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Research Article

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Risk Factor Identification for EPC Contract of Power Plant Projects using In-House Form of General Conditions of Contract in Indonesia

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Abstract The application of EPC contract in power plant construction projects in Indonesia has been numerically increase since the Government of Indonesia introduced fast-track program/ FTP-1 in 2007 for 40 power plant projects throughout Indonesia with total capacity about 10,000 MW. In fact, the development of the projects has been derailed due to excessive time delay, cost overrun, and low quality of the plants. It is identified that source of the problems were caused by unbalance risk allocation in the contract, specifically in the conditions of contract, that has been set-up independently by in-house consultant at early stage of the project without proper benchmark to the EPC contract common practice. The purpose of this research is driven by curiousity of: (1) what are the factors and risk variables to the EPC contract on power plant projects in Indonesia? (2) What are the potential risk sources to the EPC contract on power plant projects in Indonesia? (3) What are the potential risk impacts to the EPC contract on power plant projects in Indonesia? (4) What is the initial recommendation for better project risk management on power plant projects in Indonesia? However, this paper will focus on identifying risk factors to the EPC contract on power plant projects. The research methodology would reflect a process of findings: identification to the research problems, identification of relevant issues in the industry, literature review and relevant research results, qualitative analysis by using data from previous research in the industry, and recommendation. The research results at final end would offer a valuable reference to the project owner that recently launched a new program to build power plants with total capacity about 35,000 MW in the next period in Indonesia.

Keywords risk, construction contract, power plant project, EPC

1. Introduction

The implementation of the First Stage of Fast Track Program (FTP-1), which is known as a development of 10,000 MW steam power plants, have facing many problems that are dominated by late project completion and substantial additional costs, as well as the emergence of issues regarding the low performance of power plants which leads to the quality issue of the project. It can be noted that until the end of 2016 or after 10 (ten) years of FTP-1 has been launched by the Government, there still less than 10% of total capacity is not completed yet.

Risks in the First Stage of Fast Track Program (FTP-1) have had negative impacts on the project, *i.e.* late project completion, large additional costs, and poor quality of the work. Taking into account the risks that have taken place, research on the managing strategies of risk impacts on power projects using EPC contracts is inevitably interesting. Preliminary research shows that the source of risk found in each project is relatively the same and led by a changing of project delivery system adopted by the owner - who originally used to the design-bid-build (DBB) method to be an engineering-procurement-construction (EPC) method. Unfortunately, the changing are not accompanied by a full understanding of risk sharing or risk allocation for the parties, which is reflected in

the Conditions of Contract –that specifically prepared by in-house consultants for power plant construction contracts under the FTP-1 program. The above mentioned research hypothesis is derived from the problems that arise in contract implementation and disagreement between the contractor and the project owner during the closing contract period that concludes with the appointment of the dispute board or arbitration for the final decision.

The development of new power plant construction project in Indonesia which adopted the new EPC Contract system has been started significantly in 2007, when the Government of the Republic of Indonesia through Presidential Decree No. 71 of 2006 launched the program of 'Accelerating the Development of Coal-powered Power Plants' by assigning the only electricity state-owned company, called PT Perusahaan Listrik Negara (Persero) or PT PLN (Persero) to take role as executor of the program as well as project owner for development of 40 power plant projects throughout Indonesia with total capacity of 10,000 MW.

Considering the time of the project completion is the main objective to be achieved, then the program are adopting a different project delivery system, that is traditional system (Design-Bid-Build/ DBB) has been replaced by the Engineering-Procurement-Construction (EPC) contract. The use of the EPC contract is assumed to be able to response the targets given by the Government of Indonesia, that the completion of all projects must be achieved in 3 (three) years period. Shen et al [1] stated the increasing use of EPC contracts on international markets which implicated as fast-track delivery with cost savings and short project duration.

