



Health, Safety, and Environment in the Management of Hazardous Wastes in an Oil Refinery in Tehran Province Based on the Oil and Gas Producers Association Guide

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ABSTRACT

Background: Health, safety, environment (HSE) - management evaluation (ME) is a managerial tool used to control and improve the health, safety, and environmental performance in development programs and industrial projects or organizations. The present study aimed to evaluate HSE in the management of the hazardous wastes of an oil refinery in Tehran province, Iran based on the guidelines of oil and gas producers association OGP.

Methods: In this cross-sectional study, a HSE questionnaire and a checklist were completed based on the basic information of the organization, HSE documentation, and interviews with those involved in HSE-ME and waste management. The questionnaire was prepared based on the OGP guide and validated by a panel of HSE experts.

Results: The refinery had favorable conditions, and all the items presented in the questionnaire were in the C and D ranges. In addition, the checklist results were indicative of favorable HSE and waste disposal conditions in the refinery. On the other hand, the physical, chemical, and biological risk of exposure to waste was not properly assessed in the company, which was a major setback to waste management.

Conclusion: The refinery employees had moderate knowledge level regarding HSE-ME. Therefore, attempts must be made by the management of the organization in order to improve the issue through correct policies.

1. Introduction

The 20-year vision of Iran is to achieve sustainable development. Several factors are involved in attaining sustainable development, including economic, social, and cultural issues, as well as safety and environmental health [1]. Not only the latter requires organizations to minimize the adverse effects of industries on the environment, but it also determines the interaction of immune and environmental health factors with the enhanced favorable effects of organizations through assuring safety for all the

employees of equipment and facilities, as well as environmental protection through a creative cultural context based on novel, systematic approaches. As a result, organizational will be able to evaluate potential risks systematically and propose preventative methods.

The growth of chemical production and consumption in various industrial processes is the hallmark of an industrial society. While the use of chemical compounds in various branches has brought about significant economic development, several studies have shown that most industrial wastes are hazardous and adversely affect health,



causing environmental pollution (water, soil, and air) [2].

Waste generation is an integral part of human life, and waste generation in different quantities and qualities is a significant environmental issue in every human community. High-risk industrial wastes could cause toxicity, reactivity, infectivity, and explosion.

Therefore, inattention to the produced chemicals by industries may lead to chronic and acute risks to humans.

Today, several organizations, including OSHA, UNEP, EPA, and WHO, have enacted special laws and regulations for the classification, collection, and disposal of hazardous industrial waste. In this regard, the correct implementation of managerial methods could effectively reduce the possible negative consequences [2].

Human resources are the main axis of sustainable development in advanced management [3]. Various methods are known to result in global industry and sustainable development; nevertheless, such development will fail without attention to human resources [4]. In order to improve customer satisfaction, advanced organizations in the world should particularly focus on the health and safety of their staff and environmental protection [5]. In addition to the legal issues that companies are required to comply with, many corporations have exceeded the standards set as the key indicators of the community where they operate. As such, they attempt to increase their productivity by decreasing environmental risks and improving the health and safety of the staff [6].

Evaluations have indicated that workplace accidents in the United States have imposed an annual financial loss of approximately 142.2 billion dollars on the US economy. Moreover, about four million non-fatal injuries and 5,734 deaths were reported in the United States in 2005 [7]. With the associated injuries leading to 80 million days of lost work. In 2003, 4,664 work-related deaths and one accident per five seconds were recorded in the European Union. In Iran, 300,000 billion Rial are lost annually due to work-related accidents, and 1,891 deaths also occur every year due to work-related accidents [8]. Some of the occupations depend on oil, gas, and petrochemical industry. Due to their specific nature, these occupations demand high mental and physical capabilities in the staff with regard to the utmost importance of health, safety, and environment (HSE) factors to employees, employers, and shareholders [9]. These parameters may lead to the sustainable development of organizations. The main purpose of these components of the HSE management system (HSE-MS) is to ensure the establishment of these elements in organizational strategies [10]. The special attention of the world's largest oil, gas, and petrochemical companies to the HSE-MS is indicative of its pivotal role in the planning and development of products, services, and processes based on health, safety, and environmental considerations [11].

