



Storage Oil Tank Fire Accidents (The Sidra Oil Port Fire Accident Case Study, In Libya 2014)

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Abstract

Large outdoor crude oil storage tank fires pose substantial risks, including severe property damage, economic disruption, and environmental harm. Storage facilities, such as oil warehouses, supply depots, and surrounding areas, are particularly hazardous due to the flammable and volatile nature of their contents. In 2014, a significant fire occurred at the Sidra Oil Port in Libya, triggered by armed conflict. This study assesses the response of the port administration and firefighting personnel to the incident through a structured questionnaire. Data were analyzed using the Statistical Package for the Social Sciences (SPSS). The findings reveal that 94% of personnel lacked adequate training in combating oil storage tank fires, severely impairing their response efficiency during the crisis. Alarmingly, 68% of workers reported that they had not received the necessary training even after the incident, highlighting systemic neglect by the port administration and the associated company in managing fire-related risks. Furthermore, the investigation revealed that not all 19 oil storage tanks at the Sidra Oil Port were equipped with automatic fire alarm systems, underscoring the urgent need for enhanced fire prevention measures and improved safety protocols to mitigate future emergencies.

Keywords: Oil Storage Tank, Fire Accidents, Sidra Oil Port, Crude Oil Tanks, Firefighting Preparedness

حوادث حريق خزانات النفط (دراسة حادث حريق ميناء السدرة النفطي، في ليبيا 2014)

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المخلص

حرائق صهاريج تخزين النفط الخارجية الكبيرة يمكن أن تسبب أضراراً جسيمة في الممتلكات، واضطراباً اقتصادياً، وأضراراً بيئية. حيث تعتبر أماكن تخزين النفط الخام، مثل المستودعات ومراكز الإمداد اللوجستية والموانئ النفطية أماكن خطرة بسبب محتوياتها القابلة للاشتعال. في عام 2014، اندلع حريق في ميناء السدرة النفطي في ليبيا نتيجة للاشتباكات المسلحة التي شهدتها منطقة الهلال النفطي في تلك الفترة. حيث قيمت هذه الدراسة إدارة الميناء والمسؤولين عن إطفاء الحريق باستخدام استبيان معد. وتم تحليل نتائج الاستبيان باستخدام برنامج الرزمة الإحصائية للعلوم الاجتماعية (SPSS). وأظهرت النتائج أن 94% من العمال يحتاجون إلى مزيد من



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التدريب لتحسين مهاراتهم في مكافحة حرائق صهاريج تخزين النفط، مما أثر على قدرتهم على الاستجابة السريعة أثناء الحادث. إلا أن 68% من العاملين بالميناء لم يتلقوا هذا التدريب حتى بعد الحادثة، مما يدل على إهمال إدارة الميناء والشركة في إدارة الأزمة لتجنب حدوثها مستقبلاً. بالإضافة إلى ذلك، ليست جميع صهاريج تخزين النفط في ميناء السدرة النفطي البالغ عددها 19 مزودة بأنظمة إنذار تلقائية، مما يشير إلى ضرورة تحسين هذه الأنظمة لمنع الحرائق وضمان السلامة أثناء حالات الطوارئ.

الكلمات المفتاحية: تخزين النفط، حوادث الحريق، ميناء السدرة النفطي، خزانات النفط الخام ، إطفاء

Introduction

Fire is nature's most destructive element despite its many uses and advantages. While under human control, it is referred to as fire or flame; nevertheless, if power is lost, it transforms into a fire regardless of its value or resistance. As for large fires, such as those that occur in locations where valuable commodities are kept, including warehouses, supply centers, forests, and crude oil storage depots, a small percentage of them causing extremely large damage and significant losses [1]. Crude oil storage places are hazardous and important for storage and transportation. It contains a large quantities of crude oil stored in large tanks prepared for this. It also has other auxiliary facilities, Which are considered dangerous sources of fire and explosions [2]. Crude oil storage tanks in ports and factories contain Large quantities of flammable and dangerous crude oil. A minor accident can cause a million-dollar property loss and a production interruption in addition to their effects on the environment and public safety [3]. Moreover petroleum products are stored in oil depots, which might result in terrible outcomes such as fires and explosions. With rising global energy consumption, these facilities may potentially harm the environment [4]. The fires that occur in oil storage places are very expensive and their losses are exorbitant and affect the economies of the countries in which they occurred ; Like Libya, for example, as oil is the main nerve feeding the Libyan treasury and losses That could happen in Libyan oil negatively and directly affect the lives of citizens . This requires us to take all necessary precautions to prevent the spread of oil fires and, in the event that they do occur, to try to mitigate the losses caused by them. Therefore, ports for exporting crude oil and its derivatives are of great importance to the state, as they must meet all safety conditions [5]. Oil tank



