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Reflection Hazard Analysis and Risk Assessment in HSE Management for Oil and Gas Operations in Kirkuk province: An Analytical Study of the opinions of Employees in Baghdad Oil Refinery and the Barham group for refining petroleum products

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ABSTRACT:

The primary objective of this paper is to investigate the Reflection of risk analysis and risk assessment into HSE management for oil and gas operations in Kirkuk province. The study focuses on the Baghdad Oil Refinery for petrochemical and bitumen production and the Barham Group for refining petroleum products, which has significant implications for health and safety management. A descriptive analytical method was used to examine the data and describe the relationships between the variables. Questionnaire forms were used for data collection; 92 forms were distributed, and the study population consisted of 64 employees from the two oil operations who completed and returned the form. The IBM SPSS 26 statistical program was used for statistical analysis and findings. The results revealed a direct and significant relationship between the Reflection of risk analysis and risk assessment in HSE management. The relationship variables of Reflection these two aspects also had a positive impact on the HSE management system. The study offers practical recommendations to address identified challenges in the two operations and suggests implementing the findings across industrial facilities in Kirkuk province. It is the first time these variables have been combined in a study of the Baghdad Oil Refinery and the Barham Group.

Key Words: Hazard Analysis, Risk Assessment, HSE Management, Oil and Gas Operations, Kirkuk province.

1 INTRODUCTION

1.1 BACKGROUND OF THE RESEARCH

Various hazards face the environment in which the oil and gas industrial processes are located. The most important and necessary system to prevent these hazards is the health, safety and environmental management system (HSE-MS), because this system is used to reduce risks and ensure continuity of operation [1]. Over the past several decades, the inflection of risk analysis and risk assessment into HSE management frameworks has been recognized as a strategic and important topic to improve safety performance and reduce the frequency of workplace accidents [2]. While the Iraqi Government continues to intensively develop the hydrocarbon sector with local and international companies, this process continues in more than ten regions, for example, Khurmala, Chamchamal, and Tawke [3]. This complex

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industrial process is in dire need of implementing advanced risk management strategies that fit within a logical framework of regional operational challenges [4].

Risk analysis topics include techniques such as Hazard and Operational Analysis (HAZOP), Failure Mode and Effects Analysis (FMEA), and Probability Analysis, all of which are systematic methods used to identify potential hazards in complex oil and gas operational processes [5], [6]. On the other hand, risk assessment quantifies the possibilities and consequences of such risks [7], which gives organizations clarity to plan and adopt safety management practices by organizations to prioritize safety interventions [8]. If these methodologies are steadily reflected into HSE-MS, they foster a proactive safety culture; these will protect and enhance employees, the working environment, operational efficiency and compliance with international safety standards [9], [10].

Past studies have established that comprehensive inflection of risk analysis and risk assessment has contributed significantly to reducing accident rates [11]. This systematic process will also reduce financial losses, improve employee awareness and vocational training outcomes [12]. Furthermore, digital tools such as real-time risk monitoring platforms for predictive analytics have emerged in recent years as a valuable and state-of-the-art component of risk alert decision-making processes [13]. These tools save a lot of cost, time, human resources, etc. for companies and organizations [14]. In the Kirkuk province, a government facing multiple geopolitical, infrastructural and environmental challenges, there is limited research examining the local application of HSE reflected risk models [15], [16].

This study has several objectives, the main of which is to address the research gap by examining how risk analysis and reflected risk assessment framework effectively in HSE management system in the oil and gas sector in the Kirkuk province [17]. The study contributes to a broader discourse concerning industrial safety and sustainable development in emerging energy economies [18].

