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Analysis of Operational Risk Using Loss Distribution Approach : A Study of Epc Business

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Abstract: This abstract describes a comprehensive analysis of operational risks in engineering, procurement, and construction (EPC) business by using calculation of loss distribution approach methods. This research involves an examination of historical operational losses data spanning from January 2019 to December 2022 to calculate the Operational Value at Risk at different percentiles. The OpVar, a key metric in this study, is determined to be Rp17,68Billion at a 95% percentile and Rp41,4Billion at a 99% percentile. These figures represent the estimated financial loss that EPC company may face due to operational risk with a higher percentile may indicate more precise. These results were declared valid through backtesting. From these points, the research emphasizes that the signigance of understanding and learning from historical data, will enable EPC companies to understand potential risks and manage risks through risk mitigation strategies in the complexity of EPC business environment.

Keyword: Operational risk, EPC Companies, Loss Distribution Approach Method, Operational Value at Risk, Risk Mitigation

INTRODUCTION

The Engineering, Procurement, and Construction (EPC) business model is widely adopted by numerous companies, both domestically and internationally, across various industries such as infrastructure, energy, oil, and gas for large-scale projects. EPC companies are involved in comprehensive project management, encompassing planning, procurement, and construction activities, all consolidated into a single contract, typically a turnkey contract. This approach aims to streamline construction processes, minimizing costs and time investments. Essentially, project owners favor this concept to mitigate risks and simplify the management of multiple contractors, ensuring that projects are completed within specified timelines and budgets.

The EPC sector, characterized by its competitiveness, necessitates constant innovation and performance enhancement. In Indonesia, EPC industry has quite large potential for implementing EPC projects. There are various companies both national and international develop strategic EPC projects in Indonesia, show us that each company has strong capabilities and innovation so that they remain in EPC market share. This provides the significance of comprehending a company's resources

and business strategy to secure successful bids for Engineering, Procurement, and Construction (EPC) projects. Differentiation strategies typically evolve around various attributes such as product quality, technology and innovation, efficiency, brand image, company reputation, durability, and customer service traits that are often challenging for competitors to replicate (Moses, 2010). Employing this strategy involves creating hurdles for potential entrants by fostering customer loyalty through quality offerings, employing effective marketing techniques, and offering competitive pricing.

EPC projects share similarities with turnkey projects, which can be described as a project delivery system where a single company or organization handles the design and execution of a project. This approach has the potential to substantially reduce project timelines, primarily by integrating design and construction phase activities, allowing concurrent tasks to take place. In the execution of an EPC project, the contractor assumes responsibility for project costs, quality, and the implementation time. The chosen contractor undertakes various tasks, encompassing engineering, procurement, and construction, while overseeing and coordinating subcontractors within defined budget constraints and a predetermined schedule (Ishii et al., 2014). The selection of contractors is carried out through a competitive bidding process. The owner initiates a request for proposals and invites several potential contractors to submit their bids (Micheli & Cagno, 2016). However, it is important to note that if the implementation schedule is not effectively managed, delays frequently arise within this procurement system (Yau & Yang, 2012).

Contractual agreements typically require the contractor shouldering all the risks associated with the contractor's proposed performance. Consequently, tasks beyond the primary scope, including testing, pre-commissioning, commissioning, and maintenance, are obligatory responsibilities for the contractors. Financial risks also pose a significant concern for contractors, and project funding plays a crucial role in enabling job owners to engage contractors without requiring upfront capital (Lee et al., 2015). In instances where job owners lack the necessary capital, they may seek financial support from lenders. This situation can potentially impede cash flow billing to the owner during the execution of EPC project work.

Basically, risk will always be inherent in all construction projects, where this will affect project completion in relation to time, cost and quality (Osipova, 2015). In recent years, with the continuous development of the engineering contract market, the requirements for the industry have greatly increased (Song & Hao, 2020). Gradually, EPC contracts increasingly have high risks due to complex capabilities and project models. Due to the long construction time, large scale, fixed number of contracts and other characteristics, international EPC projects still face many major risks. The project construction process, which is characterized by interdependence, really requires management and consideration from various stakeholders (Taroun, 2014).

There is a high risk of implementing an EPC contract and the contractor faces potential losses or disputes with the owner due to obligations to fulfill or reject the contract (Carrillo, 2005). The EPC industry must be able to manage contractual risks with general non-negotiable terms and agreements. The obligations stipulated in the contract create financial difficulties for potential entrepreneurs to implement the project. If a company fails to implement and monitor contracts properly, it will experience many negative impacts such as delays, cost overruns and will cause huge losses (Pícha et al., 2015).

