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House of Risk Model Application of The Supply Chain in Indonesia Light Rail Transit Project

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ABSTRACT

The growing importance of the construction sector, there needs good management to avoid waste. There are several construction projects being focused on by the government such as toll roads, reservoirs, and Light Rail Transit (LRT). The special LRT project is very unique because it is still a very new work in Indonesia. This unique and large project will potentially pose many risks. The purpose of this study is to conduct risk management on the LRT supply chain project which is expected to assist contractors and other stakeholders in identifying what risks will occur. This research focuses on risk management on the LRT supply chain project which will take the case study at the currently operated LRT Jabodebek. The research method used the House of Risk (HOR) model with the result there are 25 risks in the LRT project which have been ranked based on Aggregate Risk Potential (ARP) value. Mitigation is categorized into three types: high risk, medium risk, and low risk with each handling.

Keywords: House of Risk; Light Rail Transit; supply chain

1. INTRODUCTION

Infrastructure or construction projects become one of the important sectors in the development of a country. Especially as a developing country like Indonesia, the construction of public facilities will be very useful in prospering the people. According to Statistics Indonesia (2016), the value of construction completed by type of work is very large as in Figure 1 below.

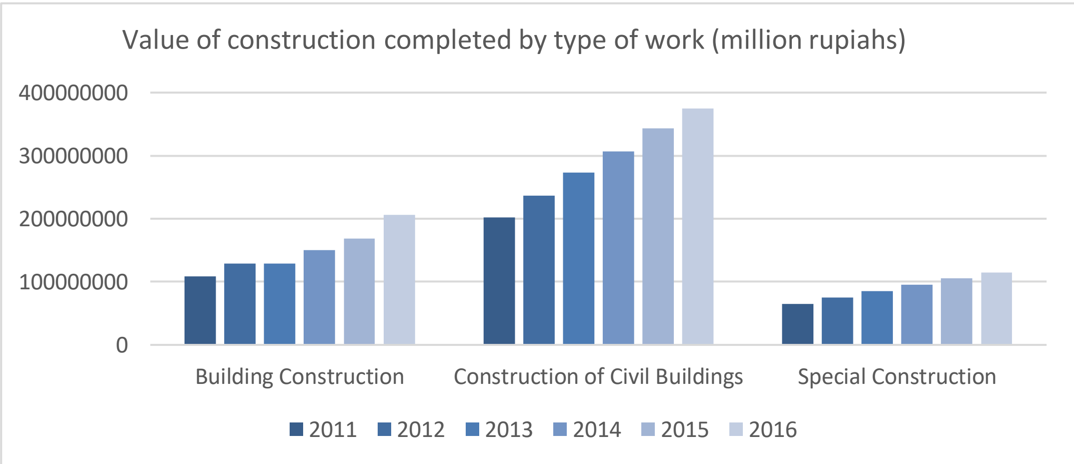

Figure 1: Value of construction completed by type of work (million rupiahs) (Source: SI, 2016)

Based on Figure 1 above we can see that the value of construction of both building construction, civil construction, and special construction increased every year. Along with the increasing importance of this construction project, there needs to be good management also to minimize waste [1]. Waste in a construction project is something to be avoided because it will impact poor quality, slow timing, and rising costs. In previous research said that waste occurs at every phase of the life cycle project [2].

There are several major construction projects being undertaken by the Indonesian government today such as toll roads, reservoirs, Light Rail Transit (LRT), and so on. The special LRT project is very unique because it is still very new as a big project in Indonesia. Referring to the previous study, the definition of LRT is one of the Passenger Railway systems operating in urban areas where the framework is light and can travel with other traffic or in special trajectories, also called trams [3].

Problems that occur in the construction project include LRT i.e. lack of budget funds, coordination among stakeholders, poor implementation methods, unattended quality, and ineffective supply chain [4]. The supply chain becomes interesting to be discussed in the LRT project because of the complexity of work in the middle of urban activity hence how the contractor can minimize accidents and waste. Previous research has reviewed supply chain management on materials that support sustainable construction, about 10-20% can reduce waste [5]. The contractor must be good at managing material flow from suppliers to project locations. Risks in construction projects especially large-scale projects are very potential, need good risk management from all parties [6].