1.2 RESEARCH IMPORTANCE

The importance of this study is that it can fill an important gap in the use of reflected risk analysis and risk assessment within HSE systems in both oil and gas sectors in Kirkuk province. In this paper, the implementation of internal strategies is the main focus. The research contributes to advancing the science of oil, gas and energy management by developing sensitive risk management frameworks in a context that enhances safety performance, leads to reduced environmental impacts, and ensures regulatory compliance. The findings of the study are expected to support decision-makers, HSE managers and policy developers in adopting scientific evidence-based practices. This research will contribute to the protection of human capital, assets, efficiency, and sustainability across organizational activities. Furthermore, this paper contributes to the global discourse on industrial safety in emerging economies, which requires robust and reflected HSE systems to maintain competitiveness and resilience in hazardous environments.

1.3 RESEARCH PROBLEM

Although the management of oil and gas in Iraq is gaining strategic significance, it is still very difficult to reflect risk assessment and risk analysis into HSE management system. Because many accidents have occurred in the operation of oil and gas, causing death and injury to employees. In light of the processes of oil and gas in the Kurdistan region and Iraq, this study aims to examine the barriers to using the skills framework for risk identification and risk assessment. In addition to assessing how local legislation, cultural norms and technological infrastructure affect safety and risk management procedures. The study also seeks to pinpoint the barriers that hinder the incorporation of risk management techniques into routine business operations. Additionally, the study emphasizes how the implementation of global best practices may enhance HSE performance and reduce the frequency of industrial accidents.

1.4 RESEARCH QUESTION

- What are the levels of each process involved in the reflection of risk analysis and risk assessment in the HSEM in oil and gas operations in Kirkuk province?
- Is there a correlation between the reflection of risk analysis and risk assessment in the HSEM for oil and gas operations in Kirkuk province?
- Is there the impact of the reflection of risk analysis and risk assessment on HSEM for oil and gas operations in Kirkuk province?

1.5 RESEARCH OBJECTIVE

- To determine a level of reflection of risk analysis and risk assessment in the HSEM in oil and gas operations in Kirkuk province.
- To determine correlation between the reflection of risk analysis and risk assessment in HSEM for oil and gas operations in Kirkuk province.

- To determine an impact of the reflection of risk analysis and risk assessment on HSEM for oil and gas operations in Kirkuk province.

2 LITERATURE REVIEW

Reviewing the reflection of risk analysis and risk assessment into HSE management systems is essential, as it enhances operational resilience, workforce safety, and overall productivity in the oil and gas sector. The unique socio-political and environmental challenges in Iraq and Kurdistan require a localized approach to implementing HSE management systems [19]. A combination of leadership commitment, strategic training, and digital tools is essential to building a comprehensive and adaptive HSE framework [20]. This chapter focuses on several important dimensions of reflection risk analysis and risk assessment into HSE management systems operational resilience and workforce safety.

2.1 HAZARD ANALYSIS

In industrial processes, hazard analysis forms the cornerstone of health, safety, and environmental (HSE) systems. This statement is especially true for a hazardous industry such as oil and gas. This process involves systematically identifying and assessing hazards, implementing this systematic process to prevent adverse events and improve occupational safety [21].

2.1.1 HAZARD IDENTIFICATION

In the sequence of implementation of processes related to health, safety and environmental management, hazard identification is the first stage in hazard analysis, and this stage refers to the identification of all potential sources of harm within a working framework. According to [22], identifying effective hazards in oil and gas processes requires the combination of workplace-specific information, which explains the hazards in a standardized manner. In addition, predictive analytics, using digital tools are widely used nowadays to enhance the level of risk identification in a very accurate way [23].

2.1.2 SEVERITY ASSESSMENT

Severity assessment refers to evaluating the possible consequences of identified hazards. Studies have concluded that quantifying possible outcomes helps prioritize risks based on their potential impact [19]. One important approach, the qualitative-to-quantitative approach, which refers to data that record historical events, enhances decision-making during HSE planning [24].

2.1.3 CONTROL MEASURES

All stages implemented for control are designed based on the nature and severity of the identified hazards. Strategies within this phase include control engineering, changes in operating units and equipment to protect those working [25]. Proactive risk reduction methods, including safety design, automatic shutdown systems, reduce the likelihood of accidents significantly [20].