fires and accidents happen now and then During the production of oil and chemicals, as well as during the storage process. Fires, leaks and explosions are the main types of potential accidents in crude oil tanks, and these accidents usually have devastating effects on lives , property and the environment in general . Based on the structural characteristics of crude oil reservoirs, the greatest risks include floating ceiling fires As a result of leaks, gases and vapors gather in the space between the floating roof and the liquid If they provide an ignition source such as lightning strikes [6].

This study deals with the Sidra oil port fire that occurred at the end of 2014. It is one of the most important and largest oil ports in Libya and has witnessed fires during the past few years. The cause of the fires was the result of armed clashes that took place in the area during the same period, which led to the fire breaking out in the port's warehouses. Through a questionnaire designed specifically for this purpose, this study investigates the incident and evaluates the performance of the port administration and those responsible for extinguishing the fire. The questionnaire results were analyzed using the Social Science Statistical Packages Program (SPSS), and the questionnaire's validity was confirmed, giving confidence in the study's findings.

Sidra Port storage oil tanks fire in 2014

The Sidra Oil Port is located on the eastern coast of Libya and is one of the country's major oil export terminals. It plays a crucial role in Libya's oil industry, handling a significant portion of the country's oil production and exports. The port consists of storage tanks, loading facilities, and infrastructure necessary for the transportation of crude oil. it can accommodate giant oil tankers with up to 2 million barrels of crude oil. The port has 19 storage tanks with varying capacities, storing 6.2 million barrels of oil [7] [8]. The primary cause of the fire at the Sidra Oil Port was the armed conflict between rival factions in Libya. The clashes led to the shelling of oil storage tanks, which subsequently caught fire. The ongoing instability and violence in Libya at that time contributed to the escalation of the situation, resulting in extensive damage to the oil facilities [9]. The fire had a devastating impact on the oil infrastructure at the Sidra



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Oil Port. Several storage tanks were engulfed in flames, leading to their destruction and causing a significant loss of stored crude oil. The damage to the infrastructure disrupted oil production and export activities, affecting Libya's economy and its ability to meet international oil demands. The release of large quantities of crude oil into the environment had severe environmental consequences. The spilled oil contaminated nearby land and water bodies, posing a threat to local ecosystems and wildlife. The environmental impact also extended to coastal areas, affecting marine life and fisheries [10].

On the morning of 25 December 2014, Sidra port were directly bombarded as a result of military conflicts in the oil crescent region during that period. This bombing caused a fire in storage tanks 13 and 14. The Sirte Oil Company for Production - Manufacturing of Oil and Gas firefighting team was the first to arrive to help control and extinguish the fire before it spread to other tanks adjacent to the two burning tanks [11]. Due to Waha Oil Company evacuating its employees, the team was unable to determine the amount of stock in the two burning tanks or the firefighting supplies and equipment that were accessible to create a firefighting plan. This made it difficult for the team to begin the extinguishing operation. Therefore, to prevent an economic and environmental catastrophe, the National Oil Corporation of Libya set up an emergency committee and sought support from neighboring oil companies. Indeed, the companies responded, and firefighting teams began arriving at the site from Zueitina Oil Company, Ras Lanuf Oil & Gas Company, Arabian Gulf Oil Company, and Harouge Oil Operations, in addition to firefighting teams from Sirte Oil Company for Production - Manufacturing of Oil and Gas and Waha Oil Company [12].

