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Risk Management in Petrochemical Companies: Sankyu Company as Case Study

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Abstract: Numerous risks associated with petrochemical projects can lead to cost overruns and negatively impact the quality of petrochemical products. These problems result from a failure to implement a plan to manage risks related to the operation and maintenance of petrochemical equipment and machinery. Therefore, this study aims to examine the risk mitigation strategies represented by risk retention, risk control, risk prevention, and risk transfer related to improving the financial aspects of petrochemical projects. To achieve the research objectives, the study relied on the quantitative approach by using a questionnaire that included the definition of all potential risks related to operational, human, environmental, and maintenance risks. The questionnaire also included an extensive study of risk mitigation strategies. The organization distributed the questionnaire to 268 Sankyu Company employees who operate and maintain petrochemical equipment. The study sample reached 159 respondents. The SPSS statistical analysis program calculated averages and standard deviations after collecting the data. The study found that the potential risks assessed using the risk index have a significant impact on petrochemical projects. The study also provided a comprehensive guide that includes risk mitigation strategies in petrochemical projects. The study has proven effective in improving the financial aspects of petrochemical projects.

Keywords: Petrochemical, Risk Management, Retention, Control, Prevention, Transfer-Operation, Maintenance.

1. Introduction

Risk management can be defined as a regime that ensures continuous enhancement and advancement in the job application and indicates the decision-making process in organizations. Enterprises use risk management as a proactive tool to avoid risks and to enhance the value of their organizations. Efficient management strategies usually consider risk management as a significant origin and a main section of a flexible job environment, according to Wilson (1997)[1]. In recent years, the risk management concept has become extremely common in numerous enterprises and firms. To reduce the correct economic cost and to mitigate projects correlated to dangers, several times construction firms with extended and complicated projects are keen to employ danger management strategies. To enhance performance and earnings, numerous petrochemical firms began to create risk management tools, as mentioned by Samson et al. (2009).[2] Numerous situations consistently place petrochemical projects in significant danger, with causes ranging from reliance on complex technology to the involvement of multiple parties. According to AlNoaimi & Mazzuchi (2021)[3], a danger can be defined as a series of unplanned unwanted events that have the potential to alter the allocation prospects of a specific investment[4] .

The Research Problem

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Oil and gas manufacturers are among the top industries that can significantly contribute to the economy. The industry also takes a leading part in KSA in comparison to other members of the Gulf Cooperation Council (GCC). The Gulf Cooperation Council (GCC) provides nearly 16% of the world's petrochemical products, with KSA alone accounting for approximately 60% of the total production in the petrochemical industry. KSA is considered the 11th highest petrochemical exporter globally (AlNoaimi & MazzuchiEven though KSA petrochemical manufacturing firms are making the most progress in petrochemical products, these industries are losing a lot of money because they don't plan well enough for machinery and equipment maintenance, emergencies happen out of the blue, and machines and equipment break down while they're being used. [4]This causes projects to take longer than planned, cost more than planned, and produce lower-quality petrochemical products. roducts.[5] Thereby, risk management should be planned in the planning stage of a petrochemical project and establish a maintenance and operation plan that is essential to avoid any cost and time overrun in petrochemical projects and gain the optimum financial performance for the petrochemical firm[6][7].

This research has the potential to significantly benefit the management of petrochemical industry projects, particularly in the areas of machine and plant operation and maintenance. [8]The significance of this research lies in its incorporation of risk management methods into the equipment maintenance stage and operation plan, as it provides a strategy that equips the practical field with a basis and guidelines to prevent any potential hazards that may arise from the maintenance of petrochemical plants and machines. [9]This research not only benefits the research and academic community by incorporating risk management into the project execution plan for the maintenance of petrochemical equipment and plants, but it also serves as a foundation for future research and enhancements in this field[3].