2.2 RISK ASSESSMENT

Risk assessment is the logic that continues risk analysis. They include identifying, assessing and managing risks with the goal of reducing the likelihood of adverse events [26].

2.2.1 RISK IDENTIFICATION

Risk identification refers to identifying all events that may adversely affect operational processes. The dynamic nature of sites where oil and gas processes are implemented makes it possible to display historical data and real-time indicators of the use of hazard identification indicators [27]. In Iraq oil fields, political instability and infrastructure limitations are additional contextual risk factors [28].

2.2.2 RISK EVALUATION

This phase sets numbers for the likelihood and impact of identified risks. Various tools are used for risk assessment and analysis [29]. Current research emphasizes the use of Bayesian networks and Monte Carlo simulations for more accurate risk modeling [30].

2.2.3 RISK CONTROL

Risk control focuses on strategies to minimize risks, such as process redesign, regular maintenance, and workforce training. Reflection risk control with real-time monitoring systems significantly improves operational safety [31]. In Kurdistan and Iraq, all domestic environmental and organizational challenges require a framework to control their risks [32].

2.3 HSE MANAGEMENT

When hazard and risk management is effective if it creates a strong attachment to the HSE management system, they include policy formulation, workforce training and regular performance reviews [30].

2.3.1 POLICY AND LEADERSHIP COMMITMENT

Organizational leadership is vital to instilling a culture of safety. Senior management's commitment to HSE policies will significantly influence employee compliance and contribute to a positive safety climate [33]. Recent work in shows that visible leadership engagement is directly related to improved safety performance across oil and gas projects [34].

2.3.2 TRAINING AND COMPETENCY DEVELOPMENT

Training is one of the most important principles to ensure that employees understand potential hazards and the protocols for treating them. Several processes within the training process such as ongoing training, HSE workshops, and competency assessments enhance safety outcomes [35]. Specialized training, which is an appropriate process in the work environment in Iraq and Kurdistan, will improve local workforce reflection and performance [36].