The ultimate goal of the HSE-MS is the protection of individuals, properties, and the environment [12].

The simultaneous consideration of health, safety, and environmental issues eliminates parallel activities as a result of economic balance, thereby facilitating higher productivity and sustainable development. Furthermore, the HSE attempts to foster a healthy, pleasant, and lively environment free of accidents, damages, and wastes as an

integrated system that converges and aligns human resources and facilities. In fact, the HSE-MS is a part of the current total management system in every organization [13].

The present study aimed to evaluate the HSE status in the management of high-risk wastes in an oil refinery in Tehran province (located at 22nd km, Karaj Makhsoos Road), Iran based on the guidelines of the International Association of Oil and Gas Producers (OGP).

2. Materials and Methods

This cross-sectional, descriptive-analytical study was performed after evaluating the related references and a survey of the HSE unit of the refinery and university professors. The HSE-MS status in the high-risk wastes of the refinery was evaluated to determine the HSE management indicators derived from the OGP guidelines. In addition, the checklist proposed by William F. Martin in Hazardous Waste Handbook for Health and Safety was applied to evaluate the implementation process of the health safety status in the management of the high-risk wastes of the refinery [14]. The checklist has been specifically developed for high-risk wastes. The HSE-MS was evaluated in nine sections based on the OGP guidelines and Deming Cycle, as follows:

1. Commitment and leadership ;
2. Strategic policies and goals ;
3. Organization, responsibilities, resources, standards, and documentation ;
4. Risk management ;
5. Planning and processes ;
6. Implementation and performance monitoring ;
7. HSE audit and HSE-MS review management;
8. HSE management of new features (EXTRA-organizational);
9. Exclusive HSE hazardous waste information

2.1. Research Methodology

The HSE evaluation questionnaire was extracted from guideline No. 291 of the OGP (1999) and translated into Persian [14]. Considering that the questionnaire has been generally developed for all activities of oil industries (e.g., excavation, petro chemistry, and refinement), its specific use in the refinery industry requires the assessment and validation of the questionnaire by HSE experts. In the HSE capability assessment grading system, different grades (A, B, C, and D) are defined as scores zero, three, six, and ten, respectively.

2.2. OGP Questionnaire Validation

The translated version of the OGP questionnaire was reviewed by a panel of experts (n=24), including specialists in the area of safety and environmental health. In total, 15 members of the panel responded fully to the validation questions. In fact, validation was carried out to extract the content validity ratio (CVR) and content validity index (CVI) and confirm the test validity. After the extraction of the CVR and CVI, the minimum level of the two components (0.49 and 0.79) was considered, and 59 out of 81 items were formed in the questionnaire.

The first step to determine the test validity was to assess the content validity of the test. Content validity depended on the rational analysis of the content of a test and was determined based on mental and individual judgment. The process involved providing the test items to the experts or some of the participants and asking them to determine whether the items could properly measure the desired traits. Another objective was to determine whether the items covered the entire test contents. The accredited OGP questionnaire was completed in collaboration with the HSE unit of the refinery, which resulted in the extraction of nine expected indices regarding compliance with the OGP criteria.

The HSE checklist was prepared and translated based on the proposal by William F. Martin in order to evaluate the execution status of hazardous waste in the refinery [14]. In total, 77 items on the oil refinery industry were selected and completed in cooperation with the HSE unit.

