

# **Study of Risk and Cost at Planning Phase of Construction Project in Oil and Gas Industry (Study Case: Project XYZ)**

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**ABSTRACT:** The construction industry for industrial buildings, especially the oil and gas industry is very vulnerable to the risk of uncertainty because of the nature of its business from the assessment of the initial project investment to the physical completion at the end of the project. Risk management ensures that risks can be identified, examined and mitigated where stakeholders are key in any decision making. The application of risk management in a project is very necessary so that the success rate is high and generate high profits on the project team. In this study the risk and cost study was carried out by analyzing the HAZOP study report with probability techniques and Monte Carlo simulation with Crystal Ball Version 11.1.2.3 software. To determine the most significant risk and cost consequences in the entire system in the production plant and the feasibility of the project to be able to continue in the construction phase (EPC). From the simulation results at 90% confidence level, the risk range values in Low category based on OWNER risk ranking matrix specifications. While estimated cost of the project based on the AACE international standard at 90% confidence level is still within the range of the cost value.

**KEYWORDS:** Risk Management, HAZOP study, Monte Carlo Simulation and Crystal Ball.

## **I. INTRODUCTION**

The Oil and Gas Sector is an important element for developing countries to improve the quality of people's lives. And also catch up with other countries. The high public consumption of fuel oil (BBM) along with very high population growth each year has become a central issue of energy lately. So that the national development efforts being carried out in essence are efforts to improve people's welfare by increasing oil production from existing wells.

Field X is located in Pelawad Village, Karawang-West Java which is the working area of PT. ABC - Subang Field. The surface production facility called the Collecting Station X is located on the ABC-03 well site, which will be built with 2 (two) procurement schemes, namely: rental and permanent facilities. The oil fluid from field X will be produced in advance of all X wells. The field production fluid X will be processed to meet the gas and oil sales specifications.

Gathering Station X is designed to produce 7 MMSCFD of gas (6 MMSCFD non asso gas and 1 MMSCFD gas asso), 2700 BOPD and 500 BWPD. Asso gas is a gas with high CO<sub>2</sub> content and cannot be processed while non asso gas is a gas with low CO<sub>2</sub> content and can be processed.

The purpose of this study are:

1. To Obtain and know the risks and costs at the planning stage of the construction project of the oil and gas industry.
2. From the results of the risk study based on HAZOP study report and costs at the FEED stage, it can be seen the feasibility of the project to proceed to EPC construction stage with the help of Crystal Ball software version 11.1.
3. To obtain and find out the factors that most influence / significantly affect the entire system with the help of Crystal Ball software version 11.1.

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## II. LITERATURE REVIEW

### FEED (Initial Planning)

FEED (Front End Engineering Design) is also called FEL (Front End Loading) is a planning phase of the project where the FEED document will be used as a tender / tender document for EPC work. In FEED phase will determine the basic design and carry out the initial design of the construction of the building to be built.

The aim of the FEED is to develop the scope of the project and to provide all specifications needed for project implementation. Engineering design specifications and estimated project costs (OWNER Estimate) are the main products of this phase. The FEED phase is carried out by an engineering consultant appointed by the OWNER through the Auction / Tender process.

### EPC (Engineering, Procurement and Construction)

A process by which a contractor works on a project with the scope of responsibility for completing work including design studies, material procurement and construction and planning of the three activities. Usually used for complex project projects such as: oil and gas industry, fertilizer factory, petrochemical. The scope of EPC's work includes: procurement of materials and equipment, all design, engineering, procurement, construction and installation work including commissioning, start-up, training, and reception and testing activities. So that all the required tasks are ready to be operated and submitted to the OWNER.