Many contractors are unable to complete the work according to the estimated costs. This is due to the poor quality of the early design which causes endless changes during the project implementation process and this has an impact on delays and increased costs (Adafin et al., 2016). The causes of budget overruns in major construction projects are influenced by the following variables (1) the skills and abilities of the consultant, (2) the quality of the information, (3) the experience of the project team, (4) the tender period, (5) local market conditions, (6) level of completion of pre-contract design, (7) complexity of design and construction, (8) changes to the project scope, (9) design changes, (10) inappropriate design, (11) unclear technical specifications or regulations, and (12) as well as disputes in the engineering design process.

Companies and banking services face various risks, and one significant risk is operational risk (Hull, 2023). Operational risk encompasses all costs, including salaries, technology-related expenses, and other overhead costs. As a business expands, the value of operational risk tends to increase unless managed meticulously. To address instances of losses observed in various scenarios, it becomes essential to make informed decisions by incorporating operational risk management processes. This ensures that each business process is better equipped to mitigate the identified risks, as they have been recognized and factored into the decision-making process (Prabantarikso et al., 2022)

Risk assessment may have been carried out at the first stage of project by the top level management to identify and prevent any risk that may cause project delays and cost overrun (Mukilan et al., 2020). Besides, Contract Risk Management which is mostly used in EPC Industry, is particularly crucial since it affects contractor's ability to improve the economic benefit and also improve the management level of general contractor to face new opportunities and challenges (Wu, 2021)

Namely abc, one of EPC business has stated a huge loss until 2022. The responsibility has made company to carry out the ongoing project rather than stop in the middle of construction phase for the greater loss. The production has been started and mutual agreements has been collaborated with various of subcontractors and supplier. Besides, the contractual commitments between owner and contractor are binding, implying that contractor can't simply halt the operation due to enormous consequences. Consequences may include such as liquidated damage, bank guarantee disbursement, uncollectible gross amount due from customers, claim from supplier or subcontractors, and potential legal losses in the future. Consequently, continuing the ongoing project becomes necessary and main focus of these company. The huge of losses that have occurred up to 2022 and the potential losses from project activities in the future will significantly affect the financial of epc business. Based on accumulated loss which stated until 2022 was around IDR1.4 trillion, indicates that potential losses increase over time.

METHOD

This type of research is a survey with a quantitative approach. Data was collected from operational losses epc company for 48 months, conducted in the period from January 2019 to December 2022. The data obtained from profit and losses of epc's project each month. Table 1 shows the number of projects which experienced losses in the following month. This data demographed the data of frequency.

Table 1. Frequency Data

Month/ Year	1	2	3	4	5	6	7	8	9	10	11	12
2019	4	4	3	3	2	1	3	5	4	6	6	7
2020	4	4	4	3	4	3	4	6	5	6	7	7
2021	5	6	4	4	5	6	8	8	6	6	6	5
2022	5	6	6	6	7	4	3	7	9	9	10	9

Following the frequency data, the severity data shows the the severity level or amount of loss associated with an event that occurred. Table 2 shows the amount of losses each month due to operational loss.

Table 2. Severity Data

Year/ Month	2019	2020	2021	2022
1	4.318	1.992	14.009	5.371
2	15.587	3.224	12.073	32.532
3	2.740	5.045	16.661	35.797
4	3.236	7.362	26.951	13.492

5	2.495	4.698	37.261	11.078
6	685	3.161	24.926	29.310
7	4.785	5.176	23.914	29.585
8	3.059	18.954	77.112	32.910
9	4.918	14.684	9.882	74.439
10	4.201	35.834	23.348	54.807
11	6.724	66.680	16.440	63.195
12	28.758	72.229	23.965	63.204

Then the data will be analyzed by using easyfit to get the goodness of fit from frequency distribution and severity distribution. More over these data will be calculated to get the ammount of expected loss. By using Jorion methods, each loss will be multiplied by each probabilities in order to get the amount of Opvar in percentile of 95% and 99%. According to Kupiec backtesting is an important reality check for measuring risk. This test is conducted to find out how well current size calculation procedures would have worked in the past. Backtesting is carried out after getting the Opvar value. The Kupiec test is a model or statistical method of back testing. This test will calculate the amount of loss that results from significant model assumptions that are expected or not. The Kupiec test uses the log-likelihood ratio approach (Jorion, 2007).

RESULTS AND DISCUSSION

Frequency and severity data was classified based on each distribution to get the probability of each event. Furthermore, the probability will be used for the calculation of expected loss. The table of expected loss is calculated using Jorion Methods. Table 3 shows that combination of two data frequency and severy, obtain an expected loss value of IDR 64,18 billion.