3.3.3 MONITORING AND CONTINUOUS IMPROVEMENT

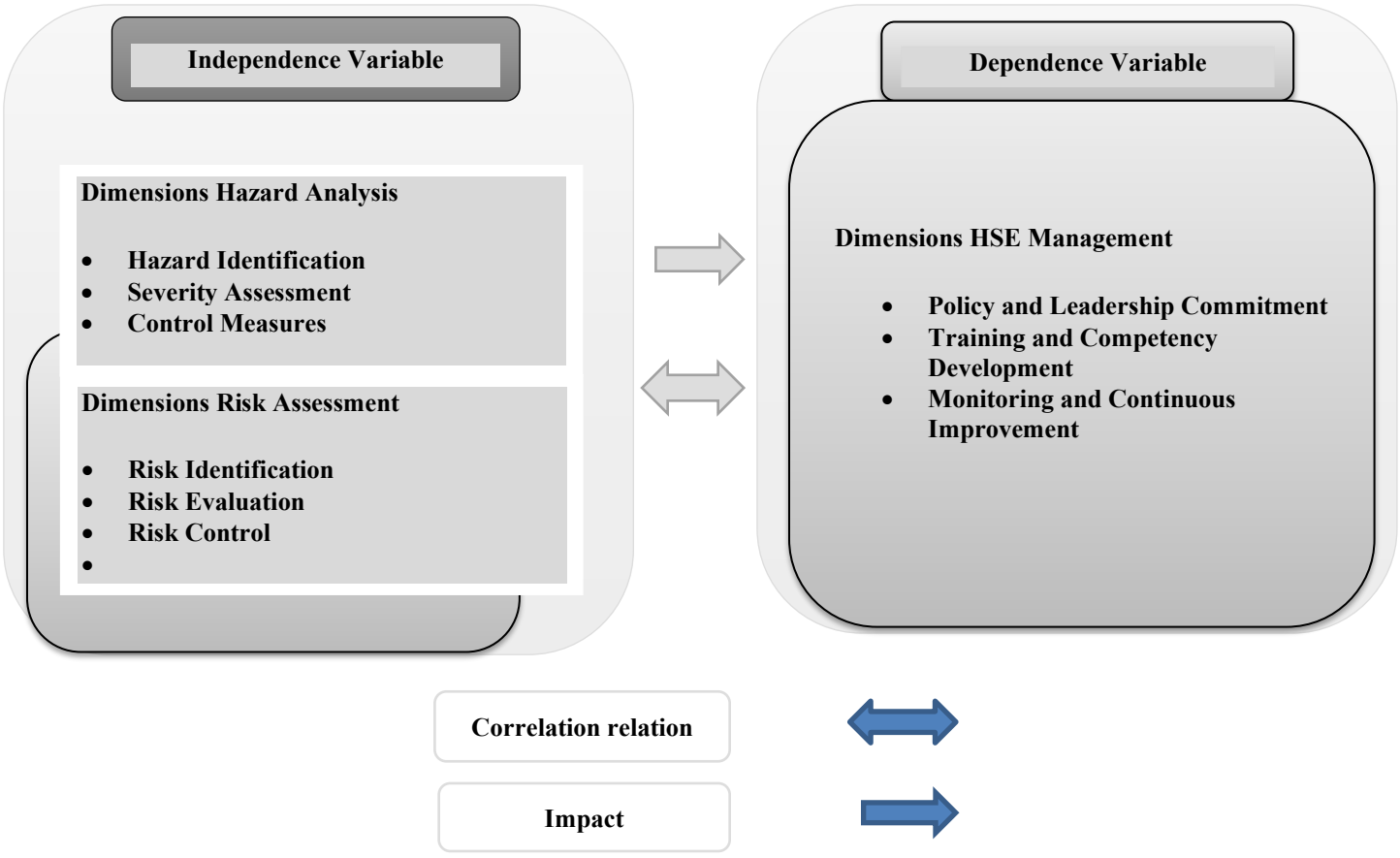
Performance monitoring and evaluation in HSE management better streamline business processes. Techniques such as Key Performance Indicators (KPIs), Incident Tracking, and Cause Analysis are fundamental reasons for standard practices [37]. Developments in the areas of digital surveillance tools have led to greater adherence to real-time corrective action mechanisms [38].

2.4 RESEARCH HYPOTHESIS

H1:

- There is the high level of reflection of risk analysis and risk assessment in the HSEM in oil and gas operations in Kirkuk province.
- There is a correlation between the reflection of risk analysis and risk assessment in HSEM for oil and gas operations in Kirkuk province.
- There is an impact of the reflection of risk analysis and risk assessment on HSEM for oil and gas operations in Kirkuk province.

2.5 MODEL FRAMEWORK



3 METHODOLOGY

Because the curriculum of the study is aligned with the objectives and characteristics of the study and may answer the research questions explicitly, the approach used in this study is that of descriptive analysis. This descriptive and analytical research approach defines the goals, examines the data and phenomena, and explains the reasons and interactions among the elements in a reasonable and scientific manner. This research method's ability to combine case description and analysis with an explanation of the findings drawn from data collecting is one of its key features.

3.1 THE BOARDERS OF RESEARCH

The study's human borders comprise every worker employed at the Baghdad Refinery for the Production of Petrochemicals and Oxidized Asphalt and Al Barham Group. In terms of location, the research was conducted at the Baghdad Refinery for the Production of Petrochemicals and Oxidized Asphalt and ABG Company. This location was chosen because it is appropriate for the variables in the study and provides a handy setting for testing the models and hypotheses. The research period extended from September to May. This period covered data collection, theoretical drafting, questionnaire distribution and retrieval, and data analysis. The objective borders are represented by two axes: HSE Management as a dependent variable, and Hazard Analysis and Risk Assessment as an independent variable. These variables are appropriate in the domains of HSE and petroleum management.