This research has found that there are two groups of risk factors affect the implementation of the FTP-1 program, namely: internal and external. The understanding for the risk group is seen from the source of risk, with internal factors associated from the internal organization and under certain conditions can be controlled, on the other hand, external factors come from outside the organization that tend not to be controlled by the organization. While the risk factors that occur in power plant projects using EPC contracts on FTP-1 program are: unrealistic project schedules with consideration to the capacity or plant sites, inconsistencies between parts of contract documents, overdue design processes, difficulty of contractors in meeting of standard contracts, old fashioned technical specifications, unavailability of access to project sites in a timely manner; land disputes during implementation stage at the project site, completion of permits and licenses, a gap between manufacturing delivery schedule and installation work at site; bad soil/ geological conditions, late payment, and regulatory changes. These risk factors were contributed to delays and additional costs and non-achievement of quality objectives in most of FTP-1 program.

Moreover, risk factors that arise in the implementation of the project are generally caused by matters such as: the timing of the completion of the project that has not taken into account the detailed site conditions, the different data and information between the contract documents and actual site condition, the mandatory approval of the owner for engineering design submitted by the contractor - but in the implementation of the approval tends to be slow, the specification on the contract documents to some extent to be very detailed - but not update with the advancement of technology, often access to the project site is not available because of unpreparedness of local government or owner for preparing access to the projects under its responsibility, there is often community claims related to land ownership on the project site, the number of permits and licenses to be completed by the owner or contractor at the central and regional levels often impending the completion of the project, the contractor tends to deliver the material early due to the benefits obtained from the terms of payment in the contract - but many times the material submitted was in completed and disrupting the installation of fieldwork, soil conditions or geology that is inconsistent with the information on contract documents which tend to perceive worse by the contractor; late payment from the owner or lender due to delays in the preparation of billing documents or the verification process of billing documents, changes in regulation during the project implementation that affect the contractor's ability to complete the work such as changes in the amount of taxes or stringent immigration policy for foreign workers.

2. Research Problems

Reviewing at the background of the research problems, this research initially started by a project question, that is, how the company's strategy to absorb losses due to unbalance risk allocation that occurs in EPC contracts in FTP-1 program. In addition, other variables also appear to be issues such as risks to EPC contracts that cause

additional costs and extensions of time; the provisions of the conditions of contract which have the potential to cause a dispute between the employer and the contractor; and allocation of the risks which includes response and handling of risks that might arise during the contract period.

The above questions were triggered to undertake research that not only covers at the past situation, but also discusses the formulation of a strategy for prevention of the same situation might be occured in new program of strengthening power plant capacity in Indonesia. In regard to the above approach, the research questions are: (1) what are the factors and risk variables to the EPC contract on power plant projects in Indonesia? (2) What are the potential risk sources to the EPC contract on power plant projects in Indonesia? (3) What are the potential risk impacts to the EPC contract on power plant projects in Indonesia? (4) What is the initial recommendation for better project risk management on power plant projects in Indonesia? Despite the ideal research questions above, however, this research will focus on researching problems in the early stages: What are the contract risk factors with the EPC approach in power plant construction projects in Indonesia? In respect to the limitation of the research, thus this research will be bounded to the identification of risk factors of power plant projects in Indonesia. In reviewing the research problems, this study will examine from the perspective of the owner as the primary data source.

3. Literature Review

3.1. Risk Management

Some researchers have claimed that risks in the construction projects can be defined as anything that influences the construction project in the planning phase as well as the execution phase [2-4]. Another researcher, Cabano [5] stated that risks can be defined as uncertainties or unknown factors in the project life cycle. Even though the term 'risk' often suggests a threat perspective or negative connotation, risks can also offer positive effects on project objectives although Moavenzadeh and Rosow, and Mason (cited in Kartam and Kartam [6]) viewed risks as an exposure to loss only. In other words, they viewed risks as always creating negative effects on the construction process. Despite the arguments surrounding risks in the construction project, Kezsbom and Edward (cited in Ghosh and Jintanapakanont [7]) stated 'risk management is an important and integral element of project management'. Ren [8] held similar views. He stated that the success of a project manager was heavily influenced by efficient and effective management of the risk involved. Therefore, systematic risk management needs to be applied in order to manage a project effectively throughout its life cycle.