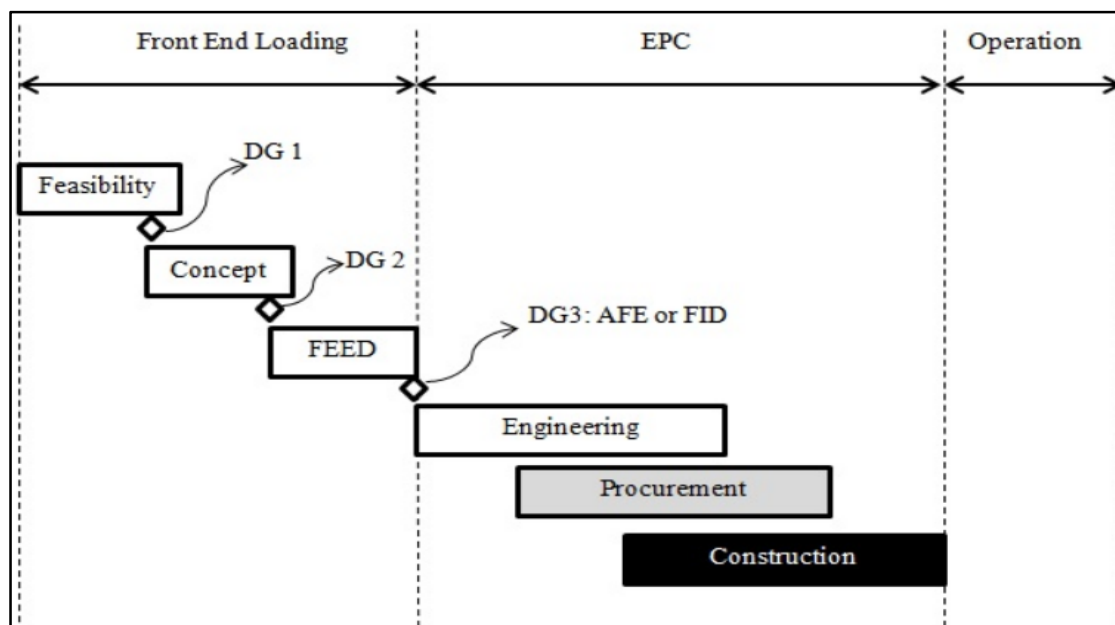


Fig. 1 Typical life cycle of oil and gas projects (Moazzami, M, 2015)


The level of cost accuracy at the FEED stage is included in Class 3 based on the cost estimation classification system developed by the International AACE (Association of Advancement Cost Engineering), the range of accuracy of low and high estimates at the FEED stage is Low: -10% to -20% and High: + 10% to + 30%.

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ESTIMATE CLASS	Primary Characteristic	Secondary Characteristic			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range marked. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.  
[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

Fig. 2 AACE Cost Estimate Matrix

## Risk Management

A structured approach / methodology for managing uncertainty related to threats. A series of human activities including; risk assessment, development of strategies to manage it and risk mitigation by using empowerment / resource management.

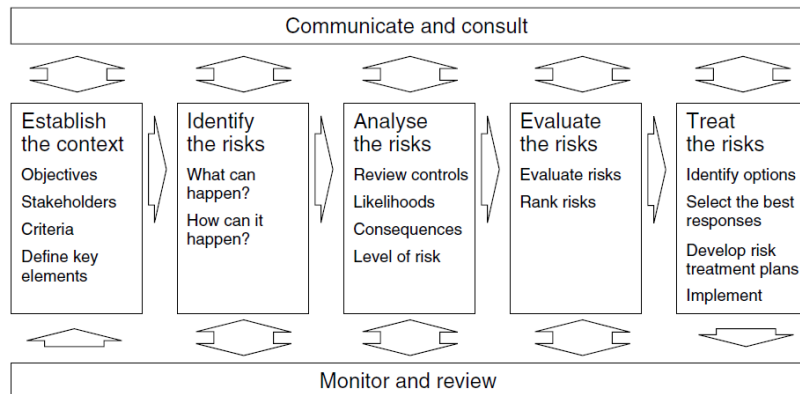


Fig. 3 Risk Management Process in project (Dale, 2005)

## HAZOP

Hazard and Operability (HAZOP) is one method of qualitative analysis to identify potential hazards and operational problems of a project / facility. According to Dale (2005) the HAZOP focuses on examining the proposed process systems, equipment and procedures systematically and in detail, through structured use through the process of "brainstorming" using guidewords to immediately check deviations from design conditions.

The HAZOP study uses a group of experts with expertise that includes the design of the process or product and its application (ICHQ9). According to Dale (2005) the HAZOP study was facilitated by independent and experienced

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people including management, design, operations and maintenance and operation personnel directly involved in the project.