3.2 METHODS OF COLLECTING AND ANALYZING DATA

In order to achieve the research objectives and answer the research questions, several English and Kurdish sources as well as articles and theses have been used for the theoretical components of the research. Benefits have also been derived from earlier studies that were required for the scientific foundation of this research, in addition to the articles and papers offered through the web sources pertaining to the research issue.

3.2.1 THE QUESTIONNAIRE FORM

It is an appropriate instrument for collecting information and data for this study's practical components. Some of the items have been modified to meet the requirements of the research in Iraq, although the majority is based on evaluations used in studies pertaining to the research issue. Two distinct sections were included in the research questionnaire form, and they are explained as follows:

A. General Information: This includes some basic details about the respondents to the questionnaire, such as their sex, qualifications, and level of responsibility at Baghdad Refinery for the Production of Petrochemicals and Oxidized Asphalt. Age, length of employment at this refiners, total amount of time spent working for the oil and gas firm, and involvement in oil and gas courses.

B. Hazard Analysis, Risk Assessment variable: (10) paragraphs were assigned to measure the management system variable and its three dimensions (Hazard Analysis, Risk Assessment).

C. Five items were given to measure the HSE Management variable.

Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree are the five response kinds that were the subject of the surveys, which based on the so-called five-point Likert scale. The weights assigned to each response type ranged from (5) to (1). The responders are able to select the best response as a result.

Table 1. General Information

Research Variable	Dimensions of variables	Number of items	Scientific Sources
General information	General information	8	Authors
Hazard Analysis	Hazard Identification	5	Al-Maamari et al. (2022)
	Severity Assessment	5	(Zhao & Zhang, 2023)
	Control Measure	5	Shukla & Ramakrishnan, 2021)
Risk Assessment	Risk Identification	5	(Wang et al., 2021)
	Risk Evaluation	5	(Yazdani-Chamzini et al., 2021)
	Risk control	5	(Ghasemi et al., 2020)
HSE Management	Policy and Leadership Commitment	5	(Ali et al., 2020)
	Training and Competency Develop	5	(Nwankwo et al., 2021)
	Monitoring and Continuous Improvement	5	(Tariq & Aziz, 2022)

Prepared by: researcher

3.3 RELIABILITY TESTING USING CRONBACH'S ALPHA

This study used Cronbach's alpha to quantify the reliability of the data used.

Table 2. Reliability Testing Using Cronbach's Alpha

Reliability Statistics	
Cronbach's Alpha	N of Items
.960	45

In Table 2, based on the Cronbach alpha value, the results of the reliability assessments are clearly shown. Which yielded a value of 0.960 for the 45-item scale? This result indicates excellent internal consistency among the items used to measure the constructs of hazard analysis, risk assessment, and HSE management. According to George and Mallery (2003), they argue that if the alpha values were above 0.9, that result was considered excellent. Therefore, the measurement tool used for this study is very reliable and suitable for further analysis.

3.4 DESCRIPTIVE STATISTICS AND SAMPLE PROFILE

Another part of the information and data in this study is the general information, which was answered by the respondents. These data revealed demographic analysis of important characteristics of the study sample.

Table 3. Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	53	82.8	82.8	82.8
	Female	11	17.2	17.2	100.0
	Total	64	100.0	100.0	

Table 2 shows distribution of the gender: the sample shows that the majority of respondents were male (82.8%), reflecting the characteristics of the workforce composition in the petroleum refineries sectors, particularly in practical aspect of industries in oil and gas fields.

Table 4. Academic qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Educated	4	6.3	6.3	6.3
	Central	6	9.4	9.4	15.6
	High School	1	1.6	1.6	17.2
	Diploma	12	18.8	18.8	35.9
	Bachelor's Degree	37	57.8	57.8	93.8
	Master's or Doctorate	4	6.3	6.3	100.0
	Total	64	100.0	100.0	

In Table 4, the information shows the academic qualifications of the study participants. A significant proportion (57.8%) of the participants held a bachelor's degree, but 18.8% had a diploma, while about 6.3% had a master's or doctoral degree. These different proportions indicate that most participants are academically well qualified, perhaps with basic knowledge in the area of understanding and implementing HSE practices.