3. Results and Discussion

3.1. Results Obtained from the OGP HSE Evaluation Questionnaire

According to the results obtained from the HSE evaluation questionnaire of the OGP in the refinery, the company had a favorable status in terms of management commitment and adherence to HSE policies and strategic goals. In this regard, the mean score was within the D range. According to the information in Table 1, the score of 16 (out of 20) was reported for the management commitment section. Regarding the adherence to the HSE policies and strategic goals, the company achieved the score of 56 (out of 60) (Table 1). In addition, the refinery had favorable conditions in terms of the organizational structure for effective HSE-MS and reinforcement of human resources through gaining information and general/specialized HSE training. The implementation and improvement of standards and their documentation were also favorable at the company. In this respect, all the items of the questionnaire were within the D score range, and the company obtained the score of 138 (out of 170) in this regard (Table 1).

The refinery had favorable conditions in terms of risk management, risk control and assessment, and monitoring of the impact of such controls. All the items on this subject in the questionnaire were within the D score range, and the company obtained the score of 93 (out of 120) (Table 1). Furthermore, the company had favorable conditions in terms of the planning and procedures section, including the HSE operations guide, as well as ensuring safe working conditions in the factory and access to a proper system for the identification and monitoring of hazards and providing the necessary measures in emergency response situations. In this regard, the mean of the items in the questionnaire was within the D range, and the company achieved the score of 32 (out of 40) (Table 1).

According to the obtained results, the company had a favorable status in the implementation and performance monitoring section, such as the monitoring of the HSE staff performance, identifying deficiencies and shortcomings, and recording and reporting of incidents. Most of the items in this regard were in the C and D score ranges. The only section with an unfavorable condition was the reporting of

near-miss incidents, which was an important limitation. This section requires modification since near-miss incidents could easily turn into accidents (Figure 1). In this section, the company obtained the score of 79 out of 110 (Table 1).

According to the results, the refinery had favorable conditions regarding HSE audit and review of management in the HSE-ME, including audit timing, follow-up of audit results, ensuring the efficiency of corrective measures, recording of the corrective measures, and implementing the improvement processes. In this regard, all the items of the questionnaire were within the C and D score ranges, and the score of 38 (out of 50) was obtained (Table 1-4). Other features such as the confirmation of HSE-ME validity, membership in HSE-related associations, and proper interaction with governmental organizations were also favorable in the company. In this respect, all the items in the questionnaire were within the C and D score ranges, and the full score was obtained in this section (Table 1).

3.2. Results of the Checklist of Safety and Health Assessment of Hazardous Wastes

According to the findings, the company had favorable conditions in terms of waste storage documentation, history of operations, receipts, daily report offices/other general offices, and waste compartment conditions. The assessment of the biological hazards in the refinery was also appropriate, and proper actions were taken to eliminate possible hazards in case of biological factors. Furthermore, corrosive wastes or other wastes that may cause severe skin and mucous membranes irritation or severe allergic reactions were identified in the refinery. However, the flaming point tests that determine which wastes are flammable were not performed. Therefore, corrective measures are required to address this deficiency.

The general conditions and location of the external chambers, piping, and tanks in the refinery were safe for the activities. Moreover, all the applicants in the refinery were fully examined before hiring, and periodic examinations were carried out annually in the company. The medical care program encompasses a healthcare test plan to determine whether the employees have been exposed to specific toxins. In this regard, an important shortage was the lack of a medical plan to separate the employees who were susceptible to excessive heat, especially during summer. Comprehensive safety and health training for all the recruits was provided prior to work, and all the employees received the necessary training on the management of hazardous waste, followed by recording and archiving the educational documents. In the refinery, a written plan is also available for emergencies, in which the responsibility of all the members of the emergency response team has been defined.

Good communication and agreement was observed between the company and other emergency service organizations, including the fire department, clinics, and local hospitals. However, the company failed to properly evaluate the physical, chemical, and infectious risks of contact with wastes, which is mostly related to the waste management section of the refinery. Therefore, corrective measures should be taken, and their effectiveness should be monitored as well irrespective of the identification of extremely corrosive waste wastes or other wastes that could cause severe skin and mucous membrane irritation or allergic reactions (Figure 2).

