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SUBCONTRACTING MANAGEMENT IN AN EPC PROJECT: A CASE STUDY OF DELAY RISKS

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Subcontracting was adopted in a major EPC power generating infrastructure project in South-Sumatera, Indonesia. The completion of this project, which was executed in the framework of the government's alternative energy power generation acceleration endeavor, was delayed. This paper analyzes subcontracting management as the main cause of the delay. A data collecting survey, which included interviews with project respondents, was conducted in the objective to obtain their perception on delay risk caused by subcontracting management. A risk factor list was created based on this survey. A qualitative risk analysis was used to assess the risk extent. 18 risk factors with high and significant levels are presented. The list of risk factors in each of the EPC project's phases was then used in analyzing the project's completion delay. It is shown that the main contractor's lack of experience in the work's subcontracting management has caused miscommunications in engineering phase, tender process miscalculations, lack of procured materials and equipment quality, imperfect construction preparation, imperfect commissioning, and reworks. Construction was identified as the most critical project phase due to a relatively high number of subcontractors involved in the work and the complexity of the EPC project. The interaction of the whole factors finally caused project completion delay.

Keywords: Risk analysis, Risk perception, Project phases, Engineering, Procurement, Construction, Reworks.

1 INTRODUCTION

Economic and population growth have caused augmentation in electricity provision needs in Indonesia. In 2005, the country's electricity average demand growth was around 7% per year while electricity production was only growing at 2% per year. Due to this situation Indonesia is facing the challenge of electricity crisis that would hamper its economic development in the long run. In order to catch up with the demand the government has set a policy of electricity power generation infrastructure development acceleration program. This program included, among others, a project to build a 200 MW steam powered electricity generation plant using coal as fuel in South Sumatera which was also intended to reduce dependency on oil as an energy source. This Engineering, Procurement, and Construction (EPC) project, started in 2007, was targeted to be completed by 2010, but up until the end of 2012 it was still unfinished. The huge delay was deemed to be caused by the general contractors' lack of experience in subcontracting management. In this regard, Thomas and Flynn (2011) stated that a

major problem in subcontractor management is scheduling, while contractor's incompetence as one of the causes for construction delays was pointed out, among others, by Ogunlana and Pomkuntong (1996). The present paper analyzes subcontracting management as delay risk source in the EPC project**.**

2 PROJECT DESCRIPTION

The owner of the project is Indonesia's state electricity company. The project's objective is to deliver steam powered electricity generation plant facilities which mainly consist of: boiler, turbine, coal and ash handling, make up water system, waste water treatment, and switchyard. The EPC general contractor, which is one of the country's main state-owned contractors, hired seven subcontractors with the following composition: one foreign subcontractor for engineering, five local subcontractors for construction, and one local subcontractor for commissioning test. See Table 1.

Table 1. Project work assignment.

Project phase	Assigned party	Scope of work
Engineering	Subcontractor1	Basic design, equipment specification, detailed exploration survey, trial piling, detailed design drawings
Procurement	General Contractor	Material and equipment
Construction	General Contractor	Civil works: site preparation, foundation, facility building, access road, chimney, jetty
	Subcontractor 2	Mechanical construction: steel structure erection, piping system
	Subcontractor 3	Mechanical construction: turbine house steel structure
	Subcontractor 4	Make up water system
	Subcontractor 5	Electric instrument
	Subcontractor 6	Switchyard and transmission line
Commissioning	Subcontractor 7	Commissioning test

The general contractor have never handled an EPC project to build steam powered electricity generation plant before, so that a number of relationship set up with various subcontractors and suppliers needed to be first initiated. Work execution time consumed by the general contractor and subcontractors up until 2012 is shown on Figure 1.

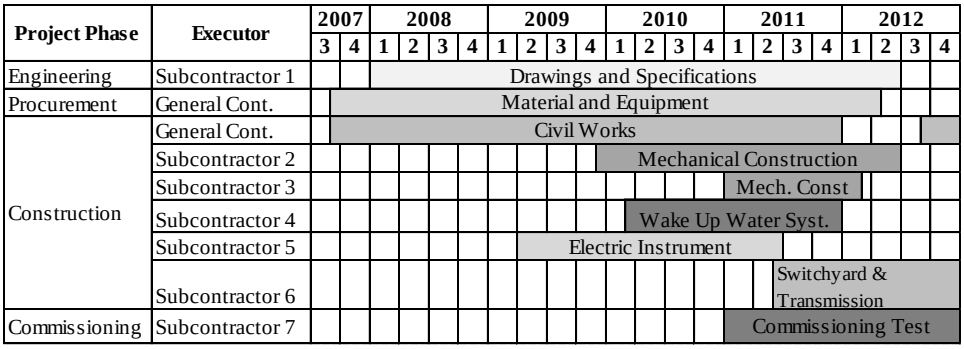

Figure 1. Delayed project schedule.