Table 5. Responsibility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Company owner	1	1.6	1.6	1.6
	Part manager	13	20.3	20.3	21.9
	Employee	40	62.5	62.5	84.4
	Worker	10	15.6	15.6	100.0
	Total	64	100.0	100.0	

Table 5 is to show job responsibilities, the results show that most of the respondents were employees (62.5%), followed by department managers (20.3%), then workers (15.6%). This is a clear indication that the data largely represent performance level perspectives.

Table 6. Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 20 year	8	12.5	12.5	12.5
	21 - 30 year	40	62.5	62.5	75.0
	31 - 40 year	15	23.4	23.4	98.4
	41 50 year	1	1.6	1.6	100.0
	Total	64	100.0	100.0	

Table 6 is the age distribution. The statistical results of this table show that a large proportion (62.5%) of the participants was between 21 and 30 years old, so the workforce in this study is a young workforce. This demographic pattern is highly suited to new and accepted training processes and safety management practices.

Table 7. Length of service in this current company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	15	23.4	23.4	23.4
	1 - 5 Year	32	50.0	50.0	73.4
	6 - 10 year	12	18.8	18.8	92.2
	Above 10 years	5	7.8	7.8	100.0
	Total	64	100.0	100.0	

Table 7 shows work experience, the result is presented as follows, half of the respondents (50%) had between 1 and 5 years of experience in their current job, and about 23.4% less than 1 year, suggesting a relatively early career profile with limited possibilities but developed exposure to HSE systems.

Table 8. Courses about oil and gas projects

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	36	56.3	56.3	56.3
	No	28	43.8	43.8	100.0
	Total	64	100.0	100.0	

Table 9. Number of courses about oil and gas projects

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	One course	17	26.6	47.2	47.2
	More than one course	19	29.7	52.8	100.0
	Total	36	56.3	100.0	
Missing	System	28	43.8		
Total		64	100.0		

Table 9 shows the training processes on oil and gas projects. The results are explained as follows: More than half, ie 56.3% of the participants had received special training on different oil and gas projects, more than half of the participants participated in more than one course (52.8%). This indicates that having a moderate level of specialized training can positively influence the understanding and implementation of HSE practices.

4 RESULTS AND ANALYSIS

4.1 DESCRIPTIVE STATISTICS OF THE MAIN VARIABLES

The mean scores in this study for the three main constructs were all above 4 on a 5-point Likert scale.

Table 10. Descriptive Statistics

	Mean	Std. Deviation	
Hazard Analysis's	4.2333	.58518	4
Risk Assessment	4.2312	.57569	4
HSE Management	4.2073	.61436	4

The results of the table 10, displayed as follows, show for Hazard analysis (mean = 4.23, SD = 0.59), for risk assessment (mean = 4.23, SD = 0.58) as well as for HSE management (mean = 4.21, SD = 0.61).

All show high mean values. These results, clearly suggest that in general the perceptions and attitudes of the employees are very positive towards all the three variables in the study. The relatively low standard deviations are also an indicator of consistency in responses across participants.

4.2 CORRELATION ANALYSIS OF MAIN VARIABLES

Statistically, this study has shown a strong, positive and significant correlation for the Pearson correlation coefficients, such that the correlation between the three main variables was shown at the 0.01 level.

Table 11. Correlation Analysis of Main Variables

		Hazard Analysis's	Risk Assessment	HSE Management
Hazard Analysis's	Pearson Correlation	1	.877**	.844**
	Sig. (2-tailed)		.000	.000
	N	64	64	64
Risk Assessment	Pearson Correlation	.877**	1	.882**
	Sig. (2-tailed)	.000		.000
	N	64	64	64
HSE Management	Pearson Correlation	.844**	.882**	1
	Sig. (2-tailed)	.000	.000	
	N	64	64	64

**. Correlation is significant at the 0.01 level (2-tailed).

- **Hazard Analysis and Risk Assessment**: **r = .877**, p < .01
- **Hazard Analysis and HSE Management**: **r = .844**, p < .01
- **Risk Assessment and HSE Management**: **r = .882**, p < .01

The results tend to indicate that effective hazard analysis and risk assessment methods are closely related to better HSE management performance. Another result is also the existence of strong relationships between risk assessment and HSE management, further emphasizing the important role of proactive risk assessment to promote workplace safety and environmental compliance.