Study Objective

The primary goal of the research is to determine how danger management techniques affect the financial performance of petrochemical projects in the oil and gas industries, specifically about operation, equipment, and plant maintenance. Consequently, we can mention the following minor objectives:

1. To assess the current operation and maintenance plan at petrochemical companies in KSA and identify the dangers and potential hazards.
2. To incorporate risk management methods during the planning phase of petrochemical projects in petrochemical firms
3. To investigate the effect of the danger retention tool on the financial performance of the project,
4. To verify how risk avoidance impacts the project's financial performance.
5. To verify the influence of risk control on the project's financial performance.
6. To assess the impact of risk transfer on the project's financial performance.

Research Questions:

1. What hazards are more likely to occur during equipment maintenance and operation in petrochemical industries?
2. To what extent does risk retention influence the project's financial performance?
3. How does danger prevention affect the financial performance of projects?
4. How can we apply risk control to achieve the project's optimal financial performance?
5. What is the effect of risk transfer strategies on the project's financial performance?

2. Materials and Methods

In this study, we used quantitative methods, organized the survey questionnaire, and distributed it to Sankyu company employees.[10]

Research Sampling

We targeted a sample size of Sankyu, [11]a petrochemical production company in KSA. The survey participants comprise engineers, project managers, and labor and maintenance engineers. A survey link was used to distribute a questionnaire to all staff in Sankyu Company's maintenance department. [12]The questionnaire was distributed using a quantitative technique that analyzed the knowledge, views, and skills of the participants. The sample population in this company is approximately 268 people who are working in the operation and maintenance machines, and accordingly, the sample size required to answer the questionnaire is 159 respondents.[4]

The survey questionnaire design is based on three sections:

Section A: Demographic information of respondents

Section B: operational dangers, maintenance dangers, human dangers, and environmental dangers.

Section C: Risk reduction strategies include: risk retention, risk control, risk prevention, and risk transfer.

159 employees responded to the survey, accounting for 40.67% of the total workforce, or nearly 268 employees.

Scale development

We have adopted a five-point Likert scale, based on the significance level, to evaluate the hazards and dangers, along with risk reduction strategies (Babatunde, 2021).

Statistical significance levels= (Max value-Min.value)/(Max.value)

Statistical significance levels= (5-1)/5=0.8

Table (1) shows a significance level and Likert scale that the researcher adopted.

Table 1. Significance Levels and 5-point Likert scale.

Level	Interval of Mean	Description
1	1-1.8	Strongly disagree
2	1.81-2.6	Disagree
3	2.61-3.4	Neutral
4	3.41-4.2	Agree
5	4.21-5	Strongly agree

Data Analysis

The quantitative method's data analysis forms the basis of this section. Following the data collection process, we executed the statistical analysis using SPSS software, an efficient data analysis tool. We use Cronbach's alpha to guarantee internal consistency and reliability.

We extracted and imported the collected data from the survey questionnaire into SPSS version 23.0, where we conducted a descriptive analysis to describe participant characteristics, assess identified risks, and evaluate the effectiveness of risk mitigation strategies in enhancing the financial aspects of petrochemical projects. This was done using

statistical techniques such as frequencies and percentages, mean scores, and SD. We assessed the reliability of the instrument by adopting the Cronbach's alpha coefficient.

3. Results and Discussion

Survey tool reliability

The results in Table 2 show that the value of the (<0xD3>) coefficient varies from 0.966 to 0.97, indicating that it is significantly more reliable than the criteria mentioned above, which suggests that the accepted value should be higher than 0.7. Table2. shows (<0xD3>) coefficient values for each section of the survey study.

Table 2. Reliability analysis findings for the developed sections.

Section Designation	(α)
Risks (probability)	0.97
Risks (severity)	0.966
Risk mitigation Strategies	0.967

Moreover, reliability analysis was executed to attain consistency for total survey items and the value of alpha coefficient is illustrated in Table 3.

Table 3. Reliability Test.

(α)	N of Items
0.97	91

Demographic information

We questioned the respondents about their scientific qualifications, offering them the following choices: 1. PHD 2.Master's degree 3.Diploma 4. Bachelor 5. other.

Figure 1. Which Displays The Percentage Value Of The Respondent's Answers, Illustrates The Results As A Pie Chart.