Despite the different definitions for risk management, Berkeley, Humphreys and Thomas (cited in Zhi [9]) introduced a systematic approach to risk management, in four distinct stages: risk classification, risk identification, risk assessment, and risk response. Similar risk management steps were also introduced by A Guide to the Project Management Body of Knowledge (PMBOK® Guide) [10] which stated there were four fundamental steps of risk management: risk identification, risk analysis (qualitative and quantitative), risk response planning, and risk monitoring and control. Other researchers, however, have shown less numbers of steps in risk management; Smith, Merna and Jobling [4], for example, set three steps for the risk management cycle: risk identification, risk analysis, and risk response. Moreover, Wang, Dulaimi and Aguria [11] emphasized a systematic approach to risk management in one particular field, i.e. the construction industry, which consists of three main steps: risk identification, risk analysis and evaluation, and risk response.

A systematic approach to risk management, as introduced by most researchers and adopted in this study, consists of three main steps; at the first step, risks should be classified into different groups with certain criteria in order to clarify the relationship between them. This step is called risk identification [7, 9, 12-14]. Further, Ren [8] explained that the background of the identification of risk and the creation of a risk list is dependent upon many factors, such as past experience, personal tendency, and the possession of information. Further, the researchers, Cohen and Palmer [14], stated there are two common techniques to employ in risk identification: experienced-based risk and brain-storming-based risk assessment. The experienced-based technique might be used with interview techniques with project personnel from each discipline within the organization who have experience of similar projects, and/or with an examination of historic data from previous projects to facilitate utilization of corporate knowledge. Conversely, the examination of historic data might not have been carried out since the data from a previous similar project may not have been recorded. Thus, this technique can only be

successful in a limited number of cases. The brainstorming sessions involve all key stakeholders in identifying and listing the risks. This technique enables the stakeholders to exchange opinions and views on potential risks with the other members of the project team [4].

The second step entails the risk analysis and evaluation of the risks pertaining to risk management. Wang, Dulaimi and Aguria [11] suggested that risk analysis response management may only be performed on identified potential risks. Further, risk analysis and evaluation is the intermediate process between risk identification and risk response. It elaborates uncertainty in a qualitative and quantitative manner to evaluate the potential impact of risk. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) [10] divides risk analysis techniques into qualitative and quantitative approaches. Qualitative risk analysis is the process of assessing the impact and likelihood of identified risks. This process prioritizes risks according to their potential effect on project objectives. On the other hand, the quantitative risk analysis process aims to analyze numerically the probability of each risk and its consequences on project objectives, as well as the extent of overall project risk. This process in construction projects uses techniques such as risk premium; risk adjusted discount rate, subjective probability, decision analysis, sensitivity analysis, Monte Carlo simulation, stochastic dominance, Caspar and intuition [2, 10]. In short, as Zhi [9] explained, risk analysis can be broken down into two main criteria as follows: the probability that indicates the possibility of an undesirable occurrence, and the impact which is shown on the degree of seriousness and the scale of the impact on other activities.

The third step is to put in place an appropriate method in order to treat the risks. At this step, the project management team should decide and formulate risk treatment strategies or mitigation measures [11]. A Guide to the Project Management Body of Knowledge (PMBOK® Guide) [10] defined the risk response stage as the process of developing options and determining actions to enhance opportunities and reduce threats to the project's objectives by employing appropriate methods. Further, the Guide also introduced several risk response strategies, i.e. avoidance, transference, mitigation, and acceptance [10]. Those strategies were found to be slightly different from the risk response methods adopted by Baker, Ponniah and Smith [12] in their research. They defined four possible techniques: risk elimination, risk transfer, risk retention, and risk reduction. Research by Baker, Poniah and Smith [12] found that the most popular technique of risk response among companies within the oil and gas industry in the UK was risk reduction. The researchers believed that reducing a risk needs good understanding of risk and its impacts. The end result would be improving procedure and management in the organisation such as applying quality management and training mechanisms.

Furthermore, the approach of risk management could also refer to AS/NZS 4360:2004 that consist of serial processes: establish the context, identify risks, analyse risks, evaluate risks, and treat risks. In purpose of the research, the whole processes of the risk management would be adopted. However, this paper would only study about establishing context and identifying risks on power plant construction projects.

In view of the importance of risk management in the construction industry, however, Flanagan and Norman, Raftery; Simister, Ward et al (cited in Uher and Toakley [15]) found that the construction industry had been slow to realize the potential benefits of risk management. Moreover, Ward et al (cited in Uher and Taokley [15]) revealed the main reason preventing application of risk management in the construction industry was 'cultural issues' such as lack of knowledge, negative attitude, and mistrust of risk analysis. Turner and Simister (cited in Smith, Merna, and Jobling [4]) expressed their belief that benefits would be gained from using risk management techniques, and these techniques served not only the project or investment but also other concerned parties in the organization.