4.3 REGRESSION ANALYSIS OF KEY DETERMINANTS

This regression summary table presents the results of a multiple linear regression analysis conducted to evaluate the influence of two independent variables (Hazard Analysis and Risk Assessment) on the dependent variable, HSE Management.

Table 12. Multiple Linear Regression Summaries for Predicting HSE Management

Predictor Variable	Unstandardized Coefficient (B)	Standard Error	Standardized Coefficient (Beta)	t -value	p-value (Sig.)
(Constant)	0.075	0.267	—	0 .282	0.779
Hazard Analysis	0.320	0.125	0.305	2 .561	0.013*
Risk Assessment	0.656	0.127	0.615	5 .159	0.000**

This table some results have been shown about regression analysis, the constant (B = 0.075) represents the estimated value of HSE Management when both Hazard Analysis and Risk Assessment are zero. However, this value is not statistically significant (p = 0.779), indicating that the intercept does not meaningfully contribute to the prediction of HSE Management.

Hazard Analysis is the unstandardized coefficient (B = 0.320) indicates that for each one-unit increase in Hazard Analysis, HSE Management increases by 0.320 units, assuming Risk Assessment is held constant. The standardized beta (β = 0.305) suggests a moderate positive effect size. The result is statistically significant (p = 0.013), showing that Hazard Analysis makes a meaningful contribution to the prediction of HSE Management.

Risk Assessment The unstandardized coefficient (B = 0.656) shows that for every one-unit increase in Risk Assessment, HSE Management increases by 0.656 units, assuming Hazard Analysis remains constant. The standardized beta (β = 0.615) indicates a stronger effect than Hazard Analysis. This predictor is highly significant (p = 0.000), making it the most influential variable in the model.

4.4 MODEL SUMMARY ANALYSIS

Table 13. Model Summary

R	0.894
R^2	0.800
Adjusted R^2	0.794

Std. Error of Estimate	0.27918

*Significant at the 0.05 level
** Significant at the 0.01 level

The R^2 value of 0.800 reveals that 80% of the variance in HSE Management is explained by the combined effects of Hazard Analysis and Risk Assessment. The Adjusted R^2 (0.794) confirms the model's strong explanatory power, even after adjusting for the number of predictors. The standard error of the estimate (0.27918) indicates the average distance that the observed values fall from the regression line.

This table demonstrates that both Hazard Analysis and Risk Assessment significantly and positively predict HSE Management performance. Among the two, Risk Assessment has the stronger influence. The overall model is robust, explaining a substantial portion of the variance in the dependent variable.

4.5 ANOVA REGRESSION MODEL

The regression model is another statistically significant model; this table shows the results of the regression module.

Table 14. ANOVA [a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.024	2	9.512	122.043	.000[b]
	Residual	4.754	61	.078		
	Total	23.779	63			

a. Dependent Variable: HSE Management

b. Predictors: (Constant), Risk Assessment, Hazard Analysis's

Table 14 shows the regression model statistically, presented as follows
F (2, 61) = 122,043, p < .001. This confirms that the independent variables significantly predict HSE management.

4.6 ANALYSIS OF REGRESSION COEFFICIENTS

Table 15. Analysis of Regression Coefficients [a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.075	.267		.282	.779
	Hazard Analysis's	.320	.125	.305	2.561	.013
	Risk Assessment	.656	.127	.615	5.159	.000

a. Dependent Variable: HSE Management

Table 15 shows that Risk Assessment had the strongest standardized coefficient (Beta = .615) and a highly significant p-value, indicating it is the most influential predictor of HSE management. Hazard Analysis also had a significant impact, though to a lesser degree (Beta = .305, p = .013).