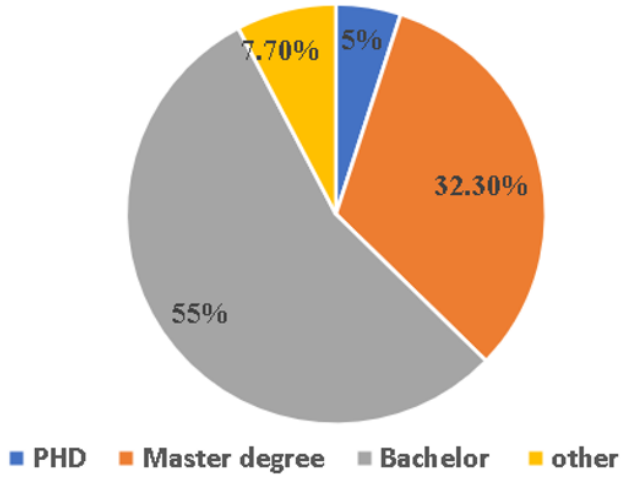

Figure 1. Scientific qualification

Figure 2. Displays The Respondents' Years Of Experience In Petrochemical Firms.

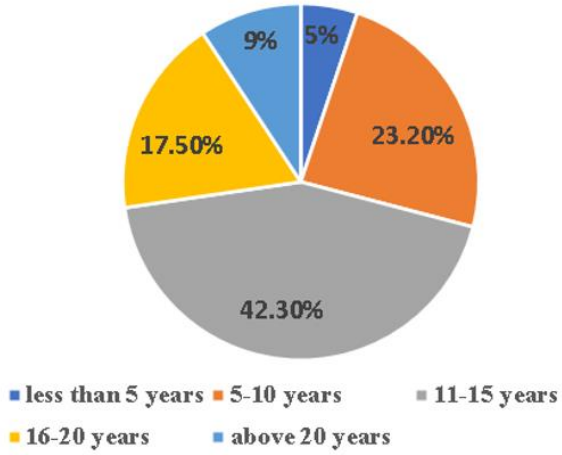

Figure .2 .Respondent's Experience

Figure 2 shows that the majority of respondents (42.3%) have experienced 11–15. Additionally, 28.3% have experience varying from 5 to 10 years. Furthermore, 17.5% of respondents have 16–20 years of experience.

Demographic data shows that respondents have the necessary qualifications to complete the survey.

Risk Assessment in Petrochemical Companies

We have obtained survey questionnaire outcomes to assess all risks in industrial companies that impact financial project aspects, lead to cost overruns and reductions in maintenance and operation of machines and plants, and result in significant additional cost losses[13].

Based on the risks that Sankyu Company experienced and the previously mentioned comprehensive literature review, this research categorized the dangers into four classes. The categories of dangers include operational dangers, human dangers, maintenance dangers, and environmental dangers.

We conducted the assessment process of the identified dangers by defining descriptive statistics, such as means, SD, and risk index (R.I.), based on the 5*5 risk matrix in Figure 3, which takes into account the probability of danger occurrence and its intensity.

R.I= risk likelihood * risk severity…. equation (1)

