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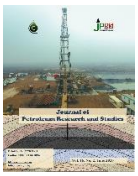

Investigating the Crisis Management Approaches in Liquid Petroleum Gas Storage Projects

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Abstract

This research aimed to investigate the crisis management approaches in liquid petroleum gas storage projects in Iraq, using a descriptive survey-type method with an applied goal in 2024. 75 people participated in the study using the census method of senior and middle managers of 15 oil and gas companies in Iraq. In this study, research questionnaire under 3 criteria (before the crisis, during the crisis, after the crisis) and 30 sub-criteria were designed based on the research literature, interviews with 15 CEOs of Iraqi oil and gas companies and 2 Delphi phases with an agreement coefficient of 0.741. The validity was confirmed by using Lawshe content validity and construct validity and reliability by use of Cronbach's alpha coefficient in SmartPLS software. Data was analyzed by the help of SPSS software. The results of the t-test indicated that crisis management in liquid petroleum gas storage projects in Iraq is above-average. On the other hand, it was determined in the ranking of the factors by the Friedman test that the approach of before the crisis with a mean rank of (2.15) was ranked 1st, after the crisis with a mean rank of (1.99) was ranked 2nd and during the crisis with a mean rank of (1.87) was ranked 3rd. Also, the sub-criterion of "Design and strengthening of pressure and heat infrastructures, automatic fire extinguishing systems and emergency evacuation equipment for liquid petroleum gas storage against crisis" with a mean rank of (18.08) was ranked 1st and the sub-criterion of "repair and reconstruction of damaged equipment including replacing pipes, repairing tanks and upgrading safety systems" with a mean rank of (13.74) was achieved the last rank in the general ranking of the sub-criteria.

Keywords: Liquid Petroleum Gas, Storage Projects, Crisis management.

دراسة أساليب إدارة الأزمات في مشاريع تخزين غاز البترول المسال

الخلاصة:

يشير البحث إلى دراسة مناهج إدارة الأزمات في مشاريع تخزين الغاز البترولي السائل في العراق، باستخدام أسلوب المسح الوصفي بهدف تطبيقي في عام 2024. شارك في الدراسة 75 شخصًا باستخدام أسلوب إحصاء كبار المديرين والمتوسطين في 15 شركة نفط وغاز في العراق. في هذه الدراسة، تم تصميم استبيان بحثي بموجب 3 معايير (قبل الأزمة، أثناء الأزمة، بعد الأزمة) و 30 معيارًا فرعيًا بناءً على أدبيات البحث

والمقابلات مع 15 من الرؤساء التنفيذيين لشركات النفط والغاز العراقية ومرحلتي دلفي بمعامل اتفاق 0.741. تم التأكد من الصلاحية باستخدام صلاحية محتوى Lawshe وصلاحية البناء والموثوقية باستخدام معامل ألفا كرونباخ في برنامج SmartPLS. تم تحليل البيانات بمساعدة برنامج SPSS. أشارت نتائج اختبار t إلى أن إدارة الأزمات في مشاريع تخزين الغاز البترولي السائل في العراق أعلى من المتوسط. ومن ناحية أخرى، فقد تم تحديد في ترتيب العوامل حسب اختبار فريدمان أن النهج قبل الأزمة بمتوسط رتبة (2.15) جاء في المرتبة الأولى، وبعد الأزمة بمتوسط رتبة (1.99) جاء في المرتبة الثانية، وأثناء الأزمة بمتوسط رتبة (1.87) جاء في المرتبة الثالثة. كما جاء المعيار الفرعي "تصميم وتعزيز البنى التحتية للضغط والحرارة وأنظمة الإطفاء الأوتوماتيكية للحرائق ومعدات الإخلاء في حالات الطوارئ لتخزين الغاز البترولي السائل ضد الأزمات" بمتوسط رتبة (18.08) في المرتبة الأولى، كما حقق المعيار الفرعي "إصلاح وإعادة بناء المعدات التالفة بما في ذلك استبدال الأنابيب وإصلاح الخزانات وترقية أنظمة السلامة" بمتوسط رتبة (13.74) المرتبة الأخيرة في الترتيب العام للمعايير الفرعية.