Table 1: Scores of ogp hse evaluation questionnaire in a refinery in tehran province, iran

Section	Number of questionnaire items with score A	Number of questionnaire items with score B	Number of questionnaire items with score C	Number of questionnaire items with score D	Mean score	Final score
Leadership and commitment	-	-	6	10	8.5	C
HSE policies	-	-	6	50	9.6	C
Organization, responsibilities, resources, standards, and documentation	-	-	48	90	8.6	C
Risk management	-	3	30	60	8.5	C
Planning and procedures	-	-	12	20	8.5	C
Implementation and performance monitoring	-	3	36	40	7.9	C
HSE audit and management review of HSE-MS	-	-	18	20	8.1	C
HSE-MS/Other features	-	-	-	20	10	D
Final score	-	6	156	310	8.6	C
Leadership and commitment	-	-	6	10	8.5	C

The effect of unexpected events on the daily activities of the refinery is not immediately evaluated in the company, and not all the employees attend the accident assessment session of the company. This is a major issue that must be eliminated through corrective measures.

In the refinery, disinfection stations are provided between clean and infected areas, and separate stations and large equipment items are also established for the personnel.

The disinfection stations are equipped with suitable supplies, equipment, clothing, and warehouse facilities. In addition, the effectiveness of waste disinfection is evaluated in the refinery, and the related documents include all the requirements for waste disinfection. Another limitation in the refinery was that not all the heavy machinery and equipment in the refinery were properly equipped with protective operators against flipping, explosion, sprayed liquids, and suspended particulate matter. Therefore, corrective measures should be taken in this regard, and their effectiveness should be monitored by the safety committee of the refinery. It is also notable that high-quality personal protective equipment was available in the company for the personnel who were exposed to waste; such examples were masks, safety gloves, goggles, work clothes, hats, and safety shoes. The workers use their protective equipment properly and wear two-piece chemical-resistant garments or disposable covers with protective aprons, as well as resistant gloves and boots. Nonetheless, the workers lack flame-repellent clothing despite the requirements for the possibility of chemical contact. Therefore, it is necessary to prepare such equipment for the employees as well. The maintenance and cleaning of the clothing and other protective equipment of the personnel are not performed on a daily basis by the personnel, which is an important shortcoming in the health maintenance of the personnel. It is noteworthy that the employees follow the disinfection process in the refinery and adhere to the agreement on access to areas (e.g., signing the report sheets, using protective and disinfecting equipment) (Figure 3).

The rapid growth of industrialization and its close association with the physical, social, and environmental life of individuals have necessitated the assessment of the potential of the unwanted effects of different industries from environmental and social perspectives [15].

In Iran, oil extraction, exploitation, and refining have grown significantly owing to the existence of oil extraction

areas, prompting the establishment of petrochemical, oil, gas, and refinery industries, along with sensitive biological resources and human communities. Oil refineries are classified as oil and petrochemical industries. The HSE management system is a tool used to control and improve health, safety, and the work environments in all industrial and non-industrial development programs. In fact, it is an integrated system that uses human, equipment, and financial resources in support of each other to ensure the provision of health, as well as an environment free of incidents and injuries [16]. Therefore, we used relevant resources and managerial models (e.g., OHSAS 18000, ISO 14001, and ISO 9001) in the present study in order to assess the HSE unit of a refinery, and feedback provided by professors was exploited to evaluate the HSE management system for hazardous waste based on the OGP guidelines [17-19].

According to the results of the HSE evaluation questionnaire, the commitment status of the managers and adherence to the HSE policies and strategic goals of the company were in the C and D ranges.