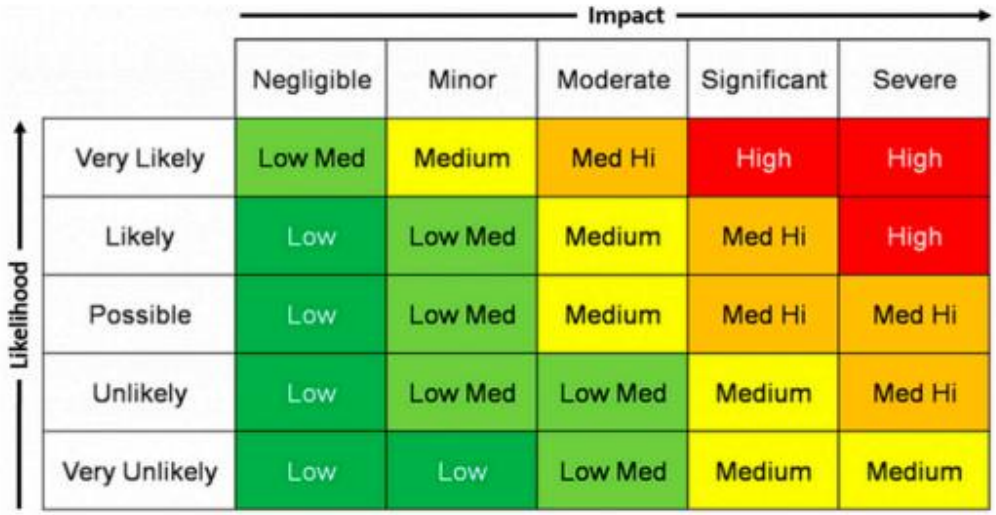

Figure 3. Risk Matrix

Table 4 displays mean values, SD, and R.I. of operational dangers that impact financial aspects in petrochemical firm projects. Table 2 outlines the steps for evaluating operational risks. We use the Risk Index (RI) from Equation 1 for each operational danger, which requires the mean values of probability and severity for that particular danger. We then estimated the risk index value using the risk matrix instrument in Figure 3.

Table 4. deviations, R.I.I and R.I of operational risks

code	Operational danger	average		SD		R.I	evaluation
		Probability	Severity	Probability	Severity		
OR1	Cleaning processes for vessels that result in the formation of chemicals inside the vessel	4.52	4.64	0.83	0.72	21.0	**High**
OR2	Crane break downs that result in damage in Production tubes.	4.63	4.66	0.76	0.71	21.6	**High**
OR3	Crane break downs that result in dropping lifted items.	4.50	4.58	0.78	0.75	20.6	**High**
OR4	Oil leakage from machines during operation.	4.50	4.60	0.78	0.72	20.7	**High**
OR5	Production, storage and waste landfill lead to contamination and firing	4.41	4.53	0.86	0.76	20.0	**High**
OR6	erosion in gas regimes	4.50	4.57	0.81	0.76	20.6	**High**
OR7	Gasket deterioration lead to escape of operation fluid	4.58	4.67	0.76	0.68	21.4	**High**
OR8	valve failure result in fluid seepage	4.55	4.62	0.76	0.67	21.0	**High**
OR9	pipe failure result in Intermixing of operation liquid, flow reduction , heat transition shortage	4.50	4.57	0.77	0.73	20.6	**High**
OR10	Lack of plants and machinery	4.52	4.62	0.77	0.68	20.9	**High**
OR11	plant operating mistakes	4.52	4.62	0.79	0.74	20.9	**High**
OR12	wasting energy	4.43	4.55	0.85	0.78	20.2	**High**
OR13	material supply delays	4.37	4.49	0.94	0.86	19.6	**High**
OR14	adopting inconvenient suppliers	4.52	4.63	0.79	0.73	20.9	**High**
OR15	supply chain management shortage	4.44	4.57	0.88	0.79	20.3	**High**

Table 4 shows that according to the risk index (R.I.) calculated, all operational dangers evaluated form a high influence on financial performance in petrochemical firms, and these operational risks should be considered in the planning stage of petrochemical projects.

Table 5 displays mean values, SD, and R.I. of human dangers that impact financial aspects in petrochemical firm projects. Table 5 illustrates the process of assessing human risks, where we evaluate each human danger using the Risk Index (RI) from equation 1, which requires the mean values of probability and the means of severity for each danger. The risk index value was then estimated using the risk matrix instrument shown in Figure 3.