3 METHODOLOGY

Identification of delay risk factors due to subcontracting management was first conducted. A data collecting survey, using questionnaires and interviews involving project respondents, was conducted in the objective to obtain their perception on delay risks caused by subcontracting management. A risk factor list was created based on this survey. The risk factors were grouped according to sources of risk in each project phase. The causes of each risk factor were also provided.

A qualitative risk analysis was conducted to assess the risk extent. Perception of the respondents on the frequency and impact of each risk factor was given based on numerical scales. A scale of 1 to 5 for risk frequency of occurrence (1 = very low, up to 5 = very high) is adopted. Meanwhile, a scale of 1 to 5 was also used for risk impact (1 = no impact on schedule, 2 = low impact i.e. less than 10% behind schedule, 3 = moderate impact i.e. 10%-20% behind schedule, 4 = high impact i.e. 20%-30% behind schedule, very high impact i.e. more than 30% behind schedule). The risk index was then obtained by multiplying the risk frequency mean and the risk impact mean. Based on the risk index, four classes of risk levels were adopted i.e. high risk (H), significant risk (S), moderate risk (M), and low risk (L). The range of each class' level of risk was determined by dividing the difference between the highest risk index mean value and the lowest risk index mean value by the number of classes (4). The resultant was the level of risk class range, i.e. low risk (L) class with risk index range of 3.60-7.98, moderate risk (M) class with risk index range of 7.98-12.36, significant risk (S) class with risk index range of 12.36-16.74, high risk (H) class with risk index range of 16.74-21.12.

Two groups of respondents were involved in this survey. The first group consisted of five managers (division head, project manager, project manager-mechanical, project control manager, and finance manager) of three EPC companies in Indonesia. A questionnaire that included a preliminary list of risk factors was administered involving these respondents. Based on their responses some risk factors with low significance were eliminated. This first round of questionnaire survey resulted in a validated and more concise risk factors list. Suggestions of risk response were also given by this first group of respondents. The validated risk factors list was then integrated into a second questionnaire which was distributed to the second group of respondents (ten key persons) consisting of the general contractor's managers involved in this project, i.e.: project manager, lead mechanical engineer, engineering manager, QA/QC manager, general site manager, project control manager, project finance manager, general accountant, commissioning manager, assistant project control manager.

4 DELAY RISKS DUE TO SUBCONTRACTING MANAGEMENT

4.1 Perception on Delay Risk Factors

As previously mentioned, experienced EPC project managers' served as respondents of the first questionnaire survey round. 59 risk factors with 158 causes were included in this perception questionnaire which covered engineering, procurement, construction, and commissioning phases of an EPC project. In this first round, 32 risk factors with

67 causes were perceived as having significant or high risk level. These validated risk factors were then put into the second questionnaire with the general contractor's managers as respondents. This second round resulted in 18 risk factors with 29 causes that were perceived as having significant or high risk levels. Construction was identified as the most critical project phase due to the relatively high number of subcontractors involved in the work and the complexity of the EPC project. These risk factors are then designated as the main risk factors and the details are shown on Table 2 and Table 3. The following project facts explain the causes of the identified risks.

The high risk level with regard to the time required for the whole subcontractor procurement process could be explained by the fact that for the general contractor this was its first EPC project in steam powered electricity generation plant construction. Consequently, few partnerships had been established beforehand with experienced subcontractors. The fact that until recently power plant construction projects in Indonesia had been mostly executed by foreign contractors had also contributed to the situation where few local contractors had sufficient experience in handling this kind of project.

Delay of payment from the owner to the general contractor had caused delay of most of the outputs' delivery. The subcontractors faced problems of pre-financing. One of the consequences was the late completion of the basic design which had in turn caused problems during the construction phase. The importance of timeliness of payments in subcontracting practice was also pointed out by Arditi and Chotibhong (2005) indicating that, for subcontractors, receiving delayed payments from their general contractors is a cause of friction between the two parties.

Mediocre coordination quality between the general contractor and subcontractors had caused perception discrepancies regarding work specifications and quality standards. This situation resulted in work execution errors and, consequently, reworks that caused project completion delay.

Lack of subcontractors' familiarity with newly adopted standard and technology in this plant's design had caused high difficulties in executing performance test during the commissioning phase. Construction damage could also happen due to this condition.