1. Introduction

Crisis management in oil storage projects has particular importance as one of the vital parts of the oil and gas industry. These projects require detailed and comprehensive planning in the face of crises not only because of the sensitive and critical nature of petroleum, but also because of its wide-ranging effects on the global economy and energy security [1]. Crisis management refers to a set of approaches, processes and strategic actions specifically in this field that are designed and implemented with the aim of reducing and managing the risks and effects of possible crises [2]. On the other hand, oil as a strategic and economic energy source plays a very important role in the global economy and energy security [3]. Any crisis in oil storage projects can have wide consequences, including extreme fluctuations in global markets, lack of energy resources, and even political and economic conflicts [4]. Therefore, crisis management in these projects is recognized not only as an operational necessity, but also as a key tool for maintaining economic stability and national security in oil-producing countries [5].

The importance of liquid petroleum gas storage projects has clearly increased in recent years as a critical solution for providing sustainable energy and dealing with energy crises [6]. Iraq as one of the countries with huge gas and oil resources faces many challenges in the field of crisis management and liquid petroleum gas storage. Due to the unbalanced state of the energy infrastructure in this country and the increasing need to exploit gas resources, liquid petroleum gas storage projects have been proposed as a basic solution to provide energy in times of crisis and maintain national energy security. In this regard, examining crisis management approaches in liquid petroleum gas storage projects has particular importance. These approaches include detailed planning, creating appropriate infrastructure, using advanced technologies, and developing managerial and organizational capabilities in three phases of before the crisis, during the crisis, and after the crisis [7]. Crisis management in these projects requires a comprehensive and systematic approach that includes all possible aspects, including technical, economic, social and environmental issues [8, 9].

One of the main challenges in this field is the lack of legal and institutionalized frameworks for crisis management in liquid petroleum gas storage projects [10]. The absence of specific laws and regulations in this field increases the risks and reduces the efficiency of these projects [11]. Furthermore, security and political issues in Iraq such as political instability and security threats can have destructive effects on the implementation of these projects. By considering these challenges, a detailed and comprehensive review of different crisis management approaches in liquid petroleum gas storage projects can help to identify the strengths and weaknesses of these approaches, as well as provide solutions to improve and increase the productivity of these projects. According to what was mentioned in this study and the main goal of the research which is "investigating the crisis management approaches in liquid petroleum gas storage projects in Iraq", the researcher intends to answer the following questions.

1. What approaches can be considered for crisis management in liquid petroleum gas storage projects in Iraq?
2. What is the status of crisis management in liquid petroleum gas storage projects in Iraq?
3. What is the ranking of effective factors in crisis management of liquid petroleum gas storage projects in Iraq?

The effect of strategic foresight on crisis management in the energy security sector of Jordan was investigated in a research and it was concluded that the dimensions of strategic foresight including technological intelligence, political environment foresight and consumer foresight have an effect management. In contrast, competitive intelligence had no effect in the crisis management in Jordan [12]. An input-output nested system dynamic model (IO-SD) to study the resilience of natural gas systems in critical conditions was proposed in another research and it was found that two key measures should be done to increase the flexibility of gas systems under the title of increasing flexibility and the operational efficiency of emergency facilities (the ability to release storage and gasification efficiency and make efficient infrastructure and services) and increase the connection of storage infrastructure and supply networks and remove bottlenecks in regional connections [13]. It was found in another study conducted in Isfahan Oil Refining Company that the components of identifying the type of crisis, the phase of life and the threshold points of the crisis in the before the crisis - during-crisis area, the components of controlling access to information, the allocation of sufficient options, management of destructive emotions in the during-crisis - after the crisis area, strategic thinking components at all levels of the organization, identification of the strengths and weaknesses of organization in the after the crisis-before the crisis area, and components of honesty,