This research will focus on risk management on LRT supply chain projects that will take case studies in LRT Jabodebek Indonesia. Several studies have identified that potential risks to LRT projects are the land risk, construction risk, operational risk, organizational risk, financial risk, income risk, legal risk, undesirable risk [7]. While supply chain risk in the building project is the risk of information flow, material flow risk, and fund flow risk [8].

2. METODOLOGY

This study adopted a quantitative research approach to collecting useful information about supply chain risks in the Light Rail Transit (LRT) project. The case study was conducted at LRT Jabodebek Indonesia by taking several sections as data retrieval. This project is the first LRT project in Indonesia so it is very interesting to study. How the data acquisition is done by in-depth questionnaires of the expert respondents who have worked a few years and understand the supply chain and the overall project. An in-depth questionnaire is a questionnaire that peeled sharply and deeply from what was discussed by way of respondents fill out the questionnaire then the researchers asked why they fill the choice [9]. It would be better if the results of data processing were then validated to previous respondents or collected respondents by focus group discussion.

Respondents who fill in the questionnaire as in Table 1 below:

Table 1: Expert respondents who filled out a questionnaire

No.	Position	Age (years)	Length of Work (years)
1	Project Manager	42	12
2	Project Manager	37	14
3	Project Manager	36	12
4	Project Manager	33	9
5	Project Manager	31	8
6	Manager of Civil Construction Division	40	16

Based on Table 1 above, we can that their respondents who have very experience in the field. 5 respondents are project managers and 1 respondent is a manager of civil construction division whose age was at the peak of his career and his work experience averaged over 10 years. The results of questionnaires and discussions with respondents were processed based on the House of Risk (HOR) model.

3. RESULT AND DISCUSSION

A. Identify Risk Events

Risk identification is done by contractor interviews to determine risks that occur in the project activity, identify potential risks that affect the supply chain activities of the project and identify the cause of the risk. There are 15 risk items identified, the results of respondents' assessment can be seen in Table 2. Severity values are between 1 to 10, where the value 1 indicates that the risk event has no impact and 10 shows a very big impact.

Table 2: Risk identification and the results of risk assessment

Code	Risks	Severity
E1	Resources procurement problem (material, labor, equipment)	8
E2	Poor material quality	6
E3	Poor project financial condition	7
E4	Limited project work time	5
E5	Insufficient human resources condition	7
E6	Project equipment failure	5
E7	Unfulfilled technical specifications	7
E8	Schedule delay	8
E9	Poor job quality	7
E10	Problems of technology or construction methods	8
E11	Job coordination problem	7
E12	Technical changes from the owner	7
E13	Change of work schedule	6
E14	Incomplete drawing information and technical specifications	8
E15	Policy changed	5

This impact value will be used in the calculation of Aggregate Risk Potential (ARP) to determine the agent or cause of the most influential risk based on the calculation.

B. Identification of Agents / Risk Causes

The next step after identifying the risk event is to assess the severity of the impact. Identification of the agent or cause of the risk aims to assess how often it is likely to occur in the agent or cause of the risk. Assessment of respondents to the possibility of the risk occurring as in Table 3.

Table 3: Assessment of respondents to the probability of risk agents

Code	Risk Agents / Causes of Risk	Occur-rence
A1	Delivery of material that is behind schedule needs	6
A2	Loss or damage to the material on the way	5
A3	Unavailability of material as needed	5
A4	The material approval process, work permit and work drawing from the owner of the rambling	8
A5	Postponement of work caused by the owner	7
A6	Sub-contractor work is not in accordance with specifications	5
A7	Delays by sub-contractor work	5
A8	Less number of workers	8
A9	Low labor competencies	8
A10	Low labor productivity	5
A11	Poor labor management by sub-contractors	7
A12	The field supervisor is inexperienced	5
A13	Working accident occurred	5
A14	The owner is late paying	5
A15	Poor management of subcontractor finance	5
A16	Increase in material prices	5