Table 3. Expected Loss

Frequency Distribution		Severity Distribution	
Prob	Frequency	Prob	Severity
0,04	1	0,58	IDR 7.700
0,35	2	0,27	IDR 29.600
0,38	3	0,02	IDR 54.800
0,15	4	0,13	IDR 69.400
0,08	5		
Expectation	2,88	Expectation	IDR 22.325
Expected Loss		IDR 64.184	

Next, the loss value is calculated by sorting the probability of severity level and frequency level based on Table 3. Each loss will be calculated into probability combination multiply to get 95% and 99% percentile data. The maximum severity of operational losses that may occur with a 99% confidence level is IDR 183,8 billion and the maximum loss value that will occur with a 95% confidence level is IDR 292,6 billion. Calculation data can be seen in Table 4 below:

Table 4. Confidence Level 95% and 99%

Confidence Level	Total Risk	OpVar Estimation
95%	IDR 292.600	IDR 17.683
99%	IDR 183.800	IDR 41.443

Table 5 shows the result of the backtesting as validity test with confidence level 95% and 99%. The result demonstrates that actual cost is below than the Opvar, which shows a validity in measuring the Opvar.

Table 5. Backtesting Model

No	Month	Year	Opvar		Actual Loss	Opvar	
			95%	99%		95%	99%
1	Jan	2023	39.371	62.850	17.525	0	0
2	Feb	2023	68.483	64.037	17.712	0	0
3	Mar	2023	68.671	65.390	17.899	0	0
4	Apr	2023	68.863	66.742	18.091	0	0
5	May	2023	69.055	68.095	18.283	0	0
6	Jun	2023	69.247	69.633	18.475	0	0
7	Jul	2023	69.439	71.188	18.667	0	0
8	Aug	2023	69.632	72.743	18.860	0	0
9	Sept	2023	69.824	74.299	19.052	0	0
10	Oct	2023	70.016	76.018	19.244	0	0
11	Nov	2023	70.208	77.874	19.436	0	0
12	Dec	2023	70.400	79.865	19.628	0	0

Setting aside for operational risk losses is a step that can be taken by the company to anticipate losses that may arise due to operational risks. Operational risks are risks associated with the failure of internal systems, processes or people within an organization. This loss allowance aims to protect the company's finances and maintain the continuity of its operations. After obtaining the operational VaR value using the LDA Actuarial model, and after backtesting with valid results, the company can reserve losses equal to the operational VaR value, namely for a 99% confidence level of IDR 41.4 billion and with a 95% confidence level of IDR 17.6 billion. This operational risk value calculation can be used as a consideration for EPC management in determining future loss as a result of the year-end accounting audit for loss projects. Refer to financial side, future losses is a thing regulated by PSAK 72 for companies. Construction contract revenues and expenses are recognized using the percentage of completion method to determine the appropriate amount to be recognized in a certain period. If there is a substantial probability that total contract costs will exceed total contract revenue, the expected loss is immediately recognized as an expense.

Risk Management Strategies

Researcher tried to interview to find insight about EPC companies and its complexities. Here are result of interview in order to find management strategies related to high risks : EPC companies are responsible for the entire project cycle. In several ways, EPC companies are different from other companies, where EPC companies offer a "lumpsum price" which includes engineering, procurement and construction stages. These differences can affect the management of the company itself, where the differences can be explained as follows:

1. **Risk Complexity:** EPC companies often face more complex operational risks compared to other companies. Involvement with many stakeholders, complex material procurement, short completion times and inappropriate budgets can cause more significant operational risks. Therefore, an EPC company's operational risk management strategy should consider specific aspects related to EPC activities, such as project risk management, subcontractor management and project complexity management.
2. **Dependency of each unit:** EPC companies have an important role in managing complex supply chains for the procurement of mechanical, electrical and instrument materials and equipment. An EPC company's operational risk management strategy must pay attention to risks related to the supply chain management process, such as managing the continuous arrival of equipment, or

supplying and stocking large quantities of materials. It is important for EPC companies to have a strong control and monitoring system to mitigate these risks and ensure timely availability of materials that meet specifications.

3. **Contractor and Subcontractor Management:** EPC companies often work with contractors and subcontractors to carry out projects. This creates additional risks regarding the quality of the subcontractor's work, delays in completing tasks, or contractual issues. An EPC company's operational risk management strategy should include a process for selecting appropriate contractors and subcontractors, as well as careful monitoring and control of their performance.