Table 1: OWNER risk ranking specification matrix

HAZARD EFFECT (SEVERITY)					Level	PROBABILITY (LIKELIHOOD)					
						The consequence is almost impossible to occur	The consequence is unlikely to occur	The consequence is moderately likely to occur	The consequence is likely to occur	The consequence is almost certain to occur	The consequence is definitely to occur
People	Environment	Asset (Cost)	Reputation	Legal		1 Almost impossible	2 Very Low	3 Low	4 Medium	5 High	6 Very High
> 2 Fatality	Major impact to the environment, total Loss of Containment (≥ 500 bbbls)	Major Loss ≥ US\$ 100 M	National impact	License to operate revoked	5 Catastrophic	5	10	15	20	25	30
1-2 Fatality	Significant impact to the environment, significant Loss ≥ 100 - 500 bbbls	Significant Loss ≥ US\$ 10 M - 100 M	Regional impact	Significant penalty from regulator	4 Major	4	8	12	16	20	24
Permanent Disability, Lost Time Injury	Moderate impact to the environment, significant Loss ≥ 15 - 100 bbbls	Moderate Loss ≥ US\$ 1 M - 10 M	Local impact	Moderate penalty from regulator	3 Moderate	3	6	9	12	15	18
Restricted Work, Medical Treatment	Slight impact to the environment, minor Loss ≥ 1 - 15 bbbls	Minor Loss ≥ US\$ 100 k - 1 M	Internal impact	Warning from regulator	2 Minor	2	4	6	8	10	12
First Aid Injury	Minimum impact to the environment, not significant Loss < 1 bbbls	Not significant Loss < US\$ 100k	Not significant impact	Not significant reaction from regulator	1 Slight	1	2	3	4	5	6

The application of risk management on a project as an important tool to achieve higher quality and quantity in renewable energy development projects.

Based on the above problems, the risk studies in the HAZOP report and costs at the initial planning stage (FEED stage) will be carried out as a method to determine what factors have a significant impact on project management activities before the integrated construction phase (EPC) is continued. And to explore the process of the auction / tender stages in the construction industry, especially oil and gas from the FEED (initial planning) stage.

### Monte Carlo Simulation

One method of risk analysis found in ISO 31000 is a Monte Carlo simulation, which is a method that can overcome complex situations that will be very difficult to understand and solve with an analytical method. The usefulness of this method is to evaluate the effects of uncertainty in a system in a wide range. In the risk analysis and cost of Monte Carlo simulation is a mathematical technique that is computerized and can calculate risks and costs in quantitative analysis and decision making. Monte Carlo simulations carry out risk and cost analysis by modelling a possible outcome by substituting a range of possible distribution values for any factor containing uncertainty. The simulation then calculates the results repeatedly each time using a different random value from the probability function.

### Crystal Ball

An additional software in Microsoft Excel that provides facilities to apply Monte Carlo Simulation and time series analysis, forecasting (Forecast), optimization and decision analysis. Monte Carlo simulation is a method commonly used to handle risks and uncertainties. The simulation relates to hundreds or even thousands of replications of a model where uncertainty variables are replaced with numbers generated from the right distribution to represent the form of uncertainty of the related variable. In this study the compiler took these variables based on the data obtained from the HAZOP report of the study that had been carried out and estimated project costs at the FEED stage as a case study on the X construction field planning project. To find the probability values used various distributions. In this study the distribution used is a triangular distribution.

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## Sensitivity Analysis

This analysis helps determine which risks have the most potential impact on a project. This analysis also helps to understand how variations in project objectives correlate with variations in different uncertainties. Instead, he tests the extent to which the uncertainty of each element of the project influences the objectives being studied when all other uncertain elements remain.

## III. RESEARCH METHODOLOGY

The data used in this study is secondary data, namely data obtained from the second party. The X Field FEED Project which is used as the object of study in this study is located in Karawang, West Java.

The data analysis technique uses Crystal Ball Version 11.1.2.3 with the following stages:

1. Input data on risk and costs that have been identified
2. Input data in the form of upper limit (maximum), lower limit (minimum) and frequency level (likelihood)
3. Start the simulation.
4. The simulation results in the form of a forecast graph in the form of probability with several confidence levels of statistical data and the significance of risks and costs so that the risk factors which have the most influence on the project can be known

## IV. STUDY AND DISCUSSION

This study begins by analyzing the HAZOP report using Value Engineering techniques for each NODE, then proceed with risk and cost analysis using crystal ball software.