Table 5. SD and R.I of Human dangers

		average		SD		R.I	evaluation
		Probability	Severity	Probability	Severity		
HR1	skilled maintenance labor shortage	4.47	4.62	0.78	0.69	20.65	**High**
HR2	skilled worker to run plant and machines shortage	4.49	4.58	0.81	0.76	20.56	**High**
HR3	provision information shortage	4.57	4.69	0.75	0.65	21.43	**High**
HR4	periodic inspection shortage for machines and plants	4.53	4.60	0.79	0.73	20.84	**High**
HR5	communication shortage lead to non precise maintenance	4.63	4.70	0.72	0.65	21.76	**High**
HR6	make decision delays for maintenance operations	4.48	4.64	0.84	0.71	20.79	**High**
HR7	maintenance team awareness shortage of the original design of the machines	4.53	4.63	0.84	0.72	20.97	**High**
HR8	managerial processes shortage	4.67	4.75	0.67	0.59	22.18	**High**
HR9	knowledge shortage of operating plants and machines	4.56	4.71	0.78	0.63	21.48	**High**
HR10	inadequate training	4.53	4.65	0.87	0.72	21.06	**High**

Table 5 shows that according to the calculated risk index (R.I.), all human dangers evaluated have a high influence on financial performance in petrochemical firms, and these human risks should be considered in the planning stage of petrochemical projects.

Table 6 displays mean values, SD, and R.I. of maintenance dangers that impact the financial aspects of petrochemical firm projects. Table 6 illustrates the process of assessing maintenance risks, wherein we evaluate each maintenance danger using the RI from equation 1, which requires the mean values of probability and the means of severity for each danger. The risk index value was then estimated using the risk matrix instrument shown in Figure 3.

Table 6. SD and R.I of maintenance dangers

		average		SD		R.I	evaluation
		Probability	Severity	Probability	Severity		

MR1	hazardous Chemicals emission due to tubes Modification	4.58	4.70	0.75	0.64	21.53	**High**
MR2	Cleaning and alteration filter lead Product leakage	4.60	4.71	0.71	0.62	21.67	**High**
MR3	Cleaning and alteration filter result in Chemical powder inspiration.	4.64	4.72	0.72	0.65	21.90	**High**
MR4	Pump Strainer Cleaning lead to Product spray	4.61	4.71	0.70	0.59	21.71	**High**
MR5	Reactor Cleaning and checks result in Firing	4.59	4.70	0.78	0.62	21.57	**High**
MR6	Reactor Cleaning and checks result in Fumes and Smoke release.	4.60	4.68	0.70	0.62	21.53	**High**
MR7	Scafolding failure	4.62	4.71	0.67	0.59	21.76	**High**
MR8	Reactor Cleaning & checks result in hazardous material emission	4.63	4.74	0.69	0.59	21.95	**High**
MR9	Flying of welding Flash.	4.69	4.79	0.64	0.54	22.47	**High**
MR10	Valve alteration result in Chemicals emissions .	4.52	4.54	0.83	0.82	20.52	**High**

Table 6 shows that according to the risk index (R.I.) calculated, all maintenance dangers evaluated have a high influence on financial performance in petrochemical firms, and these maintenance risks should be considered in the planning stage of petrochemical projects.

Table 7 displays mean values, SD, and R.I. of environmental dangers that impact the financial aspects of petrochemical firm projects. Table 7 illustrates the environmental risk assessment process, where we evaluate each environmental danger using the RI from equation 1, which requires the mean values of probability and the means of severity for each danger. The risk index value was then estimated using the risk matrix instrument shown in Figure 3.

Table 7. SD, and R.I of environmental dangers

average	**SD**	**average**		**SD**		**R.I**	**evaluation**
		Probability	Severity	Probability	Severity		
ER1	Rain	3.5	3.3	0.86	0.87	11.55	**Med high**
ER2	High temperature	3.7	3.6	0.82	0.81	13.32	**Med high**
ER3	storm	1.4	2.1	0.78	0.78	2.94	**low**
ER4	Wind speed	3.5	3.8	0.77	0.76	13.30	**Med high**

ER5	Earthquakes	1.05	1.2	0.79	0.79	1.26	**low**
ER6	Fire	3.2	3.1	0.78	0.74	9.92	**Low med**

Table 7 shows that the risk index (R.I.) revealed that all environmental risks range in terms of impact from low to high.