The first action was to transfer the oil stock from Tank No. 14 to Tank No. 15. The fire crews' attempts to put out the fire in the two tanks were hampered by the flames and smoke emanating from it, despite the attempts of the fire brigades, the second day of the incident witnessed a serious development as the fire spread to three neighboring tanks, namely (12, 11, and 8). In the following days, the firefighters crews succeeded in extinguishing storage tanks 14 and 12. Despite that, they experienced another shock as they raced to extinguish the fire, which spread to tanks 6 and 5. The fire team did not



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give up and kept trying to control the fire, even though they had to use cranes outfitted with fire weapons to cool it down and extinguish it. The fire was eventually extinguished. The National Petroleum Corporation took command and extinguished the fire in the Sidra port safes on January 5, 2015 [13].

Materials & Methods:

Despite the importance of oil ports in the country's oil business, where output is collected for export abroad, they also represent sites where inhabitants and employees face numerous hazards to their safety. In addition to the hazards of soil, water, and air contamination, the resultant fires are among the most dangerous to people, the environment, and the economy [14]. Therefore, the importance of this study is to shed light on the problem of oil tanker fires that can occur in locations where crude oil is kept in the country and to give decision-makers with the required advice to decrease the risks of this problem.

To study and evaluate the 2014 Sidra Oil Port Fire incident and accomplish this objective, an 15-question identification has been made that encompasses three basic hypotheses of the study, which are:

- The association between human resources experience and training courses and the control of oil storage tank fire incidents.
- Having an adequate number of qualified human resources on hand during a fire disaster immediately adds to its control.
- Early fire alarm systems, as well as fire materials and equipment, and their role in assisting in the suppression of oil tank fires.

Questionnaire forms were distributed to workers at the Sidra Port in four different departments in the port: the Occupational Safety Department, the Safety and Environment Department, the Industrial Security Department, and the Fire Department. According to port administration data, the total number of employees in the four port departments during the period of study preparation reached 70, as a result of the company's plan to combat the spread of the Coronavirus during this period. Therefore, we relied on distributing 50 questionnaires to workers in the four departments as a



sample for the study and analyzing its results using the Statistical Package for the Social Sciences (SPSS).

1. Validation of the study tool :

The questionnaire's validity indicates that the questions measure what they were supposed to measure. The Cronbach's alpha coefficient has a value between 0 and 1 and shows the degree of correlation between the answers to the sample questions. When the Cronbach's alpha coefficient is 0, it means there is no absolute correlation between the responses to the sample items. However, if the Cronbach's alpha coefficient is 1, this suggests that the answers to the sample questions are completely correlated. The minimum acceptable value of the Cronbach's alpha coefficient is 0.6, and the optimal value varies between 0.7 and 0.8; if its value surpasses 0.8, the case is better [15].

Table 1: Shows the basic data of Sidra Port. (Source: Libyan Ports & Maritime Transport Authority)

No.	Number of phrases	Cronbach's alpha coefficient (reliability)	Honesty coefficient = square root of Cronbach's alpha * 100
scale	16	0.692	%83.1

2. Descriptive Analysis Results:

According to the examination of the study sample's primary data, 33 of the sample members vary in age from 26 to 45 years, which represents 66% of the study sample. It is also noted from the analysis of academic qualification data that 24 individuals in the study sample have a higher diploma level, corresponding to 48% of the study sample. As for those who participated in the fire extinguishing process, they were from the firefighting and environmental safety departments, accounting for 58% of the study sample. As shown in Table 2.

Table 2: Shows the basic data of Sidra Port. (Source: Libyan Ports & Maritime Transport Authority)

Age	frequency	%	Educational Qualification	frequency	%	Department	frequency	%
18-25	8	16%	Intermediate diploma	21	42%	occupational safety	15	30%
26-35	23	46%	high diploma	24	48%	firefighting	14	28%
36-45	10	20%	undergraduate	4	8%	environmental safety	15	30%



Age	frequency	%	Educational Qualification	frequency	%	Department	frequency	%
Older than 45	9	18%	graduate	1	2%	industrial security	6	12%
sum	50	100%	sum	50	100%	sum	50	100%

3. Analysis of Study Hypotheses:

1. Results of analyzing the first hypothesis of the study to determine the opinions of the study sample about the association between human resources experience and training courses and the control of oil storage tank fire incidents.