In this project based on the HAZOP report, the number of nodes has been determined by the HAZOP Team total 16 numbers, including:

Table 2: NODE list

NODE	Keterangan
NODE 1	Flowline & Manifolds
NODE 2	HP Production Separator
NODE 3	HP Scrubber
NODE 4	Gas Processing Package (CO <sub>2</sub> Removal & Dehydration Unit) dan LP Gas Compressor (Tidak dikaji, akan dikaji lebih lanjut oleh VENDOR pada fase EPC)
NODE 5	LP Production Separator
NODE 6	LP Scrubber
NODE 7	Wash Tank
NODE 8	Oil Production Tanks & Pumps
NODE 9	Produced Water Tanks, Test Tanks & Pumps
NODE 10	HP Test Separator
NODE 11	LP Test Separator
NODE 12	HP Flare KO Drum & HP Flare
NODE 13	LP Flare KO Drum & LP Flare
NODE 14	Electricity System
NODE 15	Instrument Air System
NODE 16	Fire Water System

### NODE 1

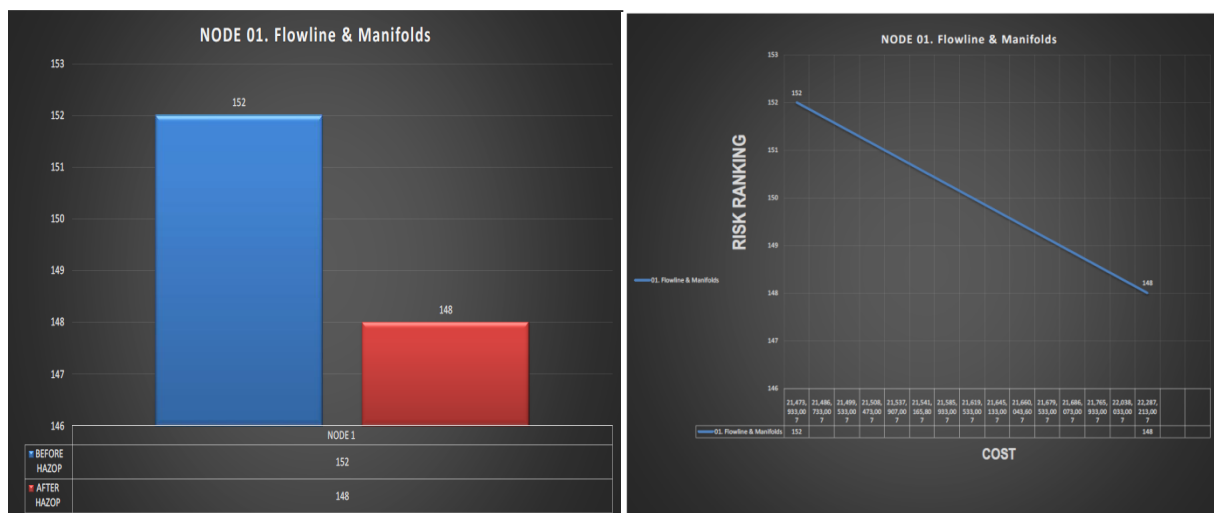
After conducting a study with VE techniques and evaluating the HAZOP report on the study of ranking risk, the results can be seen in the figure below.

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No.	Remark	Risk Mitigation		Cost		% Kenaikan
		Before HAZOP	After HAZOP	Before HAZOP	After HAZOP	
NODE 1	FlowLine & Manifolds	152	148	21,473,933,007	22,287,213,007	1.038

Fig. 4 Summary of Risk and Cost at NODE 1

Summary for the entire NODE shown at table below.