Code	Risk Agents / Causes of Risk	Occurrence
A17	Unclear drawing and specifications of owner and designer	4
A18	The construction design is incompatible within the field	6
A19	Setting a tight and unrealistic project schedule by the owner	8
A20	The owner is slow in making decisions	5
A21	The inability of the owner in coordinating with other parties	5
A22	Lack of information in the drawing	5
A23	Fewer details about material specifications	4
A24	Provisions added jobs unclearly	6
A25	Limited human and tool resources that hinder information exchange	4

From Table 3 there are 25 risk agents that are potentially at risk in the project. Based on the value of the probability scale, there is one risk agent with probability value 9 which indicates that the possibility of a risk agent is very high.

C. Calculation of Aggregate Risk Potential (ARP)

Calculating the value of Aggregate Risk Potential (ARP) is used as input to determine the priority of risk agents that need to be addressed first to be given precautionary measures against risk agents. Assessment using the numbers 0, 1, 3 and 9. Value 0 indicates between risk agent and risk event there is no correlation relationship, value 1 shows the value of low correlation, value 3 shows the value of correlation medium and value 9 indicates high correlation value. ARP value is obtained from the sum of the multiplication results severity level to the level of occurrence.

$$\mathbf{ARP_j = O_j \Sigma_i S_i R_{ij}} \qquad (1)$$

Where:

O_j = probability of occurrence of risk agent j

S_i = impact of risk event risk if i happen

R_{ij} = correlation between risk agent j and risk event i

Based on the results of the assessment of the respondents can be determined risk agent ratings based on the ARP value in Table 4.

Table 4: Calculation of ARP on HOR model

Code	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Oj	ARP	Rank
A1								9					3			6	540	14
A2							9		9							5	378	19
A3							1	9					3			5	485	16
A4	9							9			9			3		8	1848	1
A5								9				9	9			7	1323	2
A6							3		9							5	420	18
A7				9				9					9			5	855	8
A8	9				9			3								8	1272	3
A9								3	9		9					8	1200	5
A10								9			9					5	675	12
A11	1							9	9		3					7	1148	6
A12		9						9	3							5	735	11
A13						3		9					3			5	525	15
A14	3		9					9								5	795	10
A15	9	3														5	450	17
A16		9	3												9	5	600	13

Code	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	Oj	ARP	Rank
A17								9					3			4	288	21
A18								9		3			9			6	900	7
A19							9	9	3							8	1248	4
A20				3				3								5	195	22
A21								3								5	120	25
A22								9			3			9		5	825	9
A23								3	3							4	180	23
A24											3					6	126	24
A25								9			9					4	351	20
Si	8	6	7	5	7	5	7	8	7	8	7	7	6	8	5			

From the calculations in Table 4, a Pareto diagram of the risk agent is presented as shown in Figure 3. The Pareto chart shows 14 risk agents contributing to 80% of the total ARP. The highest ARP value is in the risk agent for the material approval process, work permit, and work drawing from the rambling owner of 1848. It shows that the risk agent has a high priority in handling it over others. This is because the higher the ARP value of a risk agent will be directly proportional to the level of impact.