transparency, coordination, people's commitment, awareness and inter-organizational trust in the organizational crisis management in Isfahan Oil Refining Company are important in all three phases jointly. In this study, it was found that the performance of Isfahan oil refining was not optimal in the after the crisis phase [14]. In another study, the researchers concluded that neglecting social and environmental aspects can lead to danger and cause significant damage to the economic component of the project and even delay the feasibility and implementation of the project in critical conditions. Therefore, it is necessary to pay attention to the social and environmental aspects of crisis management and their effect on the economic component at the zero phase of each project [15]. In another study that was carried out in the field of developing strategies for the guidance and management of oil and gas projects, it was found that it is necessary to use the areas of project management knowledge including management: integration, scope, time, cost, quality, human resources, communication, risk, logistics and stakeholders. On the other hand, the main achievement of this study includes a set of strategies derived from the guidelines and analysis of SWOT, which include making integrated systems for the macro-management of oil industry projects, establishing information systems in order to record the knowledge and experiences gained in projects, guiding oil companies towards making a project-oriented structure, providing the necessary grounds for healthy and optimal decision-making, developing and promoting the knowledge of law, insurance and contracts in the oil industry, developing the information bank of oil industry managers and developing the skills of interacting with human resources in projects and trying to create a network of stakeholders of the oil industry projects [16]. Another researcher acknowledged that crises are situations that disrupt systems, processes and lifestyles, they have a negative impact on people, assets, prospects, operations and reputation of the organization. And societies; therefore, it is necessary to pay attention to crisis management in the oil and gas industry [17]. The effective indicators in crisis management was investigated in another study and it was concluded that the dimensions of emergency response, risk management and early warning in the crisis prevention phase, the dimensions of the planning process, systems and guides, and training and simulation in the crisis preparation phase, the dimensions of system activation and response and crisis diagnosis during the crisis, the dimensions of recovery in the after the crisis phase and evaluation and correction in the after the crisis phase should be taken into consideration [18]. Also, it is necessary to cooperate with different stakeholders, make quick decisions in times of crisis, and pay attention to possible planning in the fields of crisis management, organizational design and organizational decision-making [19].

2. Method

The present study aimed to investigate crisis management approaches in liquid petroleum gas storage projects in Iraq, using a descriptive survey-type method with an applied goal in 2024. Senior and middle managers of 15 oil and gas companies in Iraq (State Company for Oil Project (SCOP), Oil Pipeline Company (OPC), State Organization for Marketing of Oil (SOMO), Oil Products Distribution Company (OPDC), Iraq Drilling Company (IDC), North Oil Company (NOC), Midland Oil Company (MDOC), South Oil Company (SOC), Maysan Oil Company (MOC), North Gas Company (NGC), South Gas Company (SGC), Gas Filling and Services Company (GFSC), North Refineries Company (NRC), Mead Refinery Company (MRC), South Refinery Company (SRC)) were estimated to be 75 people using the census method that all of them participated in the study. In this study, three main criteria—before the crisis, during the crisis, and after the crisis—were identified based on the relevant literature [14], [15], [17], [18], [20], [21]. In order to design the research questionnaire. After that 15 CEOs of each of the mentioned companies were interviewed and they were asked to mention the factors that have great importance before the crisis, during the crisis, after the crisis as sub-criteria of crisis management in liquid petroleum gas storage projects in Iraq. Therefore, a questionnaire was designed based on 27 sub criteria according to their opinions. Next, Delphi technique was used in order to confirm the identified sub-criteria.