3.2. Contract Management

In view of the experts, contract management is defined as an activity of drafting and achieving agreement on contract terms and conditions, with the aim of ensuring the parties will implement the terms and conditions of the contract during the execution stage of the contract. In the process, contract management activities not only cover the preparation period, but also include management activities on changes in the scope or responsibilities of the parties at the time of contract implementation – for which would be agreed and documented in the contract amendment. In summary, contract management is a systematic process in preparing a contract until the settlement of contracting issue of a project.

3.3. Contract Administration

Contract administration could be defined as a process of implementing contracts that have been prepared and agreed upon by the parties. In the process, implementing the contract requires a proper contract control and, for the purpose of this research, classify into several issues:

a. EPC Contract

The engineering-procurement-construction (EPC) contract is a form of direct contract between the Employer and the EPC Contractor, with the contractor fully responsible for design activities, procurement of specialist vendors/ contractors, construction, commissioning and asset transfer and financing if requested [16]. In another sense, it can be said that the EPC contract is a single-point responsible contract for all work packages and the project phases, so this contract can be called a turn-key contract with lump-sum price. Furthermore, EPC contracts assigned the contractor as responsible party for all phases of the project which include investigation or identification in the event of defects may occur during the contract – as a consequence of the design and construction is carried out by one entity, namely the contractor. Thus, it can be concluded that the allocation of risk to the EPC contract will be on the contractor side, so in terms of cost the EPC contract will be relatively more expensive than the type of contract such as design-bid-build.

Furthermore, another aspect of EPC contracts is that the less involvement of project owners to the project in both design and construction activities. The role of the project owner is more dominant in the contract administration activities and other necessary roles that might be determined on the terms of the contract. In purpose of the design, the involvement of the project owner with review and/ or design approval is optional since the intention of the project owner has been included in the contract requirements. Moreover, the design produced by the contractor should reflect its engineering capability in a way to seek efficient and cost-effective design.

The combination of responsibilities of the design and construction that carry by contractor on EPC contracts will also have a positive impact on project owners because of the engineering, procurement and construction activities can be done in parallel, so that the overall project completion time will be shorter than other types of contracts – that is the reason EPC contract also familiar with the term 'fast-track'. However, the potential for delays and added costs in EPC contracts still exist, especially if the selected contractor does not have sufficient project management capabilities especially for large-scale projects. In large and complex projects with the big involvement of specialized vendors/ contractors in numbers could cause problems related to interfaces, which caused by different construction methods from specialist vendors/ contractors involved in the project.

In respect to the most difficulties are arisen during implementation stage, therefore procurement stage would be a crucial, due to in very limited time – the project owner shall evaluate and select the right bidder. Therefore, in order to minimizing the errors in analyzing and evaluating the bidder's proposal, the Employer's Requirements shall quite clear and precise - so as not to result in multi-interpretation of the bidders. The project owner, as a consequence of adopting the EPC contract type, will spend a lot of time and resources at the stage of contractor selection by ensuring the proposal submitted by the bidder(s) in line with the requirements on the bid document and fulfil the quality standards for the assigned work.

b. Risks on EPC Contract

In the EPC contract, the owner takes benefit from the less risk to be borne, whereas most of the risks are on the contractor side. As a consequence, the high price of EPC contracts is enviably when it compared to traditional contract models such as design-bid-build. Although the cost on the EPC contract is considerably higher, however the project owner could be obtained more benefit of risk and impact costs that has been transferred to the other party. As a result, the adoption of EPC contract by the time is increasing the construction industry including in Indonesia.

In view to the risks of EPC contracts, there are several things that need to be part of attention of the parties in drafting and negotiating for lump-sum turnkey or EPC contracts, so that, proper risk balance in the contract would be created for the parties. Issues that need attention such as: determination of scope of work, appointment of engineer/ consultant as owner's representative, variations, extension of time, contractor’s responsibility for design prepared by the owner, risks for owner, compliance to regulation, copyright and license.