4.2 Risk Response

The suggestions given by the first group of respondents in handling project completion delay risks mainly consisted of risk reduction. The suggested risk reduction responses were: a more thorough prequalification process in selecting subcontractors, a careful set up of contract with subcontractors especially regarding terms of payment, acquiring good expertise in the required technology by making study visits to the producer's headquarters, conducting more elaborate budget control, a good and intensive coordination with involved parties, a comprehensive supervision plan, setting up a good quality plan, and a good performance test and monitoring plan for each subsystem. The importance of subcontractors pre-evaluation as a practicable subcontracting process was mentioned, among others, by Eom *et al.* (2008). Meanwhile, with regard to risk transfer, requiring subcontractors to provide adequate bonds during the tender process and carefully preparing related agreements with subcontractors with clarity of sanctions for delays were recommended by the respondents.

Table 2. Main risk factors and risk levels of engineering, procurement, and construction phases.

Project phase and source of risk	Risk factor	Cause	Risk level
1.Engineering			
Execution of Engineering process	(E1) Clarity of work sequence, schedule & and priority	(E1.1)Error in identifying type of work	Significant
	(E2) Financial problem	(E2.1) Subcontractor's lack of financing capacity	High
		(E2.2) Payment claim problem	Significant
2. Procurement			
a. Engineering subcontractor procurement and contract	(P1) Time needed for procurement process	(P1.1) Lack of general contractor's experience	Significant
	(P2) Appropriateness of subcontractor bid price	(P2.1) Cost estimation inaccuracy	High
b. Construction subcontractor procurement and contract	(P3) Time needed for procurement process	(P3.1) Lack of general contractor's experience	High
	(P4) Appropriateness of subcontractor bid price	(P4.1) Lack of information on standards and requirements	Significant
		(P4.2) Cost estimation inaccuracy	High
c. Commissioning subcontractor procurement and contract	(P5) Time needed for procurement process	(P5.1) Lack of general contractor's experience	Significant
3. Construction	(C1) Process behind schedule	(C1.1) Delivery problem	High
a. Material/equipment procurement process (subcontractor)	(C2) Below standard procured material/ equipment	(C2.1) Specification change information delay	High
		(C2.2) Budget limit	High
b. Work execution	(C3) Inaccurate preparation	(C3.1) Lack of needed data	Significant
		(C3.2) Incomplete basic design provided by engineering subcontractor	Significant
	(C4) Financial problem	(C4.1) Subcontractor's financial problem	High
		(C4.2) Payment claim problem	High
	(C5) Work execution error and rework		Significant
	(C6) Construction process schedule problem	(C5.1) Lack of design clarity	Significant
		(C6.1) Material/eq. proc. delay	High
	(C7) Delivery delay		Significant
c. Output delivery		(C6.2) Manuf. process delay	Significant
		(C7.1) Prev. processes' delay	Significant
		(C7.2) Limited workforce and equipment	
		(C7.3) Payment delay	

Table 3. Main risk factors of commissioning test phase.

Source of risk	Risk factor	Cause	Risk level
Execution of commissioning test	(T1) Financial problem	(T1.1) Subcontractor's financial problem	High
	(T2) Work execution error and rework	(T2.1) Design or construction error	Significant
		(T2.2) High difficulty level of performance test	High
		(T2.3) Construction damage during commissioning test	High
	(T3) Commissioning process not according to plan	(T3.1) Subcontractor's lack of experience	Significant
		(T3.2) Previous processes' delay	Significant
Delivery of output	(T4) Performance test and standard operating procedure delay	(T4.1) High difficulty level of performance test	High

5 CONCLUSION

In an EPC project the phases are executed in parallel with each other. When the work has high complexity and various subcontractors are involved in each phase as happened in this project the schedule performance of each of them will have an impact on the others' performance and in turn will influence the overall project completion time for which the general contractor have to bear full responsibility. Good coordination among all parties and experience as well as technical and financial capacity of them are thus very important. Risk potential could be found in all subcontracting management processes including subcontractor procurement, contract set up between the general contractor and subcontractors, work execution, from the start of the project up until the end of the collaboration between the subcontractors and the general contractor. Identification of subcontracting risk sources and factors are then very important to be able to plan risk response.

References

Arditi, D., and Chotibongs, R., Issues in Subcontracting Practice, *Journal of Construction Engineering & Management*, ASCE, 131(8), 866-876, August, 2005.

Eom, C.S.J., Yun, S.H., and Paek, J.H., Subcontractor Evaluation and Management Framework for Strategic Partnering, *Journal of Construction Engineering & Management*, ASCE, 134(11), 842-851, November, 2008.

Ogunlana, SO., and Promkuntong, K., Construction Delays in a Fast Growing Economy: Comparing Thailand with Other Economies, *International Journal of Project Management*, Elsevier, 14(1), 37-45, 1996.

Thomas, H.R., and Flynn, C.J., Fundamental Principles of Subcontractor Management, *Practice Periodical on Structural Design and Construction*, ASCE, 16, 106-111, August, 2011.