In the first phase of Delphi, it was necessary to add 3 factors of “drafting communication and information plans” to the before the crisis sub-criterion, “activating the quick response operating plan to deal with the crisis” to the crisis sub-criterion, and “conducting training maneuvers based on similar scenarios to improve the readiness of employees and systems to respond quickly and effectively to future crises" to the after the crisis sub-criterion. The second phase of Delphi was conducted after adding the factors. In this phase, the questionnaire was confirmed with 3 main criteria and 30 sub-criteria (Table 1) and Kendall’s agreement coefficient of (0.741). In order to investigate the validity of the questionnaire, the content validity method of Lawshe was used under the supervision of 15 senior and middle managers, and the content validity of the questionnaire was confirmed with a coefficient of (0.911). Then, confirmatory factor analysis was used in SmartPLS software in order to measure the construct validity of the questionnaire, and all senior and middle managers as 75 people participated in the survey, and the construct validity of the questionnaire was confirmed based on their opinions (Fig 1). It should be noted that reliability indicators with an acceptable value of 0.7 and more [22], convergent validity with an acceptable value of 0.4 0 and more [23], R^2 determination coefficient with acceptable values of 0.33 (moderate) and 0.67 (strong) [24], positive Q^2 value for measurement of the optimal predictive power of the model [25], F^2

indicator with acceptable values of 0.15 (moderate) and 0.35 (strong) [26], GOF indicator with values of 0.25 to 0.36 (moderate), more than 0.36 (strong) [27] and divergent validity were used based on the method of Fornell & Larcker [28] in order to investigate the construct validity, as reported in Table (2). T-test and Friedman test were used in SPSS software in order to analyze the data.

Table (1): Approved questionnaire by the experts in the second round of Delphi

Row	Criterion	Identified sub-criteria	Symbol
1	Before the crisis	Identification and evaluation of liquid petroleum gas storage risks (gas leakage, explosion, and damage to tanks or risks caused by environmental conditions).	Q1
2		Providing storages of liquefied gas and essential equipment to meet emergency needs and reduce vulnerability in times of crisis.	Q2
3		Improving the management of storages and the agility of logistics systems to reduce interruptions in the supply and distribution of liquid petroleum gas.	Q3
4		Compilation of preventive and safety protocols for liquid petroleum gas, including regular maintenance of tanks, pressure and resistance tests, checking valves and connections, and ensuring the proper functioning of monitoring and control systems.	Q4
5		Training employees in the field of liquid petroleum gas characteristics, such as leak detection methods, use of safety equipment, and quick response methods to possible incidents.	Q5
6		Installation and maintenance of advanced monitoring and warning systems to identify liquid petroleum gas leaks.	Q6
7		Preparation and practice of quick response plans for liquid petroleum gas leaks, including quick evacuation of the place, cutting off the gas flow, using fire suppression systems and notifying related institutions.	Q7
8		Communicating with rescue and firefighting organizations to receive immediate assistance in case of crisis.	Q8
9		Design and strengthening of pressure and heat infrastructures, automatic fire extinguishing systems and emergency evacuation equipment for liquid petroleum gas storage against crisis.	Q9
10		Developing communication and information programs.	Q10
11	During the crisis	Quick detection and containment of gas leaks using gas monitoring equipment, closing valves and related connections.	Q11
12		Immediate and safe evacuation of employees from the liquid petroleum gas storage area.	Q12
13		Use of special fire extinguishing systems for liquid petroleum gas such as foams resistant to fires caused by oil and gas materials.	Q13
14		Immediate cutoff of liquid gas flow from tanks and pipes in order to prevent the increase of gas volume in the environment and reduce the risk of explosion.	Q14

15		Managing volatile gases by using large fans, industrial ventilation and opening windows and doors.	Q15
16		Controlling and restraining the release of liquid petroleum gas in the environment through water spray systems in order to sedimentate the gas.	Q16
17		Continuous assessment of conditions and implementation of programs, including detailed examination of leakage rate, fire intensity and environmental safety level.	Q17
18		Maintaining continuous communication with crisis teams using two-way radios and internal communication systems.	Q18
19		Providing accurate and regular information to the public and the media, including details of the crisis, taken actions, and safety recommendations.	Q19
20		Activating the quick response action plan to deal with the crisis.	Q20
21	After the crisis	Complete assessment of damages to equipment and facilities such as tanks, pipes, fire extinguishing systems and equipment related to liquid petroleum gas storage.	Q21
22		Incident analysis and identification of root causes such as technical defects, human error or environmental conditions.	Q22
23		Reviewing and updating crisis management plans and operational procedures such as making changes to gas leak containment strategies and upgrading warning systems.	Q23
24		Employees' training and retraining based on the experiences and lessons learned from the crisis.	Q24
25		Repair and reconstruction of damaged equipment including replacing pipes, repairing tanks and upgrading safety systems.	Q25
26		Checking and improving warning and communication systems, including installing advanced equipment and upgrading monitoring software.	Q26
27		Documenting the incident and sharing information with other related institutions.	Q27
28		Evaluating and improving insurance and financial plans to compensate for losses caused by liquid gas crisis.	Q28
29		Providing psychological and social support to employees, including psychological counseling, return-to-work programs, etc.	Q29
30		Conducting training maneuvers based on the similar scenarios to improve the readiness of staff and systems to respond quickly and effectively to future crises.	Q30

