cost is Rp. 75,352,100,235. Meanwhile, in conditions where the contractor is able to bear 45% of the risk level, the required contingency cost becomes smaller which is Rp. 5,402,487,054. The smaller the level of risk (the possibility of cost exceeding the planning) is borne, the greater the contingency cost budget allocation should be included in the planning. This reason explained by the fact that the amount of contingency costs allocated, an indication of matters that may make the swelling of cost to be no need to worry about. Such contingency costs is able to cover any risks that may occur. The expected risk level relationship and the required contingency costs can be seen in Table 6.

Table.6 Risk Level and Contingency Cost

Risk Level on Planning (%)	Contingency Cost Needed (Rp.)
1	75,352,100,235
5	59,789,973,222
10	49,094,933,988
15	41,236,365,203
20	34,745,167,830
25	28,925,952,801
30	23,107,502,888
35	16,885,051,901
40	11,055,218,700
45	5,402,487,054

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 7, Issue 6, June 2018

Furthermore, for the 4 costs variable obtained from the results of previous statistical tests will be determined what percentage of contingency cost allocation according to each portion. The percentage determination of contingency allocation is obtained from the correlation level of the real cost of each variable to the sum of total cost. Based on the percent of allocations earned, the variables that can be the main consideration because of the effect on risks of cost increases can be a main priority in the addition of contingency costs. The amount of allocation for X6 variable (site management cost) is 38,976%, for X14 variable (contractor's site office construction cost) 3,718%, for X30 (protection cost during construction) is 1,094% and for variable X27 (additional structure cost and environmental protection) is 0.394%. In the following Table 7 is the contingency cost of each cost variable according to the planned risk level.

Tabel.7 Contingency Cost Based on Each Item of Preliminary Cost

Risk Level on Planning (%)	Contingency Cost / Preliminary Item (Rp.)			
	X6 Site Management	X14 Contractor's Site Office	X27 Additional Structure	X30 Protection of works and project area
1	29,369,519,383	2,549,123,824	296,661,812	1,597,450,930
5	23,303,965,941	2,022,664,859	235,393,595	1,267,536,645
10	19,135,427,027	1,660,857,036	193,287,142	1,040,803,743
15	16,072,441,556	1,395,005,589	162,347,895	874,203,502
20	13,542,407,934	1,175,411,632	136,791,999	736,591,289
25	11,274,288,690	978,550,501	113,881,704	613,224,980
30	9,006,467,661	781,715,253	90,974,421	489,874,892
35	6,581,181,646	571,212,852	66,476,582	357,960,054
40	4,308,923,824	373,992,514	43,524,483	234,368,642
45	2,105,693,773	182,763,432	21,269,634	114,531,751

V. CONCLUSION

The conclusions of this reasearch are:

1. Result of 1st research problem determine 35 variables on preliminary cost with high risk level. These variables can become potential risk on high-rise building construction in DKI Jakarta. All of variables have been identified and classified to 5 main factors. Those factors are general condition, temporary facilities, document – administration, enviromental condition and protection. Literature review from book and previous research used to solve this research problem.
2. Result of 2nd research problem can be concluded such as:
 - The results of the analysis indicate the contribution of each preliminary cost variable with high risk to the cost performance; such as X6 variable (increase in cost of field management purposes), X14 (increase in manufacture cost and the need of contractor's site office), X30 (increase in protection cost of construction work and protection of the project area) and X27 (increase in additional structure cost and environmental protection) simultaneously able to explain Y (cost performance increase due to cost risk analysis) of 85.2%. While the remaining 14.8% is explained by factors outside the independent variables that become the object of this research
 - The dominant main factor having an increased risk of cost affecting project cost performance is the general condition factor. The most dominant variable in this factor is the X6 variable (increase in the cost of site management purposes) with the largest R² value of 45%, the value of t is 4.446 and the regression coefficient value is 0.202 with the significant level of 0.000.
 - Based on the results and Monte Carlo simulation and conditional variance based analysis, the contingency allocation for X6 variable (site management cost) is 38.976%, for X14 variable (contractor's site office

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construction cost) is 3.718%, for X30 variable (protection cost during the construction process) is 1.094% and for the X27 variable (additional structure cost and environmental protection) is 0.394%.

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