Table 3: Summary of the results of the risk assessment of entire NODE

NO.	REMARK	RISK		COST		Deviation	% Increase
		BEFORE HAZOP	AFTER HAZOP	BEFORE HAZOP	AFTER HAZOP		
NODE 1	01. Flowline & Manifolds	152	148	21,473,933,007	22,287,213,007	813,280,000	1.038
NODE 2	HP Production Separator	182	165	21,473,933,007	21,686,073,007.19	212,140,000.00	1.010
NODE 3	HP Scrubber	108	102	21,473,933,007	22,038,033,007.19	564,100,000.00	1.026
NODE 4	(Akan dikaji oleh VENDOR during EPC stage)			21,473,933,007	21,473,933,007.19	-	1.000
NODE 5	LP Production Separator	192	168	21,473,933,007	21,645,133,007.19	171,200,000.00	1.008
NODE 6	LP Scrubber	124	115	21,473,933,007	21,660,043,607.19	186,110,600.00	1.009
NODE 7	Wash Tank	92	80	21,473,933,007	21,499,533,007.19	25,600,000.00	1.001
NODE 8	Oil Production Tanks & Pumps	188	179	21,473,933,007	21,537,907,007.19	63,974,000.00	1.003
NODE 9	Produced Water Tanks, Test Tanks & Pumps	132	117	21,473,933,007	21,508,473,007.19	34,540,000.00	1.002
NODE 10	HP Test Separator	192	189	21,473,933,007	21,499,533,007.19	25,600,000.00	1.001
NODE 11	LP Test Separator	200	194	21,473,933,007	21,619,533,007.19	145,600,000.00	1.007
NODE 12	HP Flare KO Drum & HP Flare	48	36	21,473,933,007	21,765,933,007.19	292,000,000.00	1.014
NODE 13	LP Flare KO Drum & LP Flare	48	39	21,473,933,007	21,585,933,007.19	112,000,000.00	1.005
NODE 14	Electricity System	84	78	21,473,933,007	21,679,533,007.19	205,600,000.00	1.010
NODE 15	Instrument Air System	108	105	21,473,933,007	21,541,165,807.19	67,232,800.00	1.003
NODE 16	Fire Water System	24	24	21,473,933,007	21,486,733,007.19	12,800,000.00	1.001
<b>TOTAL</b>				<b>343,582,928,114.99</b>	<b>346,514,705,514.99</b>		<b>1.009</b>
<b>COST IMPACT AFTER HAZOP (%)</b>							<b>1.009</b>
<b>COST DEVIATION</b>						<b>2,931,777,400.000</b>	

From the table above, it can be seen that the overall cost increase 1.009% after analysis on the study's HAZOP report.

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### Sensitivity Analysis for Risks

The minimum risk scale is obtained based on the OWNER ranking risk specification data. Consequences Likelihood: Risk ranking after HAZOP recommendations from the HAZOP team of the entire NODE in the system.

The maximum risk scale is obtained based on the OWNER risk ranking specification data.

Table 4: Input Risk Analysis for Crystal Ball

NODE	Guideword	Consequences	Severity	Minimum	Likelihood	Maximum
1.4	Reverse flow	Kerugian produksi	R2	2	6	12
1.10	Less Temperature	Pembentukan deposit/wax/parafin pada perpipaannya menyebabkan pembacaan instrumentasi tidak akurat	A2	2	6	12
2.3	No Flow	Kerugian produksi	R3	3	9	18
2.11	More Level	Liquid carry over ke HP Scrubber (2-14-D-05)	A2	2	6	12
3.1	More Flow	More flow di HP Scrubber (2-14-D-05) menyebabkan liquid carry over (sebagai mist) ke pipeline	A3	3	9	18
3.3	No Flow	Low pressure pada HP Scrubber (2-14-D-05) menyebabkan kerugian produksi	R3	3	9	18
5.3	No Flow	Kerugian produksi	R3	3	9	18
5.11	More Level	Liquid carry over ke LP Scrubber (2-14-D-06)	A3	3	9	18
5.12	Less Level	Gas blowby ke Wash Tank (2-14-T-01) menyebabkan high pressure di Wash Tank (2-14-T-01)	A3	3	9	18
5.18	Maintenance	Ball valve tidak bisa digunakan untuk mengatur laju alir	A3	3	9	18
14.6	More Pressure	PCV aliran dari HP Scrubber atau LP Scrubber	A3	3	9	18

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NODE	Guideword	Consequences	Severity	Minimum	Likelihood	Maximum
<b>14.12</b>	Less Level	gagal/rusak pada kondisi terbuka Gas blowby pada flare sump pit (safety hazard)	M3	<b>3</b>	<b>9</b>	<b>18</b>