Table 3: Shows the Results of analyzing the first hypothesis of the study

NO.	Questionnaire	yes	No	No Answer
1	Do you have previous experience facing oil tank fire incidents?	50%	38%	12%
2	Did you ((participate)) in confronting the Sidra Port fire in 2014?	68%	32%	0%
3	Did you ((obtain)) training courses in firefighting while working for the company?	64%	36%	0%
4	Did you take training courses in firefighting (after) the Sidra Port fire incident in 2014?	32%	68%	0%
5	Do you ((need)) training courses to develop your firefighting skills?	94%	6%	0%

According to the result, there were 50% of the sample study had previous experience confronting oil tank fire incidents, followed by 38% who did not have any experience and 12% who did not remember their participation in extinguishing previous fires. The sample's participation in dealing with oil tank fire accidents was highest, with 64% receiving training on how to deal with such incidents. 68% of participants in the study group did not acquire such courses after the incident. The vast majority of members require training courses to increase their ability to cope with oil tank fires, with 94% requiring such courses.

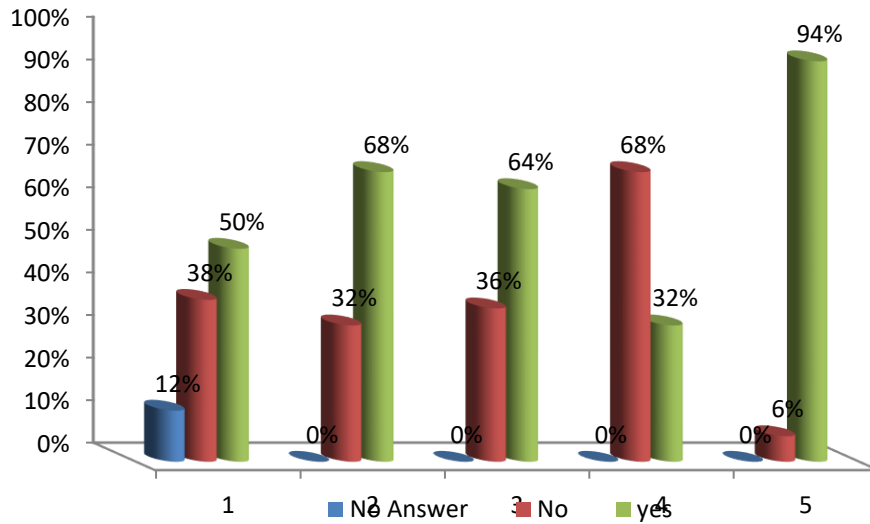


Figure 1: Shows the Results of analyzing the first hypothesis of the study

From analyzing the results of the first hypothesis of the research, the following becomes clear:

- 50% of the sample study's participants had prior experience dealing with oil tank fires incidents.
- 68% of the sample study's participants participated in confronting the Sidra Port fire in 2014.
- 64% of the sample study's participants obtained training courses on firefighting incidents while working for the company.
- 32% of the sample study's participants obtained training courses on firefighting incidents after the Sidra Port fire incident in 2014.
- 94% of the sample study's participants need training courses to develop their firefighting skills.

2. The results of analyzing the second hypothesis of the study to determine the opinions of the study sample about having an adequate number of qualified human resources on hand during a fire disaster immediately add to its control.

Table 4: Shows the results of analyzing the second hypothesis

NO.	Questionnaire	yes	No	No Answer
1	Were the ((numbers)) present human resources in the port of (firefighters, industrial safety and security) sufficient to confront the Sidra Port fire in 2014?	26%	52%	11%



NO.	Questionnaire	yes	No	No Answer
2	Is there an "emergency plan" in the event of a fire in the workplace or at oil tank sites?	84%	12%	4%
3	Do you understand evacuation strategies and how to handle emergencies?	98%	2%	-
4	Were "firefighting crews from other companies" used in the oil tank fire incident in 2014	100%	0%	-

According to the hypothesis survey, 52 % of the sample members thought the number of human resources was insufficient during the 2014 fire incident, and 26 % thought it was adequate. The bulk of the research sample (84%) had a workplace fire emergency plan in place, whereas 12% did not. Only 4% were uninformed of evacuation plans and emergency procedures, whereas the great majority (98%) were. Moreover, all members of the sample confirmed that other firms' firefighting personnel were used in the event.