In addition, the organizational structure for effective HSE management, reinforcement of human resources through public and general HSE training and implementation,

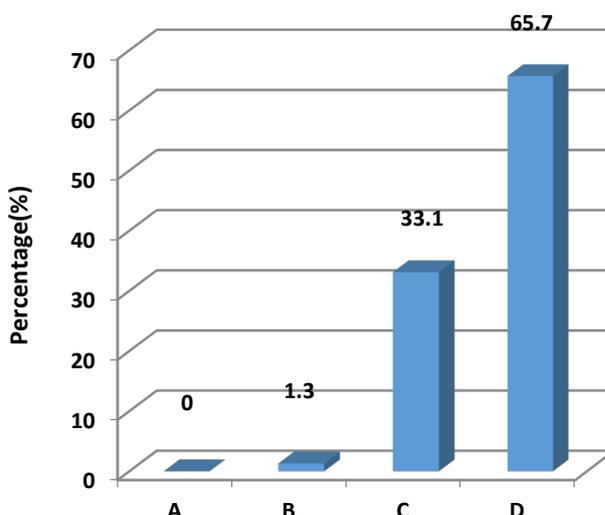


Figure 1: Comparison of distribution percentage of scores obtained from ogp environmental health safety status questionnaires in an oil refinery in tehran province, iran

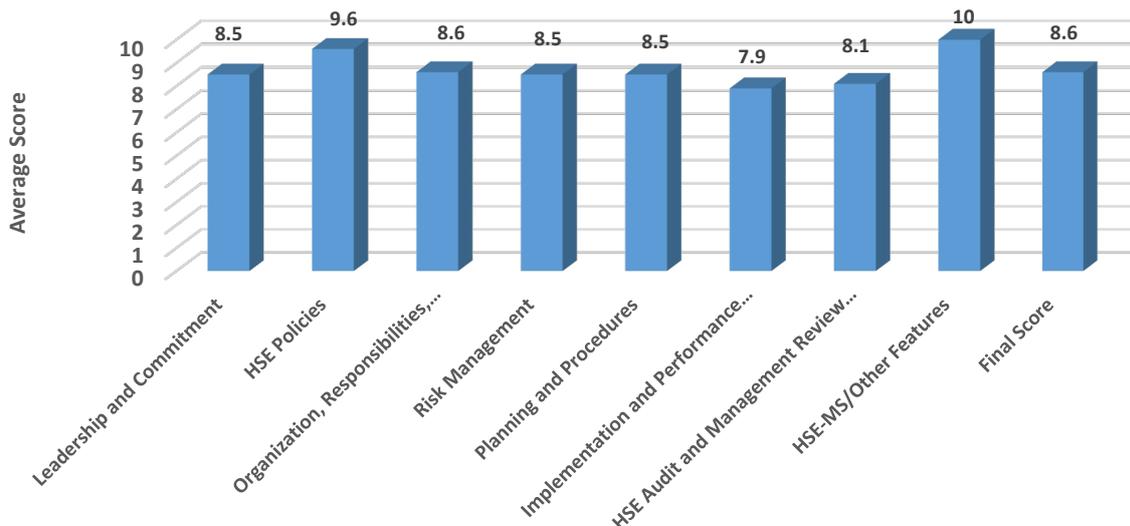


Figure 2: Scores obtained from ogp environmental health safety status questionnaires for eight criteria and final score in an oil refinery in tehran province, iran

implementation and improvement of standards, and documentation were in the C and D ranges. Furthermore, the control and assessment of risks and monitoring of the impact of these controls in the risk management section and HSE operation guide in the section of planning and processes were in the C and D ranges. A summary of the current research on this subject in Iran and the world has been further discussed in the following paragraphs.

In a research by Jafarigol *et al.* (2009) entitled the "Qualitative Evaluation of Hazardous Chemical Wastes to Provide a Minimization Solution in an Oil Refinery in Tehran", the test results on soil samples showed the presence of excess (above the standard level) of cadmium, cobalt, copper, nickel, and lead in the refinery waste. In addition, the highest and lowest mean concentrations of heavy metals in the soil of the salvage zone were reported for zinc and cadmium, respectively. Overall, the mean concentration of the total petroleum hydrocarbons was reported to be 230.58 mg/g of soil, which clearly indicated the soil pollution of the salvage zone, as well as the presence of oil waste in this region [20].