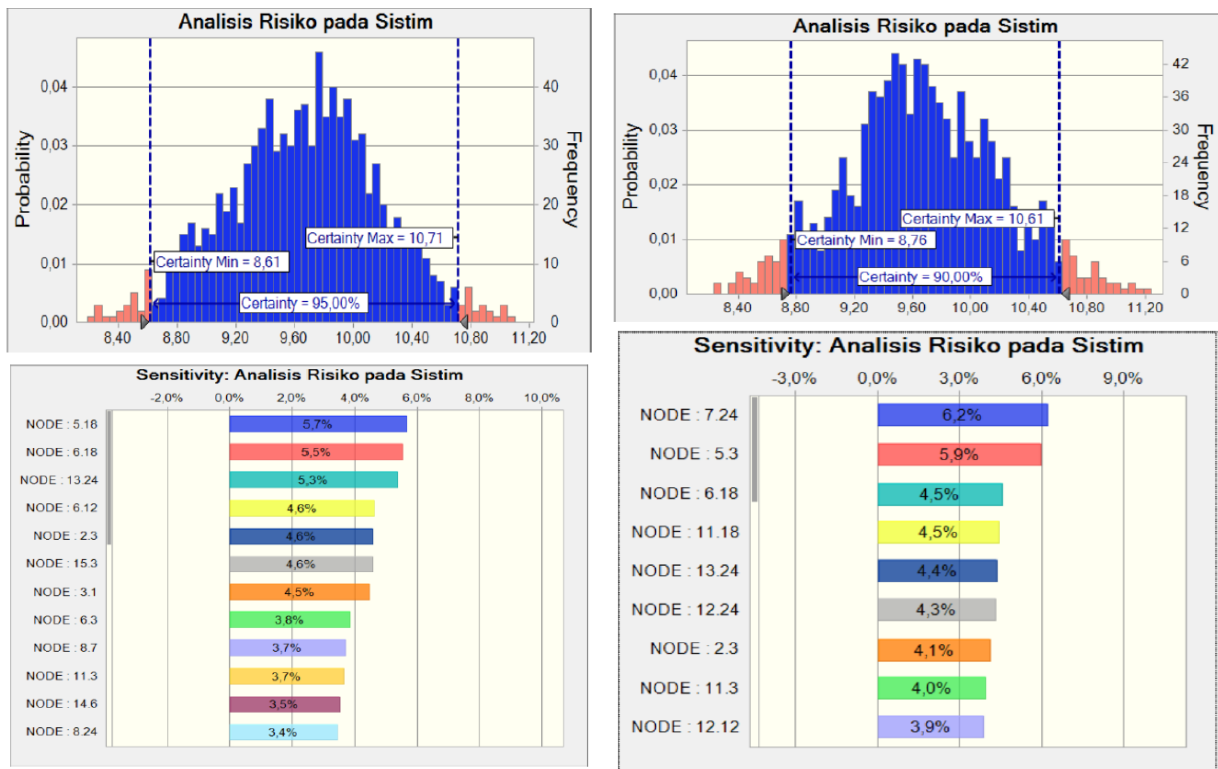


Fig. 5 Simulation results at confidence level 95% & 90% for risk

Based on some of the simulation results in the picture above, it shows the following:

1. - At 95% confidence level the results obtained are the probability of the level of risk with a range of **8.61 to 10.71**.  
- NODE 5.18 (LP Production Separator - Maintenance) with consequence that ball valve cannot be used to regulate the flow rate having the highest sensitivity value of **5.7%**
2. - At 90% confidence level the results obtained are the probability of the level of risk with a range of **8, 76 to 10, 61**.  
- NODE 7.24 (Wash Tank - Design) with consequence causing barriers to venting lines and flame arrestor not optimal for protecting tanks having the highest sensitivity value of **6.2%**

### Sensitivity Analysis for Costs

The minimum cost estimate is obtained based on the AACE Cost Estimate Matrix in Class 3 with L: - 20% of the cost at each WBS Level.

Likelihood: initial planning costs compiled at the FEED stage

The estimated maximum cost of AACE Cost Estimate Matrix in Class 3 with H: + 30% of the cost at each WBS Level.



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Table 5: Input Cost Analysis Crystal Ball

WBS Level	Remark	Minimum (IDR)	Likelihood (IDR)	Maximum (IDR)
1.1	Package static	15,124,900,000	18,906,125,000	24,577,962,500
1.2	Tank	8,636,360,559	10,795,450,700	14,034,085,910
1.3	Vessel	1,310,214,299	1,637,767,874	2,129,098,236
1.4	Fuel Gas Package	5,092,000,000	6,365,000,000	8,274,500,000
1.5	Pigging	2,290,060,924	2,862,576,156	3,721,349,003
1.6	Flare & Vent	5,917,816,800	7,397,271,000	9,616,452,300
1.7	LP Gas Compressor Package	3,290,668,000	41,613,335,000	54,097,335,500
1.8	CO2 Removal Package	2,960,000,000	28,700,000,000	37,310,000,000
1.9	Dehydration (DHU Package )	6,480,000,000.00	20,600,000,000	26,780,000,000