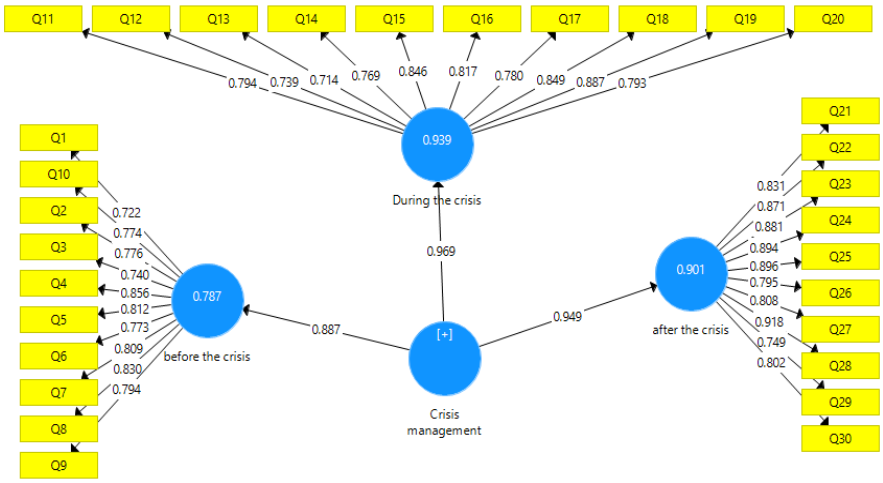

Fig. (1): Factor loading coefficients of the research questionnaire

Table (2): Fitting criteria of the research questionnaire

Main criteria	Cronbach's alpha	Composite reliability	AVE	R^2	Q^2	F^2	GOF
During the crisis	0.937	0.947	0.641	0.939	0.552	15.527	
After the crisis	0.955	0.962	0.716	0.901	0.594	9.105	0.760
Before the crisis	0.933	0.943	0.623	0.787	0.446	3.693	
Divergent validity of the model using Fornell & Larcker values							
During the crisis		**0.800**					
After the crisis		0.717	**0.846**				
Before the crisis		0.706	0.725	**0.789**			

3. Results

3.1. What approaches can be considered for crisis management in liquid petroleum gas storage projects in Iraq?

As shown in Table (1), three main criteria (before the crisis, during the crisis, after the crisis) were identified as approaches for crisis management in liquid petroleum gas storage projects in Iraq using theoretical foundations and reviewing previous studies; then, 30 sub-criteria were assigned to the main criteria by interviewing experts during two Delphi phases.

3.2. What is the status of crisis management in liquid petroleum gas storage projects in Iraq?

Table (3): Results of one-sample t-test

Main criteria	Frequency	Mean	SD	Test Value = 3			Lower limit	Upper limit
				t	df	P-Value		
Before the crisis	75	4.008	0.615	14.188	74	0.000	0.866	1.149
During the crisis	75	3.858	0.745	9.976	74	0.000	0.687	1.030
After the crisis	75	3.834	0.867	8.335	74	0.000	0.635	1.034
Crisis management	75	3.900	0.695	11.209	74	0.000	0.740	1.060

According to Table (3), the averages of crisis management approaches in liquid petroleum gas storage projects in Iraq are before the crisis as (4.008), during the crisis as (3.858), after the crisis as (3.834) and crisis management as (3.900), in general. Since the P-Value in all approaches and in the entire crisis management variable is less than (0.05), it has a significant difference with the test value, i.e. number 3, and is in an above average situation. On the other hand, considering that the upper and lower limits of the positive confidence interval were obtained, it can be concluded that

the crisis management in liquid petroleum gas storage projects in Iraq is in an above average situation.