The constant term was not statistically significant, which suggests that HSE Management is strongly influenced by the presence of these two predictors rather than occurring independently.

5 DISCUSSION

This study empirically validates the critical and statistically significant relationship between structured risk management practices—namely risk analysis and risk assessment—and the enhancement of Health, Safety, and Environmental (HSE) management performance within oil and gas operations. These results also confirm the theoretical principles of risk management, which emphasize the importance of systematically identifying, assessing, and mitigating risks in order to enhance organizational safety performance, especially in hazardous industries such as oil and gas.

Predicting and focusing on data in high-risk processes allows decision makers in oil and gas facilities to allocate resources more efficiently, implement better safety requirements, and prioritize the most critical control measures. This finding is highly consistent with the principles of ISO 31000 and OHSAS 18001/ISO 45001, which emphasize thinking of hazardous processes as an adjunct to occupational HSEM.

Another important finding of this study is the demographic profile of the workforce – which is characterized by being largely composed of young and educated people. This represents a strategic asset for organizations operating in the Kurdistan and Iraq oil and gas sector. Educated workers are more receptive to technical training and more likely to understand and implement complex risk management protocols. A younger workforce also typically shows greater adaptability and openness to cultural and procedural changes. Consequently, these characteristics can be used to

strengthen training and development programs that focus on enhancing skills in hazard identification, hazard analysis, and application of control measures.

In practical terms, the results of the research indicate that oil and gas companies in the region should more systematically invest in training initiatives based on a thorough understanding of risks. Such programs can be part of scenario-based learning processes, simulations of hazard identification exercises and investigative exercises. These programs can be part of a focus on a culture of safety in the workplace, enabling employees to adhere to current HSE policies and actively participate in identifying new hazards and suggesting improvements to existing practices.

Finally, the empirical evidence reinforces the critical role of structural risk management approaches in achieving effective HSE outcomes. By emphasizing risk analysis and risk assessment as strategic priorities—and by capitalizing on the capabilities of a young, educated workforce—organizations can significantly reduce operational risks, prevent accidents, and foster a good safety culture in the hazardous environment of refining process.

CONCLUSION

The analysis confirms that Hazard Analysis and Risk Assessment significantly enhance HSE Management performance, with Risk Assessment having a more substantial impact. This is shown in the results of the regression coefficient which is that Risk Assessment had the strongest standardized coefficient (Beta = .615) and a highly significant p-value, indicating it is the most influential predictor of HSE management. Hazard Analysis also had a significant impact, though to a lesser degree (Beta = .305, p = .013). The study supports the need for continuous training and systematic implementation of risk-based HSE practices. These findings can guide policy makers, safety officers, and managers in designing more effective safety frameworks and interventions in the refining process. One of the most interesting findings is the dominant role that risk assessment plays as an important and predictive factor in HSE performance. This indicates that structured and formal assessments of operational risks, for example assessing the likelihood and severity of potential incidents, can be an integral part of HSE systems. These assessments will also be effective tools to drive safety outcomes.

RECOMMENDATION

Several important and necessary recommendations are made for its research, which were drafted based on the findings of the research, all of which are concerned with the integration of risk-based practices in the management of HSE in oil and gas operations in Iraq and Kurdistan Region:

1. The scope of work should be expanded across the region and different companies in Iraq and the Kurdistan Region.

2. Implement and conduct research on the impact of organizational culture on risk management implementation in Iraq and Kurdistan Region.

3. Conduct long-term studies to assess long-term impacts HSEM in the petroleum refineries in Iraq and Kurdistan Region.

4. Consider research on the role of technology in HSE management based on a thorough understanding of technical and operational risks, as well as increased attention to the use of digital tools and data analysis in the energy sector in Iraq and Kurdistan Region.

5. Examine the effectiveness of training and effort to change individual and organizational behavior toward improved performance in oil and gas industry in Iraq and Kurdistan Region.

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