Evaluating Risk Management Strategies In Petrochemical Companies.

The literature has reviewed extensive risk mitigation strategies in many categories, including danger retention, danger control, danger prevention, and danger transfer. We evaluated these strategies using descriptive statistics, such as means and SD, and analyzed the data from a survey of Sankyu Company employees.

Table 8 shows the mean values and SD of risk retention strategies that impact positively on financial aspects in petrochemical companies.

Table 8 . standard deviations of Risk Retention

Symbol	Risk Retention	Mean	STDEV	Description
DR1	Waste should be stocked safety	0.77	4.54	**Strongly agree**
DR2	Reduce the depletion of natural sources	0.79	4.48	**Strongly agree**
DR3	running and maintenance according to manufacturers guidelines	0.78	4.50	**Strongly agree**
DR4	innovated technology provision	0.79	4.51	**Strongly agree**
DR5	executing training and awareness workshops	0.86	4.43	**Strongly agree**
DR6	assure following firm regulations	0.95	4.35	**Strongly agree**
DR7	periodic workshop should be coordinated	0.79	4.52	**Strongly agree**
DR8	suitable grounding.	0.88	4.44	**Strongly agree**
DR9	Management study and estimate danger management during the early stage of project planning	0.76	4.48	**Strongly agree**
DR10	machines High Temperature inspection and adopting Cooling regime	0.84	4.45	**Strongly agree**
DR11	Control Gas inspection, Oil inspection, Overpressure inspection	0.76	4.55	**Strongly agree**

Table 8 illustrates that all risk retention strategies suggested to enhance the financial performance of petrochemical projects are efficient. Table 8 demonstrates that all

respondents strongly agree with the suggested risk retention strategies, with all items achieving a mean score higher than 4.21 that of Table 8, indicating a significant level of "strongly agree." Standard deviation values are low, indicating that the data is homogeneous and close to the mean.

Table 9. shows the mean values and SD of risk control strategies that impact positively on financial aspects in petrochemical companies.

Table 9. standard deviations of Risk Control

CODE	Risk Control	Mean	SD	Description
DC1	periodic monitoring and inspection for the seepage.	4.52	0.79	**Strongly agree**
DC2	periodic monitoring and inspection that waste is get rid of according to the requirements.	4.60	0.75	**Strongly agree**
DC3	Any leakage should be cleaned as fast as possible utilizing suitable guidance.	4.48	0.84	**Strongly agree**
DC4	Commercial periodic put up with suppliers.	4.53	0.80	**Strongly agree**
DC5	suitable communication channel	4.65	0.70	**Strongly agree**
DC6	execute follow-up regime	4.53	0.86	**Strongly agree**
C7	implement periodic inspections, check sites with QHSE Patrols and periodic reviews.	4.57	0.76	**Strongly agree**
DC8	Management should keep up to date when need and regular communication	4.58	0.72	**Strongly agree**
DC9	Quality inspection of operation liquid at laboratory	4.62	0.75	**Strongly agree**
DC10	Involving Management and staff in periodic review and risk management planning practice to monitor, determine and administer dangers	4.60	0.71	**Strongly agree**
DC11	The management utilize certain danger management measures to monitor and administer dangers	4.57	0.79	**Strongly agree**
DC12	Control erosion via Shock and Vibration absorber	4.57	0.72	**Strongly agree**
DC13	reduce hydrocarbon seepage Dike	4.62	0.68	**Strongly agree**
DC14	control poisonous Air	4.62	0.70	**Strongly agree**

Table 9 illustrates that all risk control strategies suggested to enhance the financial performance of petrochemical projects are efficient. Table 9 shows that all respondents strongly agree with the suggested risk control strategies, with all items achieving a mean score above 4.21. This indicates a control level of "strongly agree," as shown in Table 9. Standard deviation values are low, indicating that the data is homogeneous and close to the mean.

Table 10. shows the mean values and SDs of risk prevention strategies that have a positive impact on financial aspects in petrochemical companies.