3.3. What is the ranking of effective factors in crisis management of liquid petroleum gas storage projects in Iraq?

Table (4): Friedman test results (Significant results of main criteria and sub-criteria)

H0 & H1	Chi-squared	df	Sign	Test result
H0: The mean rank of the main criteria is equal. H1: The mean rank of the main criteria is not equal.	0.129	2	0.129	H0 was accept
H0: The mean rank of the sub-criteria is equal. H1: The mean rank of the sub-criteria is not equal.	57.829	29	0.001	H0 was rejected

The results of Table (4) show that the significance level of the main criteria of crisis management in liquid petroleum gas storage projects in Iraq is more than the threshold of (0.05) (P<0.05); therefore, it can be concluded that there is no significant difference between the ranking of main criteria (before the crisis, during the crisis, after the crisis), but the value of the significance level in the crisis management sub-criteria is less than the threshold of (0.05), which indicates that there is a difference between the ranks of the identified sub-criteria. The obtained ranks are reported in Table (5).

Table (5): Ranking of crisis management criteria and sub-criteria in liquid petroleum gas storage projects in Iraq

Row	Main criteria	Rank average	Rank	Identified sub-criteria	Rank average in the group	Rank in the group	Total rank average	Total rank
1	Before the crisis	2.15	1	Q1	5.67	4	16.77	4
2				Q2	5.25	6	15.64	11
3				Q3	5.71	3	16.76	5
4				Q4	5.13	7	15.24	16
5				Q5	5.47	5	16.04	9
6				Q6	6.08	2	17.69	2
7				Q7	5.25	6	15.41	14
8				Q8	5.25	6	15.44	12
9				Q9	6.21	1	18.08	1
10				Q10	4.99	8	14.61	22
11	During the crisis	1.87	3	Q11	5.47	5	15.22	17
12				Q12	5.13	10	14.03	27
13				Q13	5.23	8	14.33	24
14				Q14	5.26	7	14.46	23
15				Q15	5.47	6	14.90	20
16				Q16	5.81	3	15.97	10
17				Q17	5.90	1	16.28	8

18				Q18	5.65	4	15.64	11
19				Q19	5.18	9	14.32	25
20	After the crisis	1.99	2	Q20	5.89	2	16.31	7
21				Q21	6.13	1	15.29	15
22				Q22	5.83	2	14.86	21
23				Q23	5.59	3	16.37	6
24				Q24	5.51	4	14.86	21
25				Q25	5.50	5	13.74	28
26				Q26	5.49	6	15.11	19
27				Q27	5.43	7	16.79	3
28				Q28	5.29	8	15.42	13
29				Q29	5.19	9	15.13	18
30				Q30	5.03	10	14.29	26

The obtained results in Table (5) indicate that the main criterion of before the crisis with a mean rank of (2.15) was ranked 1st, after the crisis with a mean rank of (1.99) was ranked 2nd and during the crisis with a mean rank of (1.87) was ranked 3rd.

In the ranking of the sub-criteria of the before the crisis approach, the sub-criteria of “design and strengthening of pressure and heat infrastructures, automatic fire extinguishing systems and emergency evacuation equipment for liquid petroleum gas storage against crisis” with a mean rank of (6.21) was ranked 1st and “developing communication and information programs” with a mean rank of (4.99) was ranked 8th and the last. It is necessary to mention that three sub-criteria of “providing storages of liquefied gas and essential equipment to meet emergency needs and reduce vulnerability in times of crisis”, “preparation and practice of quick response plans for liquid petroleum gas leaks, including quick evacuation of the place, cutting off the gas flow, using fire suppression systems and notifying related institutions” and “communicating with rescue and firefighting organizations to receive immediate assistance in case of crisis” with a mean rank of (5.25) achieved the same rank as 6th.

