Risk Evaluation Causes of Contract Change Order to Improve Cost Performance on Railway Construction Project

Ikhsan Setiawan[1] and Leni Sagita Riantini[2]

[1,2]Department of Civil and Environmental Engineering, Faculty of Civil Engineering, University of Indonesia

Email: [1]ikhsansetiawan99@gmail.com

***Abstract* —** In the railway construction project, there are potential risks that cause Contract Change Orders and has an impact on project cost performance. Risk factors can be seen from three aspects that consist of technical, legal, and environmental aspects. Therefore, the purpose of this study is to analyze the factors causing CCO that have an impact on costs, and determine the steps for managing CCO risk. This study uses a questionnaire to the experts which has experience on railway projects. From the research results, 29 risk variables that affect CCO are grouped into technical, legal and environmental aspects. The factors of design changes, changes in the scope of work and acceleration of the implementation schedule are one of the dominant factors causing CCO in this study. Furthermore, the identified risk factors can be used for the next step, which is to respond to the risk as a risk control strategy. This strategy is expected to improve the cost performance of railway projects.

***Keywords* —** Contract Change Order, Railway project, Risk analysis.

I. INTRODUCTION

Construction project is a big, complex, unique, dynamic, and full of risks and uncertainties job so that it cannot be denied during the implementation of construction work there will usually be job changes both big and small jobs (Wena and Suparno, 2015) [1]. In implementing the construction projects, it is often faced with problems; one of them is the occurrence of changes. The changes might happen at the early, middle and final stages of the projects. Hana et al. (2002)[2] defines the changes or change order in the construction projects as an incident resulting in the occurrence of modification in the scope of work, implementation time or cost. It cannot be avoided at most of projects as the result of each project uniqueness and limited time and money in planning process. As the result of unavoidable of Change order, Alaryan et al. (2014)[3] state that Change order is an inseparable part in construction industries.Change order happened in construction projects can give negative impact directly and indirectly for both contractors and owner. Significant and large scale job changes will influence the quality of the projects, such as construction work implementation that is inappropriate or different from contract value and document which has been agreed beforehand between the owner and the contractor (Gumelar, 2014)[4].

The causative factor of Change order can appear from various resources namely owner, consultant, subcontractor, natural factor, social factor, policy, etc. Meanwhile, Jaydeep et al. (2015) [5] state that job changes or Change order on construction cost cause swelling between 10-15% of the contract value. Service users have big roles on job changes since the service users do not give enough time to planning consultant in designing the construction project (Ndihokubwoyo and Haupt, 2009)[6]. Meanwhile according to Ibbs (1997) [7], from his 54 studied projects, Change order of construction projects can result the productivity level goes down.

The obtained data during the railway project building that has been implemented shows that there is a contract change order with the average of 9% from the early contract value. The changes do influence the cost and time performance. On the other hand, the railway construction projects based on the National Railway Master Plan [8] in 2030 is planned that it will be built along 10.524 km railways all over Indonesia. In 2017, it was recorded that the railways that operated were still focused on Java Island and parts of Sumatera with the total length of 5168 km with the status of 2.989 km from the total length were railways that did not operate. Based on the fact of the high number of railway construction projects in Indonesia, if it is not anticipated properly about the negative impact, the change order can become a handicap in the implementation. The implementation of risk management is expected to be able to use as solution in arranging an effective and efficient strategy to manage potential problems causing change order that can influence the cost performance or project budget.

II. METHODOLOGY

The research methods used are literature studies and survey method. Literature studies were carried out to find out risk factor causing contract change order that influence cost performance. Next, survey was carried

out towards risk factor in a questionnaire. The questionnaire in this research is divided into 3 stages namely expert validity on risk variables, pilot survey, and the last one is respondent questionnaire. Respondents' data collection is 33 samples with the criteria of having experience in railway construction projects minimum 3 years and having educational background minimum a Bachelor degree, from some contractors running in railway construction projects. Respondents' data analysis was carried out by validity and reliability test analysis and risk level analysis with qualitative risk analysis. From the data collected, data testing was carried out statistically using the help of application SPSS. Meanwhile, to analyse the risk level, the method of qualitative risk analysis was used with probability and impact matrix, where risk level criteria was determined by multiplying the average probability value with the average impact value.

III. RESULTS AND DISCUSSION

In this research, there are two types of variables, dependent variable (Y) namely project cost performance and independent variable (X) namely risk factor causing change order that is divided into technical, legal, and environmental aspects. Based on the result of expert validity at the early stage, from 34 variables proposed there are 5 variables that have no effect on cost performance so that there are 29 variables that have effect on cost performance in railway construction projects.