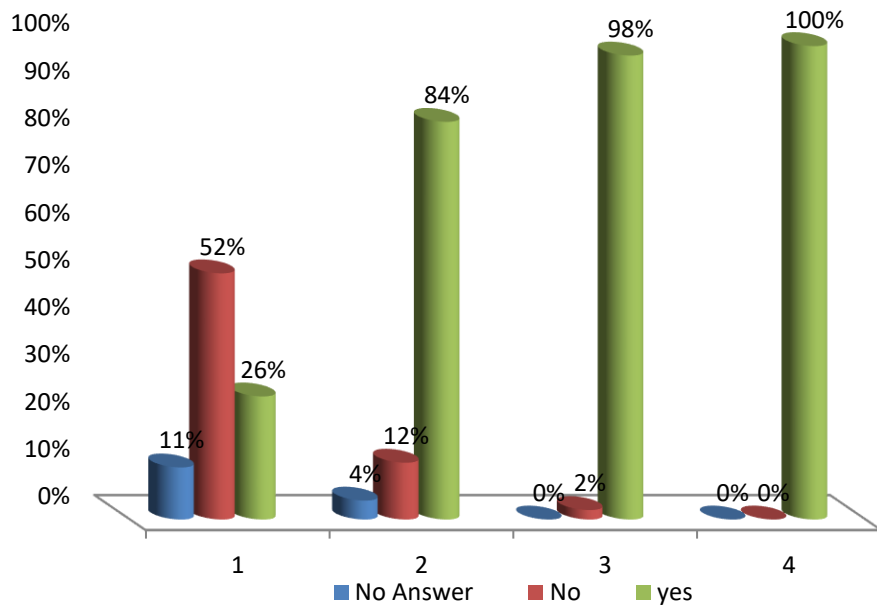


Figure 2: Shows the results of analyzing the second hypothesis

From analyzing the results of the second hypothesis of the research, the following becomes clear:

- 52% of the sample study's participants said the number of human resources is insufficient.
- 84% say that there is an emergency plan in the event of a fire in the workplace.



- 98% of the sample study's participants said they understood evacuation strategies and how to handle emergencies.
- 100% of the participants in the study sample said that other companies participated in extinguishing the Sidra Port fire in 2014.

3. The results of analyzing the third hypothesis of the study to determine the opinions of the study sample about the early fire alarm systems, as well as fire materials and equipment, and their role in assisting in the suppression of oil tank fires.

Table 5: Shows the results of analyzing the third hypothesis

NO.	Questionnaire	yes	No	No Answer
1	Was there an automatic alarm system installed on all oil tanks ((19)) in the port?	2%	92%	6%
2	Was there an automatic extinguishing system installed on all oil tanks ((19)) in the port?	50%	44%	6%
3	was there a cooling system and equipment available to cool tanks when a fire breaks out?	52%	12%	36%
4	Was the stock of foam stock (FB-70) sufficient to extinguish the oil tank fire in 2014?	50%	44%	6%

According to the survey, 92% of those polled said their oil tanks lacked an automatic alert system. and 50% thought that all oil tanks at the port had an automated firefighting system. The highest percentage of members said there was a cooling system and equipment for the tanks when the fire broke out, with 52 % believing so, and 54 % was unaware of the aid of automatic firefighting equipment placed on oil tanks in extinguishing the tank fire event in 2014.