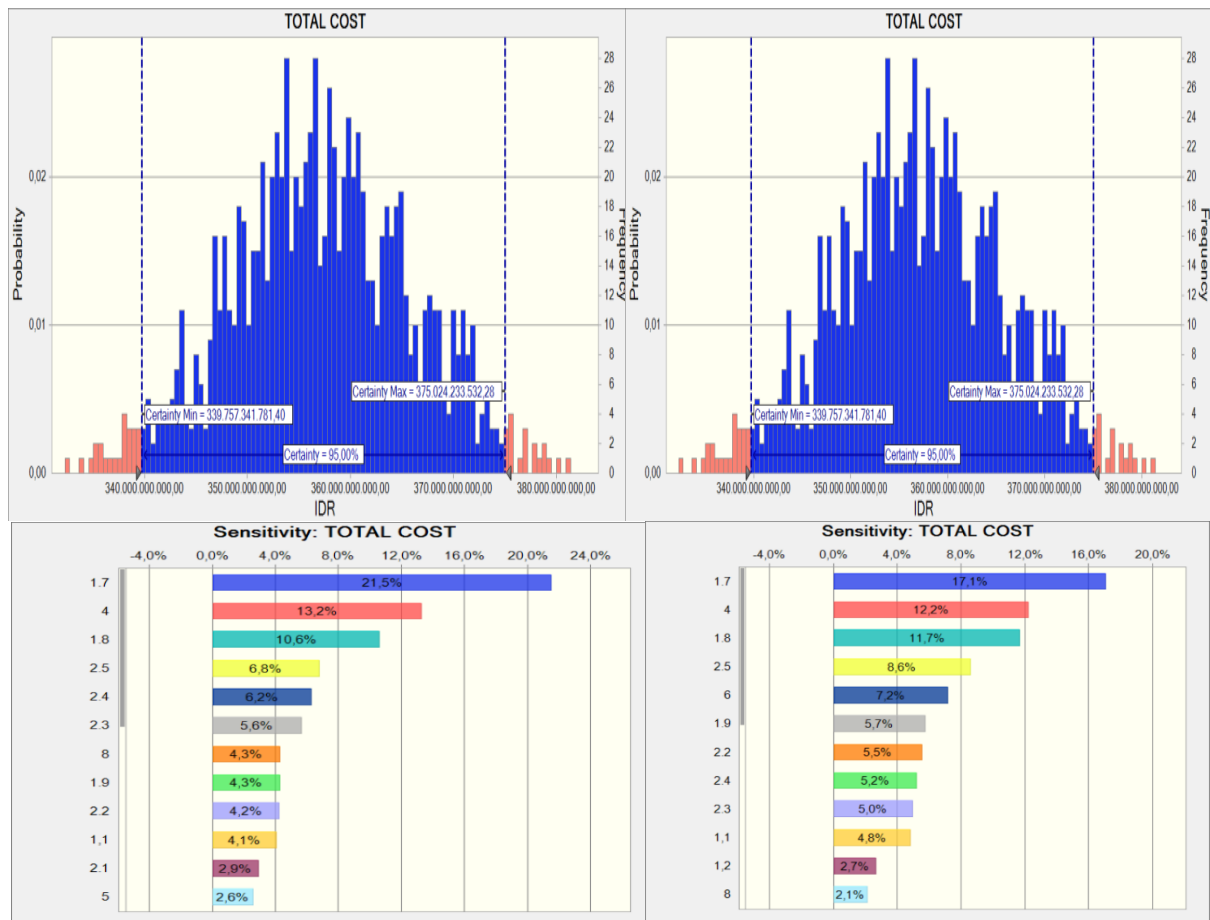


Fig. 6 Simulation results at confidence level 95% & 90% for cost

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Based on some of the simulation results in the picture above, it shows the following:

- At the 95% confidence level the results obtained are probability level costs with a range of **339,757 to 375,024**.  
- WBS Level 1.7(LP Gas Compressor Package) has the highest sensitivity value of **21.5%**.
- At a 90% confidence level the results obtained are the probability of a cost level with a range of **343,854 to 372,983**.  
- WBS Level 1.7 WBS (LP Gas Compressor Package) has the highest sensitivity value of **17.1%**.

## V. CONCLUSIONS

The results obtained can be summarized as follows.