After the data of 33 respondents has been obtained, the researcher uses mean for probability and impact. Mean is a technique of group explanation based on the average score of the group (Sugiyono, 2005)[9]. Mean can be formulated as follows:

Mean = $X = \sum xi/n$
Information:
X = average
n = the number of respondents
xi = the total score given by respondents.

After the probability and impact scale value of risk variables towards cost performance of respondents' questionnaire result are known, it is continued with risk analysis using Table of Probability x Impact (PxI) to find out risk category.

Table 1 is the plotting result towards probability and impact matrix of all risk variables in this research. From the plotting result, there are two categories namely high and medium risks. There are 10 risk variables including into high risk as follows:

Table 1. Plotting result towards probability and impact matrix of all risk variables

No	Risk Factor	Avg Probability	Avg Impact	Prob x Impact	Risk Level
X1	Project objectives are not defined properly	2.76	3.39	9.36	Medium
X2	Error and omissions in design	3.70	4.18	15.46	High
X3	Inadequate Drawings & Details	3.79	4.09	15.50	High
X4	Lack of consultant's knowledge of materials and equipment	3.33	3.42	11.41	Medium
X5	Value Engineering	3.42	3.55	12.14	Medium
X6	Lack of contractors involvement in design	2.94	3.24	9.53	Medium
X7	Design complexity	3.70	3.88	14.34	Medium
X8	Inadequate scope of work for contractor	3.15	3.58	11.27	Medium
X9	Mistaking in understanding documents of tender	3.30	3.55	11.71	Medium
X10	Change of scope	4.12	4.30	17.73	High
X11	Accelerated Construction	4.24	4.33	18.38	High
X12	Owner financial problem	3.27	3.42	11.21	Medium
X13	Replacement of material	3.88	4.03	15.63	High
X14	Change in specifications	3.73	4.15	15.47	High
X15	Change in design	4.48	4.52	20.25	High
X16	Non constructability design	3.61	3.88	13.99	Medium
X17	Different Site Conditions	3.91	4.18	16.35	High
X18	Lack of Communication	3.24	3.58	11.59	Medium
X19	Desired Profitability	3.48	3.48	12.14	Medium
X20	Complex Methods or Technology	3.45	3.61	12.46	Medium
X21	There is a utility network	4.15	4.03	16.73	High

X22	Land acquisition problems	4.27	4.18	17.87	High
X23	Disobedience towards K3L regulation	2.97	3.24	9.63	Medium
X24	Words ambiguity in a contract	3.21	3.27	0.00	Medium
X25	Incomplete contract documents	3.27	3.39	10.51	Medium
X26	Weather Conditions	3.73	3.67	11.11	Medium
X27	Socio Cultural Factors	3.30	3.52	0.00	Medium
X28	Rejection from society	3.24	3.45	13.67	Medium
X29	Change in Economic Conditions	3.39	3.64	11.61	Medium

Based on the result of average calculation and plotting towards probability matrix of risk impact on this research, there are 2 categories namely high and medium. From 29 variables, 10 variables include high risk category and 19 variables include medium risk category. As for high risk variable that affect cost performance are as follows: 1. Error and omissions in design, 2. Inadequate Drawings & Details, 3. Change of scope, 4. Accelerated construction, 5. Replacement of material, 6. Change in specifications, 7. Change in design, 8. Different Site Conditions, 9. There is a utility network,10. Land acquisition problems.

Based on the list of dominant risks or high category from the data of respondents' result, it is discussed to the experts of response act that can be carried out as risk response.

Table 2. Risk response of high category

No	Risk Factor		Risk Response	Strategy
X2	Error and omissions in design	1	Preparing planning database needed	Mitigation
		2	Preparing the detailed data about field condition	Mitigation
		3	Involving the experienced and expert planner	Mitigation
		4	Coordinating properly during the planning stage with consultant, owner and stake holder	Mitigation
X3	Inadequate Drawings & Details	1	Preparing drafter who are experienced, have expertise and skills	Mitigation
		2	Checking the drawing periodically and carrying out the procedure of picture documentation	Mitigation
		3	Providing appropriate time needed to prepare image document	Mitigation
		4	Checking and verifying the calculation of work volume	Mitigation
X10	Change of scope	1	Doing technical justification and careful and detailed inspection towards CCO document	Mitigation
		2	Ensuring the CCO proposal has been appropriate with the change in scope of work that happens	Mitigation
		3	Checking and verifying the calculation of work volume which is in CCO	Mitigation
		4	Adding article/clause of CCO in contract document	Mitigation
X11	Accelerated Construction	1	Choosing expert and experienced subcontractor	Transfer
		2	Adding article/clause in acceleration in contract document	Mitigation
X13	Replacement of material	1	Preparing standard database/technical guide/ technical specification needed	Mitigation
		2	Ensuring the availability of material and equipment needed in project	Mitigation
X14	Change in specifications	1	Preparing standard database/technical guide/ technical specification needed	Mitigation