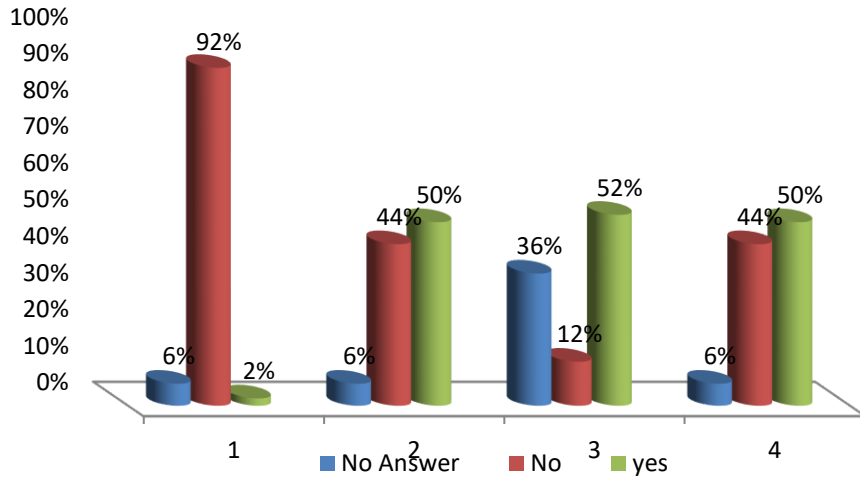


Figure 3: Shows results of analyzing the third hypothesis.

After asking the study sample, which was the last question in the questionnaire, what is your assessment of the “competent management” of the company in dealing with the Sidra Port fire accident in 2014, we analyzed the results shown in Table 6.

Table 6: shows the evaluation statement of the study sample about the company’s competent.

NO.	Questionnaire	weak	middle	good	excellent
5	What is your assessment of the company’s “competent management” in dealing with the Sidra Port fire incident in 2014?	2%	10%	52%	36%

According to the results of the most recent questionnaire, 52% of sample members said the company's handling of the Sidra Port fire incident in 2014 was good, followed by 36% who said it was excellent, and 2% who said it handled poorly.

From analyzing the results of the second hypothesis of the research, the following becomes clear:

- 92% of the sample study's participants said there was no automatic alarm system installed in the tanks.
- 50% of the sample study's participants believe that there was an automatic firefighting system installed on all oil tanks (19) in the port.
- 52% are convinced that cooling systems and equipment are available for tanks when a fire breaks out.
- The company dealt well with the Sidra Port fire incident in 2014.



Discussion

The findings of the first hypothesis underscore the critical relationship between human resource experience, training, and the management of oil storage tank fire incidents. The analysis revealed that 94% of the respondents required additional training to enhance their firefighting skills, yet a significant portion had not received any training even after the incident. This highlights a concerning lack of preparedness among workers in dealing with oil tank fires. The results emphasize the urgent need for comprehensive training programs to equip personnel with the necessary skills to respond effectively to such emergencies.

Additionally, the study found that due to a contingency plan, there was a shortage of personnel during the fire, which significantly hindered the response effort. The reduction in available staff negatively impacted the ability to quickly and effectively manage the fire, necessitating the involvement of fire squads from neighboring companies. The results of the second hypothesis further underscore the importance of adequate human resources and awareness of fire safety protocols in the workplace.

The third hypothesis highlighted the essential role of automated alarm and fire suppression systems in preventing and managing fires in their early stages. According to 92% of the participants, none of the 19 oil storage tanks at the Sidra Oil Port were equipped with automated alarm systems. This finding indicates a significant gap in fire safety infrastructure. To mitigate future incidents, it is imperative that Waha Oil Company installs automated alarm systems on all storage tanks.

Conclusion

The analysis of the study's hypotheses revealed significant shortcomings in the response of both the company and the port management to the 2014 Sidra Oil Port fire, leading to substantial material losses for the company and the Libyan state, estimated in the millions of dollars. To prevent similar failures in future incidents, the following measures are recommended:

- Implementing comprehensive and intensive training programs for personnel on the management of oil storage tank fires, alongside a thorough review and enhancement of the company's emergency response plan.
- Conducting a detailed investigation into the mistakes made during the incident, particularly in terms of response coordination and inter-company collaboration, to identify areas for improvement and to ensure faster, more effective future responses.
- Ensuring that all storage tanks are equipped with automated fire alarm systems to provide early warnings and enhance fire management capabilities.



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- Recruiting personnel with extensive experience in managing oil tank fires and providing targeted training to less experienced workers to improve overall preparedness and response efficiency.

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