- Based on the recommendations from the study's HAZOP report after a study of risks and costs in the entire NODE using the VE Job Plan technique, a cost increase of 1.009% (2,931,777,400 Billion) was obtained. The impact of the increase in cost (cost impact) of 1.009% is not too significant from the total project cost, therefore FEED project Field X is feasible to continue on EPC construction phase.
- The results of the Risk Analysis for the entire NODE can be seen in the table below.

C.L	Risk Range	Risk Significant	Percentage value
95%	8.61 to 10.71	NODE 5.18	5.7 %
90%	8.76 to 10.61	NODE 7.24	6.2 %
85%	8.91 to 10.53	NODE 5.12	5.6 %
80%	8.97 to 10.35	NODE 13.24	6.4 %
70%	9.14 to 10.25	NODE 13.12	6.9 %

From the table above it can be seen that the results of the risk sensitivity analysis vary depending on the level of confidence (Confidence Level) used.

Based on the simulation results above from several levels of confidence and based on common practice used at statistical literature. Hence author chooses at the level of confidence (C.L.) 90% with a risk range **8.76 - 10.61**. Based on the Risk ranking specification from the OWNER, the overall risk for this project falls into the category with LOW Probability (likelihood) at the Moderate - 3 level (see table 1), the project is feasible to continue on EPC construction phase.

- Results Analysis of the overall cost of the project can be seen in the table below.

C. L.	Cost Range (IDR)	WBS Cost Significant	Percentage value
95%	339.757 to 375.024	Level 1.7	21.5 %
90%	343.844 to 372.983	Level 1.7	17.1 %
85%	345.787 to 370.456	Level 1.7	27.7 %
80%	346.461 to 370.021	Level 1.7	21.1 %
70%	348.595 to 367.024	Level 1.7	21.3 %

Based on the simulation results on several levels of confidence, at confidence level 90% with a range of costs **343,844 - 372,983 billion**, hence OWNER Estimate price at FEED stage 346,514 billion is still within that range. The estimated cost of the project at the FEED stage is feasible to continue at the construction stage (EPC phase).

- From the results of sensitivity analysis at different levels of confidence (Confidence Level), the same results were obtained at WBS Level 1.7 (LP Gas Compressor Package) because had a significant impact on the overall cost of the project.
- Sensitivity analysis is very effective in helping determine what factors are the most sensitive / significant in a project.
- This HAZOP study is implemented in the Value Engineering Job Plan technique.

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## REFERENCES

- [1] AACE International Recommended Practice No. 18R-97. Cost Estimate Classification System – as Applied in Engineering, Procurement and Construction for the Process Industries, 1998.
- [2] Berawi, M.A., "The Integration of Value and Risk Management in Infrastructure Projects: Learning from others," Quantity Surveying International conference Kuala Lumpur, Malaysia, pp. 1–13, 2007.
- [3] Chapman, C. & Ward, S., "Project Risk Management: Processes, Techniques and Insight," John Wiley & Sons, 2002.
- [4] Dale, C., "Project Risk Management: Managing Risk in Large Projects and Complex Procurements," John Wiley and Sons, 2005.
- [5] Dell'Isola, "A Value Engineering: Practical Application," United States of America: RS Means Company Inc, 1997.
- [6] Hamid, R.F, Nasiri S. Integrating Risk Management and Value Engineering in the Development of Renewable Energy Project. SAS Technical Paper, vol. 6, no. 11, pp. 1–10, 2012.
- [7] Haghnegahdar Lida, and Ezzatollah A. The Risk and Value Engineering Structures and their Integration with Industrial Projects Management (A Case Study on I. K. Corporation). International Journal of Structural and Construction Engineering, vol.2, no. 4, pp. 1–9, 2008.
- [8] IEC 61882 Hazard and Operability Studies (HAZOP Studies) - Application Guide, 2016.
- [9] ISO 31000 (2009). Risk Management - Principles and Guidelines, Published in Switzerland, 2009.
- [10] Maisenbacher, Sebastian, "Extended Model for Integrated Value Engineering," Procedia Computer Science 28, pp. 1–8, 2014.
- [11] Moazzami, M. A, "Theoretical Framework to Enhance the Conversion Process in Convertible Contracts," International Journal of Construction Engineering and Management 2015, vol.4, no. 6, pp. 1–8, 2015.
- [12] Oberlender, Garold D., "Project Management for Engineering and Construction," McGraw Hill Education, 2000.  
OGC., "Achieving Excellence in Construction: Procurement Guide 04 Risk and Value Management," Office of Government Commerce, Malaysia, 2003.