Table 10. deviations of Risk Prevention

Symbol	Risk prevention	Mean	SD	Description
DP1	secure treatment tools shall be utilized	4.69	0.65	**Strongly agree**
DP2	Personal Protective tools provision	4.53	0.83	**Strongly agree**
DP3	periodic aumit of client requirements	4.64	0.77	**Strongly agree**
DP4	Assure Scaffold is secure.	4.50	0.80	**Strongly agree**
DP5	utilize Gloves resist electricity .	4.51	0.79	**Strongly agree**
DP6	Training in Work from high elevations	4.42	0.87	**Strongly agree**
DP7	provide Catridge Respirator	4.52	0.82	**Strongly agree**
DP8	provision fire fighting tools.	4.58	0.78	**Strongly agree**
DP9	Avoid elevated temperature adopting Temperature inspection system and Process Shutdown	4.57	0.77	**Strongly agree**
DP10	Overpressure inspection and Clogging inspection	4.50	0.79	**Strongly agree**
DP11	Oxygen checks via Oxygen Remover and operation Shutdown	4.53	0.78	**Strongly agree**
DP12	using Shock and Vibration absorber	4.54	0.79	**Strongly agree**

Table 10 illustrates that all prevention retention strategies suggested to enhance the financial performance of petrochemical projects are efficient. Table 10 demonstrates that all respondents strongly agree with the suggested risk prevention strategies, with all items achieving a mean score higher than 4.21. This indicates a significant level of "strongly

agree," as indicated by Table 10. Standard deviation values are low, indicating that the data is homogeneous and close to the mean.

Table 11. shows the mean values and SD of risk transfer strategies that impact positively on financial aspects in petrochemical companies.

Table 11 deviations of Risk Transfer

code	Risk Transfer	Mean	SD	Description
DT1	Assessment operation of Suppliers performance	4.38	0.95	**Strongly agree**
DT2	automation operations and build enhancements	4.56	0.79	**Strongly agree**
DT3	Crack diffusion checks and Maintenance	4.45	0.89	**Strongly agree**
DT4	Equipment provision	4.52	0.76	**Strongly agree**
DT5	machines Breakdown check	4.48	0.84	**Strongly agree**
DT6	maintenance contracts with professionals firms periodically	4.59	0.76	**Strongly agree**
DT7	Buying ensurance from machines manufacturers	4.56	0.78	**Strongly agree**
DT8	cooperation with professionals maintenance firms	4.62	0.74	**Strongly agree**
DT9	Adopting intelligent monitoring regimes to track machine performance periodically	4.52	0.84	**Strongly agree**
DT10	utilizing asset management regimes to monitor equipment state	4.56	0.80	**Strongly agree**

Table 11 illustrates that all prevention transfer strategies suggested to enhance the financial performance of petrochemical projects are efficient. Table 11 demonstrates that all respondents strongly agree with the suggested risk transfer strategies. All items achieved a mean score higher than 4.21, indicating a significant level of "strongly agree". Standard deviation values are low, indicating that the data is homogeneous and close to the mean.

4. Conclusion

The goal of this study was to examine how petrochemical companies manage risks related to the operation and maintenance of their equipment and machinery. The study concluded the following:

1. This study provided a comprehensive guide to the potential risks in the field of operation and maintenance of petrochemical equipment related to the operation of machinery, human errors, equipment maintenance, and environmental risks.

2. The study revealed that the risks identified in the areas of operation, maintenance, and human errors significantly affect petrochemical projects, whereas the risks in the environmental domain ranged from low to medium-high.
3. This study provided a comprehensive guide to the risk mitigation strategies in the field of operation and maintenance of petrochemical equipment related to risk retention, risk control, risk prevention, and risk transfer. The analysis found that these suggested risk mitigation strategies are efficient tools to use as risk management procedures in petrochemical projects to enhance the financial aspects of petrochemical projects.
4. This study recommends petrochemical companies test the efficiency of these risk mitigation strategies by applying them, measuring key performance indices, and conducting control charts to ensure the efficiency of these strategies in enhancing financial aspects of petrochemical projects.

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