In the sub-criteria ranking of the approach of during the crisis, the sub-criteria of “continuous assessment of conditions and implementation of programs, including detailed examination of leakage rate, fire intensity and environmental safety level” with a mean rank of (5.90) was ranked 1st and “immediate and safe evacuation of employees from the liquid petroleum gas storage area” with a mean rank of (5.13) was ranked 10th and the last.

In the ranking of the sub-criteria of the after the crisis approach, the sub-criteria of “complete assessment of damages to equipment and facilities such as tanks, pipes, fire extinguishing systems and equipment related to liquid petroleum gas storage” with a mean rank of (6.13) was ranked 1st and “conducting training maneuvers based on the similar scenarios to improve the readiness of staff

and systems to respond quickly and effectively to future crises" with a mean rank of (5.03) was ranked 10th and the last.

Total ranking of the sub-criteria of all three approaches of before the crisis, during the crisis and after the crisis is as follows. "design and strengthening of pressure and heat infrastructures, automatic fire extinguishing systems and emergency evacuation equipment for liquid petroleum gas storage against crisis" with a mean rank of (18.08) was ranked 1st, "installation and maintenance of advanced monitoring and warning systems to identify liquid petroleum gas leaks" with a mean rank of (17.69) was ranked 2nd, "documenting the incident and sharing information with other related institutions" with a mean rank of (16.79) was ranked 3rd; finally, "repair and reconstruction of damaged equipment including replacing pipes, repairing tanks and upgrading safety systems" with a mean rank of (13.74) was ranked 28th. It should be noted that the sub-criteria of "providing storages of liquefied gas and essential equipment to meet emergency needs and reduce vulnerability in times of crisis" and "maintaining continuous communication with crisis teams using two-way radios and internal communication systems" were both sub-criteria with a mean rank of (15.64) which were ranked 11th and "incident analysis and identification of root causes such as technical defects, human error or environmental conditions" and "employees' training and retraining based on the experiences and lessons learned from the crisis" were both sub-criteria with a mean rank of (14.86) which were ranked 21st.

4. Discussion

The obtained results in this study for the three approaches of before the crisis, during the crisis, after the crisis are consistent with the results of the studies of [14], [15], [18]. The results of the assessment of crisis management criteria in liquid petroleum gas storage projects in Iraq showed that before the crisis measures were identified as the main priority in the crisis management and received the most rank, while after the crisis measures were ranked second and measures during the crisis were ranked third. This result confirms that prevention and preparation before a crisis occurrence is important. Before the crisis measures such as hazard identification, risk assessment, employees' training and emergency planning are the keys to success in crisis management. Prioritizing this stage will help oil and gas companies in Iraq to prevent serious damage by reducing the probability of a crisis or reducing its severity. On the other hand, it can be acknowledged that major crises can be prevented by forecasting and prevention. Preventive preparation and design of crisis management protocols to deal with liquid petroleum gas leakage or explosion play a vital role in reducing crises. After the crisis measures were ranked second, which indicates the importance of reconstruction and recovery

after a crisis. In this phase, damage assessment, systems recovery and infrastructure improvement are done. This phase also includes reviewing and improving crisis management plans to prevent similar crises in the future. This result shows that learning from past crises and implementing necessary reforms has a great importance to reduce the possibility of crises happening again and make better ready the oil and gas company in Iraq. The third rank for measures during the crisis shows that this phase has a high importance, but it is in a lower priority compared to the before and after the crisis phases. Quick and effective responses during a crisis are necessary to control the situation and prevent the spread of the crisis, but this result indicates that if the before the crisis phases are done properly, the need for crisis measures is reduced. This ranking may confirm that immediate reactions and emergency management during a crisis; although it is necessary, it has less impact on the entire crisis management process than planning and reconstruction after the crisis.