3.4. Feature of Power Plant Construction Projects

Power plant construction projects in Indonesia are relatively steady in terms of project delivery system, which is the use of design-bid-build (DBB) concept since the first era of the construction of large power plants such as Saguling Hydroelectric Power Plant Project in West Java to PaitonCoal-fired Steam Power Plant Project in East Java in 1980s. Subsequently significant changes occurred for power plant contracting systems when the launch of the FTP-1 program in 2007 for the construction of approximately 10,000 MW coal-fired power plants spread across 40 locations in Indonesia throughout the project using project delivery system in the form of engineering-procurement-construction (EPC).

Since the introduction of the EPC contract system in power plant projects in 2007, the use EPC contract widely use in other power plant projects outside of the FTP-1 program. If there are some exception not to use EPC contract, it comes by request of project lender, such as the World Bank, Japan Bank for International Cooperation (JICA), as multilateral development bank who promotes intensively to use FIDIC forms of contract by adopting DBB contract system. Despite some exception, however the change of project delivery system has not taken into account as significant issue that must be managed in the company. As a consequence, the implementation of EPC contract system comes along with many difficulties with negative impacts to the achievement of project objectives, i.e. the addition of project cost, time delay, and poor quality of the works. The company considers EPC contract system was the best solution of the need for the completion of the urgent plant in order to meet the increasing demand for electrical energy in Indonesia. Currently the existing EPC contract system in the company has evolved into an EPC contract system added to the operation and maintenance period of 5 (five) years. This scenario could be called as a response to the incompatibility of the quality of the plant issues. The argument of construction contract combined with the maintenance contract within a certain period is expected that the EPC contractor will be responsible and accept the consequences of, may poor, the quality of the work produced within one or two periods of the generating cycle within the 5 (five) years time.

3.5. The Roles of Concerned Parties

The role of principal and concerned parties in the construction contracts for the construction of power plant projects in FTP-1 program basically would be classified into two big players, *i.e.*, the design consultant who develops the basic design and owner's requirement with most of them being appointed to the in-house consultants or subsidiaries/ affiliated companies, and EPC contractor that can be distinguished into two groups namely foreign EPC contractors for the class of power plant projects above 50 mega-watt (MW) and dominated by contractors from the People's Republic of China (PRC) and local EPC contractors from Indonesia, both state-owned enterprises as well as national private contractors. Nevertheless, for major equipments, most of the projects in the FTP-1 program were imported from the PRC. Therefore, it can be concluded that for the FTP-1 program in terms of project performance and equipment performance are reflected the capabilities of the manufacturer and EPC contractor from PRC.

3.6. Process of Project Implementation

The study of project management process in the company in this paper are broken-down into 5 (five) phases, namely: initiation, planning, pre-implementation, implementation, and completion. Basically, the project phases cheme introducing by the company are almost identical to the process group according to PMBOK® Guide [10], which consists of initiation, planning, implementation, supervision and control, and completion. Description of activities in the initiation phase is to conduct activity analysis of asset needs including capacity building plans for power plants and types of plants to be built, further, planning phase filled with advanced feasibility study and basic design carried out by designated consultants. While activities in the pre-implementation phase consists of fund preparation or funding activities including project financing schemes, contractor procurement, and special preparations for environmental clearance and land acquisition process. Furthermore, the implementation phase consists of construction management and construction progress payments, then the project phases would be ended with a phase of closing-out in the form of contractual

settlement activities and finalizing the interests of stakeholders. Flows of processes for project phases in the company are as follows:

Figure 1: Flow of Project Phases in the Company
(source: project management office document of PT PLN (Persero))

3.7. Results of Relevant Research

Research on risk management in power plant construction projects with specific EPC contract concepts for Indonesia has not been specifically established. However, it were found that several topic research on power plant construction projects in Indonesia and abroad including research on risk management in several large infrastructure projects could be considered as relevant to this research, as follows:

Research Topic	Relevant Issues to the Research
Risk Allocation of Road Projects in Sri Lanka [17]	Research was undertaken to obtain identified risks and risk allocation for parties to highway projects in Sri Lanka. The results showed that there were 4 (four) types of risk sources and 23 (twenty three) risk variables. The research is quite relevant to the topic of discussion because of the risk management process and findings that can be a reference in the discussion of risks in construction projects.
Perceptions of Owners in German Construction Projects: Congruence with Project Risk Theory [18]	The study reviews the owner's perceptions of risks in the construction industry in Germany. The research was done by semi-structured interview method to the practitioner from the owner. The results of the study indicate a perception that associates risk with threats rather than opportunities. The relevance of this research to the topic to be discussed lies in the perception of the owner in viewing and managing risk.
The Risk Management of Thermal Power Construction Projects in China: a Case Study [19]	The study was conducted on a thermal power plant project in the PRC with the aim of obtaining valuable reference in risk management of power plant projects, concluding that the parties involved in the project must understand the risks that may occur in the project. The results showed 9 (nine) risk categories and 37 (thirty seven) risk variables in the thermal generator project under study.
Identification of Recurring EPC Contract Risks and Mitigation Strategies [20]	The research was conducted on Iranian oil and gas infrastructure projects with a very strong correlation to the research topic being conducted, although industry and research sites differed specifically. This research offers an appropriate and effective risk management strategy in the implementation of EPC contracts, so that this research can be the basis of research conducted by offering novelty to different industries and locations.
Model for Efficient Risk Allocation in Privately Financed Public Infrastructure Projects Using Neuro-fuzzy Techniques [21]	This study describes the use of the neuro-fuzzy model for risk allocation on privately-funded projects for infrastructure projects. In this study discussed the framework for decision making efficient allocation of risk. Linkages to ongoing research are the frameworks and models that can be used in risk allocation for EPC contract-based projects.
Project Risk Management in Hydropower Plant Projects: A Case Study from the State-owned	The study shows the order of priority risk according to the perceptions of owner, consultant and contractor on hydro power plant project in Indonesia. Relevant results are about group and risk variables, power plant

Electricity Company of Indonesia [22]	projects and research sites in the same company in Indonesia.
Project Risk Management Using Multiple Criteria Decision-making Technique and Decision Tree Analysis: A Case Study of Indian Oil Refinery [23]	A study conducted in the oil refinery industry in India with the aim of introducing an integrated analytical framework to obtain effective management of project risks. The findings of the research are the classification of risk factors divided into 5 (five) groups, and 19 risk variables that occur in the project.
Heuristic Approach for Risk Assessment Modeling: EPCCM Application; Engineer Procure Construct Contract Management [24]	The study was conducted to investigate the standard conditions of contract of FIDIC-EPC which is used as the standard format and its implications in risk management strategy that must be done by the contractor. The study also used a risk breakdown structure (RBS) that divided risk groups into 5 (five) groups with identified risk variables of 25 (twenty five).
Risk Management in EPC Contract – Risk Identification [25]	The research focuses on identifying risks for projects with EPC contracts on the construction of thermal power plants in India. The results showed that there were 3 (three) risk sources with 19 (nineteen) risk variables appearing on the project under study.
Railway Risk Assessment of the EPC General Contract in Ethiopia Based on the Improved Fuzzy Comprehensive Evaluation Method [26]	The study was conducted to introduce the use of an improved fuzzy comprehensive evaluation method to evaluate the level of risk in railway development projects. The results showed 10 (ten) risk indicators with 105 (one hundred and five) risk variables.
Research on the Risks of International High-Speed Railway Projects Based on the FIDIC-EPC Total Proce Contract [27]	The study discusses the imbalance of risk allocation in the EPC contract model using FIDIC-EPC Contract on fast railway construction projects. The results reveal 7 (seven) major risk variables that affect the implementation of construction projects and often complicate the contractor.
Research on Delay Risks of EPC Hydropower Construction Projects in Vietnam [28]	The study was conducted on a hydro power plant construction project in Vietnam undertaken under an EPC contract. Research is motivated by the frequency of projects with EPC contracts experiencing significant delays in completion and significant added costs, so research is done to obtain risk factors that cause delays in project completion time. Research results in the identification of risks, calculations and groupings of impacts from risks to the project. The results of the study are recommendations that can increase confidence in much timely project completion and benefit investors and EPC contractors. Linkages to the current research topic are strategies for managing the impact of similarly probable risk factors on power generation projects although the types of plants and research sites are different.
Risk Identification and Assessment for EPCM Projects Using Fuzzy Set Theory [29]	The research introduces a new method built for the purposes of risk identification based on micro risk breakdown structure (MRBS) and procedures to identify effective problem-prevention and corrective action (PRCER) measures.
Causes of Contractor's Claims in International Engineering-Procurement-Construction Projects [1]	A principal study was undertaken to understand the causes of claims by contractors in EPC contract-based projects. Discussion of claims on construction projects can not be separated from risk management, with the results of the research issued the cause of the claim is the existence of external risks, natural conditions, and organizational behavior of the owner. Furthermore, also indicated 8 (eight) risk variables obtained from the literature review.