		2	Determining the accurate project objectives according to the desire of stakeholder.	Mitigation
		3	Ensuring the availability of material and equipment needed in project	Mitigation
		4	Involving experienced planner	Mitigation
X15	Change in design	1	Preparing database of planning needed	Mitigation
		2	Preparing detailed data about the field condition	Mitigation
		3	Involving the experienced and truly expert planner	Mitigation
		4	Providing proper planning time	Mitigation
X17	Different Site Conditions	1	Ensuring project location should in accordance with the objectives and desire of owner/stake holder.	Mitigation
		2	Providing information and database of the condition of existing project location which will be carried out	Mitigation
		3	Coordinating with stakeholder and the people around the project which will be carried out	Mitigation
X21	There is a utility network	1	Preparing the database of utility network around the project	Mitigation
		2	Coordinating with the related side of utility network at the time of planning	Mitigation
		3	PIT test is carried out at the time of planning	Mitigation
X22	Land acquisition problems	1	Making announcement of land handover with owner	Mitigation
		2	Ensuring the schedule of land acquisition with the related side	Mitigation
		3	Adding article/clause of land acquisition in contract document	Mitigation

Risk response involves act indication to reduce the possibility that risk will happen or reduce the impact of the risk that indeed happens. This strategy also involves identification of construction project stages when the act has to be carried out, both before or during the projects. Risk response strategy is needed as a process of risk controlling that has been identified and need to be monitored regularly towards the risk response. This strategy is expected to be able to improve the cost performance on railway projects.

V. CONCLUSION

This research identifies risk factors that cause contact change orders that affect cost performance. The risk factor can be divided into 3 aspects namely technical, legal, and environmental aspects. Based on the result of average calculation and plotting towards probability matrix of risk impact on this research, there are 2 categories namely high and medium. From 29 variables, 10 variables include high risk category and 19 variables include medium risk category. As for high risk variable are as follows: 1. Error and omissions in design, 2. Inadequate Drawings & Details, 3. Change of scope, 4. Accelerated construction, 5. Replacement of material, 6. Change in specifications, 7. Change in design, 8. Different Site Conditions, 9. There is a utility network,10. Land acquisition problems.

Risk response strategy is needed as a process of risk controlling that has been identified and need to be monitored regularly towards the risk response. This strategy is expected to be able to improve the cost performance on railway projects.

REFERENCES

[1] Wena, Made., Suparno, "Manajemen Risiko Dalam Proyek Konstruksi". Jurnal Bangunan, Vol.20, No.1, pp 1-12, 2015.

[2] Hanna, A., Camlic, R., Peterson, P. and Nordheim E, "Quantitative Definition of Projects Impacted by Change Orders'". Journal of Construction Engineering and Management, ASCE, 128(1), 57–64, 2002.

[3] Alaryan et al.,"Causes and Effects of Change Orders on Construction Projects in Kuwait. Int. Journal of Engineering Research and Applications,

ISSN : 2248-9622, Vol. 4, Issue 7(Version 2), July 2014, pp.01-08, 2014.

[4] Gumelar, Galih, " CCO (ContractChange Order), Adendum,Perubahan/Amandemen Kontrak.", 2014.

[5] Desai, Jaydeep & Pitroda, Dr. Jayeshkumar & Bhavsar, Prof., "A Review On Change Order And Assessingcauses Affecting Change Order In Construction. Journal Of International Academic Research For Multidisciplinary Impact Factor 1.625, Issn: 2320-5083. 2. 152-162, 2015.

[6] Ndihokubwayo, Ruben & Haupt, Theo. (2009). Variation Orders on Construction Projects: Value-adding or Waste?. Ruben Ndihokubwayo. 1.

[7] Ibbs, C. W., "Change's impact on construction productivity". J. Constr. Eng. Manage., 123(1), 89–97. 1997.

[8] Presidential Regulation Number 2128 of 2018. National Railway Master PlanStrategic Projects.

[9] Sugiyono, Prof. Dr. 2003. Statistics for research in the fifth edition. Bandung: CV Alfabeta.