It was determined based on the findings of the crisis management sub-criteria in oil and gas projects that "design and strengthening of pressure and heat infrastructures, automatic fire extinguishing systems and emergency evacuation equipment for liquid petroleum gas storage against crisis" has the most priority in the before the crisis phase. This shows that crises can be effectively prevented by strengthening the infrastructure, such as pressure and heat systems, automatic fire extinguishing and emergency evacuation equipment; and if a crisis occurs, its effects can be minimized. This finding emphasizes the necessity of investing about the safety infrastructure and creating crisis-resistant environments. In during the crisis management, the sub-criterion of "continuous assessment of conditions and implementation of programs, including detailed examination of leakage rate, fire intensity and environmental safety level" was recognized as the most important factor. This finding confirms that there is a need for continuous and accurate monitoring of the current situation to control the crisis effectively. On the other hand, flexibility in management plans and the ability to adapt them to real conditions are very important; because, critical conditions can change quickly, and a quick and accurate response to these changes will prevent the spread of the crisis and its intensity. After the crisis, it was found that the sub-criterion of "complete assessment of damages to equipment and facilities such as tanks, pipes, fire extinguishing systems and equipment related to liquid petroleum gas storage" has a great importance. This phase was identified as a necessary phase in the process of recovery and reconstruction by emphasizing on the detailed assessment of damage to equipment and facilities. This finding shows that a detailed and comprehensive assessment of the post-crisis situation, along with the quick repair and reconstruction of equipment, not only prevents the occurrence of future crises, but also helps to quickly return to the normal situation. In general, it can be acknowledged that a comprehensive and integrated approach is needed that covers all the

phases of the crisis and has full infrastructural, planning and educational support to manage effectively the crisis in the liquid petroleum gas storage projects in Iraq. This strategy can lead to improved safety, reduced losses and ensure the sustainability of operations in these critical projects.

5. Conclusions

According to what was discussed in this study, it can be acknowledged that crisis management in liquid petroleum gas storage projects in Iraq is a critical and complex issue in the field of energy and industrial development. These projects face several challenges that can have significant effects on their sustainability and efficiency. Considering the geographical location and specific political conditions of Iraq, the need for a comprehensive and effective approach in crisis management is felt more than ever. In this context, accurate identification of existing risks and threats plays a key role in crisis prevention. Therefore, this was discussed in the study and it was found that planning and preparation for facing crises should be included in the structure of these projects. Creating different scenarios and formulating effective solutions to respond to critical situations can help increase the flexibility and efficiency of projects. These measures not only help to reduce the response time to crises, but also lead to the preservation of resources and human capital. Therefore, it can be concluded that crisis management in liquid petroleum gas storage projects in Iraq is not only a necessity, but also an opportunity to strengthen the energy infrastructure and sustainable development of Iraq. Even, adopting preventive approaches and careful planning can help reduce the negative consequences of crises and guide the country towards a stable and safe development.

The findings indicate that effective crisis management in the oil and gas storage industry depends on an integrated approach covering the pre-crisis, during-crisis, and post-crisis stages. The main conclusions are as follows:

- Crisis preparedness and response: Effective crisis management requires preventive and response plans based on identified risk factors, supported by regular employee training, emergency simulations, and effective warning and notification systems.
- Technology and monitoring: The integration of advanced technologies, including GIS, smart sensors, remote monitoring and control, and CCTV systems, enhances early crisis detection, situational awareness, and the speed and effectiveness of response.
- Emergency resources and safety: Maintaining adequate LPG reserves and essential emergency equipment, together with fire protection systems, water-spray systems,

emergency pumps, ventilation systems, automatic shut-off systems, and appropriate fire-fighting agents, contributes to reducing the severity and consequences of crises.

- Storage and logistics management: Effective management of storage and logistics networks, including the appropriate distribution of warehouses and supply facilities, improves the availability of essential resources and reduces transportation time and costs during emergencies.
- Post-crisis management and learning: Systematic investigation of incidents, documentation of crisis events and responses, analysis of their causes, and incorporation of lessons learned into emergency plans and warning systems are essential for improving future crisis preparedness and response.

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