In another study entitled "Waste and Energy Management of Wastewater in the Oil Refineries in Bangladesh", Azad *et al.* (2015) emphasized on the necessity of the environmental management and control of the energy consumption rate in order to achieve the sustainability of the environment and energy carriers. Moreover, since the ecosystem could be affected by the reverse complications of pollutants, grease and oil treatment in wastewater is essential to the management of several environmental issues in the oil industry. Among the other issues in the case of oil wastes are high salinity, erosion, and high salt concentration [21].

In a research entitled the "Genetic Mutation of Petroleum Waste Assessed by DNA Degradation Test", Gupta *et al.* (2015) confirmed the presence of toxic compounds in oil wastes in the form of polycyclic aromatic hydrocarbons, phenols, and heavy metals, which directly or indirectly resulted in DNA damage. In fact, the damage increased in the participants who were exposed to oil wastes [22]. In

another research by Mishra *et al.* (2014) entitled "Amuay Oil Crisis: Consequences and Challenges", the explosion of Ponta Figo Refinery at the northern city of Venezuela was reported to claim 50 lives, leaving more than 100 others injured. In addition, the catastrophized to the complete destruction of 1,600 houses in the vicinity of the refinery, as well as the evacuation of 200 household sand over one billion dollars of damages [23].

In 2015, Antao *et al.* (2016) conducted a research entitled the "Identification of the Indicators of Health, Safety, Security, and Environmental Performance at Port Levels", concluding that a safe and healthy workplace had extraordinary benefits.

Optimal working conditions were reported to have the potential to increase profitability, ultimately developing organizational performance.

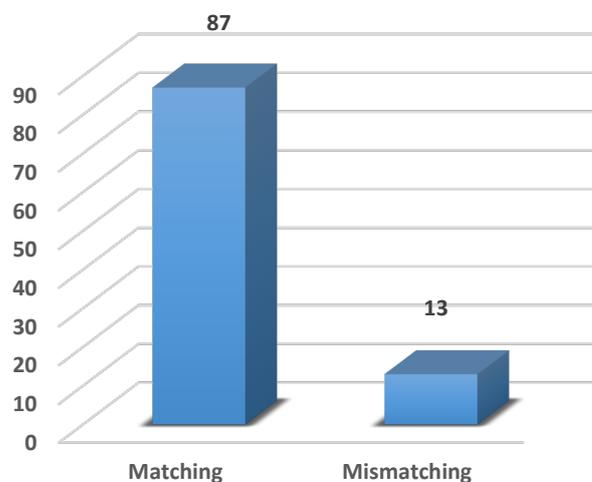


Figure 3: Compliance status (in percent) of health, safety and environment management measures of hazardous waste in an oil refinery in tehran province, iran based on the checklist results

Among the Other benefits of a favorable workplace are the positive effects on happiness and maintaining the skills of the employees. Furthermore, a safe workplace reduces the socioeconomic costs of accidents [24].

3.3. Limitations of the Study

One of the major limitations of the present study was the effect of the chaotic workplace on workers and experts while responded to the questions. Another limitation was the lack of interest and motivation in completing the questionnaires on behalf of some respondents.

4. Conclusion

According to the results, the employees of the refinery had moderate knowledge regarding the HSE-MS. In this regard, the management must attempt to improve the situation by adopting correct policies. In addition, the awareness of the TOOL BOX meeting system and continuous, periodic training should be enhanced.

Research Implications

1. More emphasis should be placed on HSE-MS training in the form of OSHA and NEBOSH training courses.
2. The involvement of the staff in the safety issues related to their work not only helps to better identify the associated risks, but it also shows that their safety and health is a major concern of the management.
3. It is recommended that the needs of HSE be reviewed systematically.

Authors' Contributions

M.M.F., and A.M., supervised the project, J.A., drafted the manuscript with the support of supervisors, all authors read, revised, and approved the final manuscript.

Conflict of Interest

The Authors declare that there is no conflict of interest.

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