Some strategies that can be carried out by EPC companies are:

1. **Risk Identification:** Companies need to identify specific operational risks related to the EPC business unit. This involves identifying all potential risks that can affect company operations, such as the risk of project delays, the risk of failure and delays in procurement of goods or services, the risk of basic design non-conformities and so on.
2. **Risk Analysis:** After identifying risks, the company needs to carry out a comprehensive risk evaluation and analysis. This involves assessing the potential impact of each risk on the EPC business unit and the company as a whole. This evaluation helps companies prioritize which risks are most significant and require effective mitigation.
3. **Risk Mitigation:** Companies must develop a comprehensive risk mitigation plan to address identified operational risks. This plan must include strategies and concrete steps that will be taken to reduce or eliminate existing risks. For example:
 - a. **Determining responsibilities:** Determine clear responsibilities to the owner, consortium or joint operation partners, project team and subcontractors regarding responsibilities and scope of work. This is operational risk mitigation where each party understands its role, is responsible for managing existing risks, and avoids gray scope areas.
 - b. **Use of appropriate contracts:** Using well-structured contracts to manage responsibilities and risks between all parties involved in the EPC project. Clear and comprehensive contracts can help reduce conflicts with job owners or subcontractors that result in litigation.
 - c. **Goods & services procurement strategy:** Goods and services procurement strategy is carried out by identifying resource needs and procurement plans. By centrally scheduling and procurement, it can help companies to "save" and reduce capital costs for carrying out work. Apart from that, the selection and selection of vendors or subcontractors who have the capacity and ability to carry out the work needs to be done so as to reduce redoing work or errors in selecting partners and become additional costs for the company.
 - d. **Implementation of a risk management system:** Implementing an effective risk management system, such as risk identification, risk analysis, risk monitoring and appropriate mitigation actions. This allows companies to proactively identify risks and take the necessary steps to mitigate their impact.
 - e. **Improved communication and coordination:** Increased communication and coordination between all parties involved in the EPC project. Effective communication and open information channels help in detecting and resolving problems quickly, thereby reducing operational risks.
 - f. **Employee training and development:** Carrying out training and development for employees involved in the EPC business unit. This will increase their understanding of existing operational risks and equip them with the skills necessary to manage risks well.

Researchers conducted a study of the risk management system of the EPC business unit to determine the mitigation value and residual risk value. From the results of analysis using internal company data, several types of operational risks were found that could trigger losses for the company, namely social risks, legal or compliance risks, human resource risks, job mismatch risks, and

performance risks. In this case, by carrying out various risk mitigation measures, the company was able to reduce losses to IDR 16.76 billion.

CONCLUSION

Through the understanding of complexity arising from EPC business process, this study contributes to measure the operational risk calculation utilized by historical operational loss data spanning from 2019 to 2022. Employing the loss distribution approach method, operational risk calculations reveal an expected loss of IDR64,18 billion with IDR17,68 billion at a 95% percentile and IDR41,4 billion at a 99% percentile. In response to these substantial risks, risk mitigation shall be conducted focusing on performance risk, work non-conformity risk, project delay risk, and other relevant factors. With exploring effective mitigation strategies, companies are able to reduce risks and minimize losses. The knowledge of specific operational risk in a planning stage will enable project management to navigate uncertainties, make decision and build a resilient and sustainable organization. This journal explores the practical implications of comprehending operational risk in EPC companies, shedding light on future research, academic, and companies' management. By embracing a forward – looking approach, future researchers can enhance the accuracy of risk prediction and capture the dynamic nature of operational risk by develop the outlier. Besides, uncover the evolving nature of operational risks over time, may allow researchers to identify emerging risk and assess the effectiveness of mitigation strategies. The practical of these studies also give some implication for academic. By encouraging collaboration between some of discipline may lead to innovative approaches for understanding and managing complex operational challenges. Drawing insights from diverse fields, can enrich the study of operational risk. Last, that the conclusion may have significant implication for EPC management. Management is encouraged to enhance the capability in understanding EPC scope of work. Knowledge sharing within organization and across industry sectors can be established by involving the expert to facilitate strategic decision-making. Establishing the best practices and lessons learned enhance collective resilience to operational risk. In examining the calculation of loss distribution, this approach allowed the researcher to bring a fresh perspective by explaining the diversity of discussion which we focus on EPC Companies. By doing so, we hope to contribute meaningfully to the ongoing dialogue within the construction community. However, the study has a limitation: the researcher has applied and considered the context of the data by excluding the outliers. Not all outliers are error, some of them represented important information. The selection of dataset of study needs to be handled with effective because the outlier may show extreme value and blur the data.

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