4. Research Methodology

4.1. Research Framework

This research has a framework of thinking, hereinafter referred to as an optimization research model which consists of: identifying research problems, analyzing based on data and relevant literature review, providing recommendations on the results of the study.

4.2. Research Process

The process undertaken in this research is to address and identify the problem issues in the project, identify the research problem, prepare the research instrument, analyze, discuss the result of the study, give recommendation from the research result. Analytical process in this research will use qualitative and quantitative research analysis approach.

5. Analysis and Discussion

5.1. Analysis Process

The research problem focuses on the risk factors of late completion, addition of project cost, and the low achievement of the quality target for generating equipment as indicated by the performance of the plant - which is not in line with the company's expectation. Risk factors during the contract implementation that affect the time, cost, and quality are identified in the following research results:

a. Zhao, Z.Y., Yun, Z.H., and Zuo, J. [19];
   Research on risk management in thermal generation projects in China that produces 9 (nine) categories of risk factors and 37 (thirty seven) risk variables.
b. Sudirman, W.B. and Hardjomuljadi, S. [22];
   Research on risk identification in hydro projects in Indonesia from perception of owner, consultant and contractor with the findings of 6 (six) risk factors consisting of 27 (twenty seven) risk variables.
c. Bali, R. and Apte, M. R. [25];
   Research on thermal power projects in India with EPC contracts shows risk divided into 3 (three) risk factors and 19 (nineteen) risk variables.
d. Rawash, A. N. A., Hagla, K.E., and Bakr, A. [24];
   Conducting research for EPCCM contract-based project risk management in Egypt that produces 5 (five) risk factors with 24 (twenty four) risk variables.
e. Hung, M.S., and Wang, J. [28];
   The risk grouping according to 7 (seven) causes of risk from 30 (thirty) variable of project risk which impact on the delay of project completion time.
f. Shen, Q. et al [26];
   Research on risk assessment of EPC contracts in Ethiopia for railroad projects that indicate 10 (ten) risk factors with 105 risk variables.
g. Shen, W. et al [1];
   Research shows the risks to construction projects with EPC contracts divided into 3 (three) risk factors and 8 (eight) risk variables: external risks (socio-political risk, natural conditions, and economic risk), organizational behavior of project owners not timely, changes in scope of work, and inefficient processes), and unclear contract definitions (unclear technical specifications, unclear job scopes).

Reviewing the above studies, it can be concluded that the contract risk factors with the EPC approach in power plant construction projects in Indonesia are: internal risk factors, external risk factors, risk factors of the parties involved.

5.2. Discussion

Reviewing to above research problems and results, this study has examined 3 (three) contract risk factors for EPC contract as the initial recommendation, namely: internal risk factors, external risk factors, risk factors of the parties involved. Internal risk factors are derived from the organization and can be controlled such as business processes, payment processes, and others but impacts on the project as a whole. External risk factors are factors

outside the organization that can not be controlled in whole or in part by organizations such as regulatory changes, changes in exchange rates, etc. Moreover, the risk factors of the parties is a factor caused by the interaction of the involved parties in the project (owners, consultants and contractors) including the interaction results, such as instructions, agreements or commitments and others. Acquisition of three contract risk factors inthe EPC contract, thus, the analysis and evalution and mitigation plan could be more focused, and it is expected to be a reference in the preparation of better conditions of contract as well as decision making in the selection of project delivery system that is more suitable with the target project.

6. Conclusion

The conclusion of this research is to answer the research problem that there are 3 (three) contract risk factors with EPC contract, i.e. internal risk factor, external risk factor, and risk factor of party which need special attention and treatment from project owner and other parties involved in construction power plant projects.

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