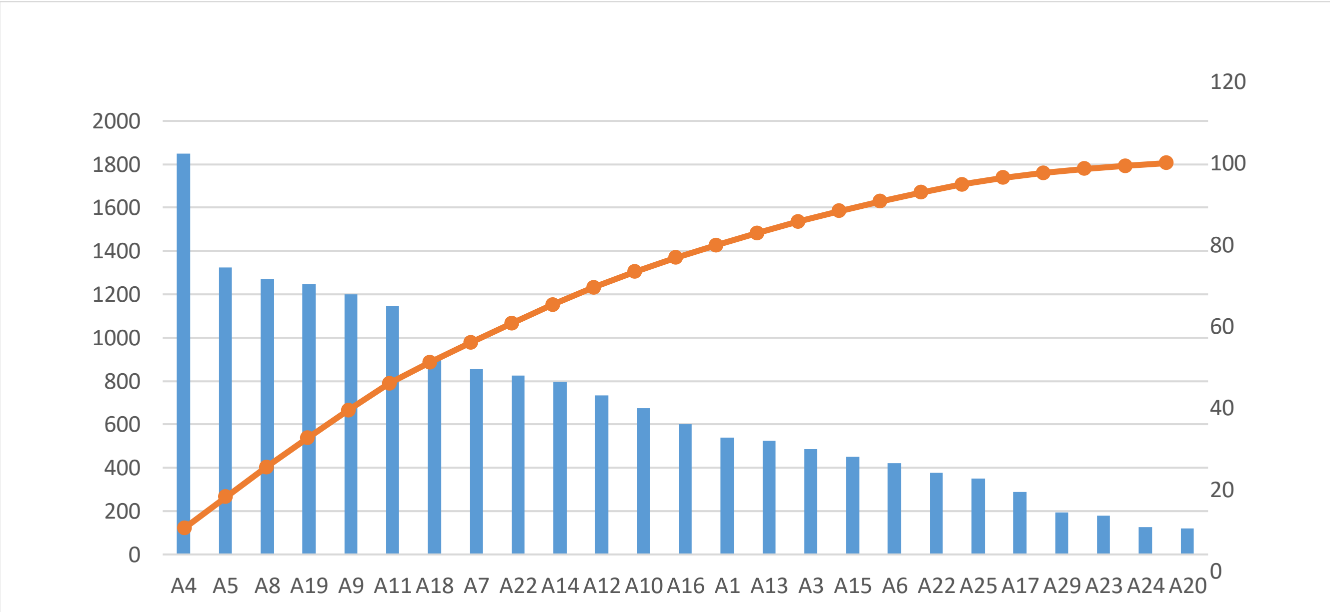

Figure 1: Diagram Pareto ARP Risk Agent

= ARP

= % ARP Cumulative

D. Risk Mitigation

25 risks with ARP values each have been ranked. The next step is risk mitigation for prevention and treatment. Based on the Pareto diagram can be divided into three risk categories namely high risk, medium risk, and low risk. This risk mitigation is based on the results of the discussion with the respondents with the following results:

1. High risk, mitigation by creating a special team of risk management field tasked with monitoring this potential risk. The risks in this risk category are A4, A5, A8, A19, A9, and A11 with values above the % ARP cumulative. If at any time this risk occurs, the risk

management team takes immediate action. The team will continue to coordinate with project managers to make quick decisions.

2. Medium risk, mitigation by making some plans for anticipation. This plan will be a reference action if the risk occurs. The risks in this category are A18, A7, A22, A14, A12, A10, A16, A1, A13, A15, and A6 with values between 30% until under % ARP cumulative. This type of risk is also managed by the risk management team but it becomes a second priority after the high-risk type.
3. Low risk, be a risk last priority. The risks in this category are A22, A25, A17, A29, A23, A24, and A20 with values under 30%. Sometimes this type of risk may be allowed because the possibility of occurrence rarely and if it happens will have an insignificant impact. Despite the last priority, these risks must be monitored and mitigated.

4. CONCLUSIONS

Based on the results of questionnaires and analysis using the House of Risk (HOR) model can be concluded that Light Rail Transit Project in Jabodebek Indonesia is very complex and potentially occur many risks. This LRT project with a high budget and done by large contractors need to get special attention from the government. Projects with a long duration of work and done in the midst of metropolitan cities will certainly be many obstacles that need to be managed properly.

The House of Risk (HOR) model has identified and analyzed at least 25 potential risks in this LRT project. The results of this study showed that the risk management LRT project risks are divided into three categories: high risk, medium risk, and low risk. Each of these risk levels has its own mitigation. The contractor needs to establish a risk management team from the beginning to the end of the project that will continue to coordinate with the project manager. When the whole team is working well, potential risks can be reduced as well.

This research certainly still needs to be developed furthermore through innovations in order to improve risk management in the LRT project. The development of other models other than House of Risk can be used so as to enrich the model to be recommended to the contractor. In addition, information technology-based risk management can be developed to facilitate contractors in the construction process. This risk management will be an early warning system integrated with projects in the field.

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