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Original Article

Investigating Response Priorities in Oil Pollution Emergencies in an Unloading and Loading Dock Using McKinsey's 7s Gap Analysis Method

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Abstract

Background & Aims: The most critical environmental challenge of maritime transport in recent decades has been oil pollution. The present study was carried out to identify and determine the rate and ranking of oil pollution in the unloading and loading dock of Imam Khomeini Port by the Development Approach of the Management Model of Prevention and Response against Pollution in Emergencies in 2020.

Materials & Methods: In the present descriptive-applied study, the criteria and sub-criteria influencing in prioritizing responses in oil spill emergencies in the unloading and loading dock of Imam Khomeini Port were identified by the documentary method, prioritized based on the technique for order performance by similarity to ideal solution (TOPSIS) multi-criteria decision-making method, and scored by 10 experts. McKinsey's 7s gap analysis method was also used to estimate the gap between the current and the ideal situation.

Results: Out of 18 oil pollution scenarios, 4 were determined as emergencies. Conservation of environmental resources in case of an accident and determination of responsibility before accidents occur, with mean scores of 4.4 and 4.35, were determined as the most important agendas for planning in emergencies. In the gap analysis process with McKinsey's method and the output spider web model, 7 components of strategy (1.65), skills (1.75), staff (2.2), management style (2.27), shared methods (2.38), structure (2.54), and system (2.79) were determined as the emergency response plan priorities.

Conclusion: The study's results showed that while several factors can result in oil pollution emergencies in the unloading and loading dock of Imam Khomeini Port, there is no ideal situation for managing these threats based on gap analysis.

Keywords: Accidents, Water pollution, Transportation

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1. Introduction

There are numerous pollutant sources in the marine environment; however, marine oil pollution is among the most hazardous types of pollution, which, if occurring, causes widespread and sometimes irreparable economic and environmental losses [1,2]. According to the estimate of the United States National Research Council, the origin of 73% of the oil spilled into the sea is the sources other than oil tankers [3,4], meaning that a huge amount of oil spills every year into the sea from sources that receive little attention from the media and public opinion [5]. Based on the statistics presented in the United Nations Oceans Atlas, the major part of the marine oil pollution source is on-shore installations. Among these sources are oil terminals adjacent to the sea in ports, which will culminate in entering the pollutants into the coastal zones continuously in normal situations and suddenly in emergencies during environmental accidents [6]. In order to minimize the effects in such situations, called emergencies, it is vitally important to foresee possible accidents and plan to prepare and deal with them [7]. Having a management plan for emergencies in dealing with this issue is of great importance in the second-and third-generation ports, whose hinterland environment is similar to an industrial town with highly diverse activities and, along with other anchor industries, can be viewed as a place for unloading and loading oil substances and derivatives [8]. The International Maritime Organization (IMO), along with the United Nations Environment Programme (UNEP), has compiled and announced the instructions for awareness and preparedness in emergencies at the local level for ports, and all ports are obliged to implement it. At present, this plan is being implemented in 30 countries. In Iran, considerable actions have been taken concerning the management of oil pollution emergencies in ports [9]. An emergency refers to a situation that is suddenly created due to natural and human events and functions and leads to

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a condition that instant and extraordinary measures must be taken to eliminate [10,11]. The word “disaster” is not traditionally synonymous with “crisis”; however, it is a condition in which important decisions must be made in a specific short time in a situation that includes threats and opportunities [12,13]. Originally, the word “crisis” refers to a situation in which important decisions must be made in a short time [14]. A critical incident or a crisis is a sudden and supervenient event showing an organizational threat that requires fast and high-quality decision-making [15]. PAS200:2011 also defines an emergency as “an unnatural and complex inherent situation that is a threat to the organization’s strategic goals, reputation, or existence” [16,17]. Various studies have been carried out regarding dealing with oil pollution emergencies at sea. For example, Valdor et al in 2014 provided a method to evaluate the environmental risk of oil in installations located in port areas [4]. Kang et al. in 2016, also developed a capability assessment model for an oil spill emergency response [18]. In a study in 2016, Chung et al also presented a method based on the ocean current model and the oil spill model to assess the risk of pollution for sensitive sources during an oil spill [19]. Eklund et al in 2019 reported that the United States Oil Pollution Act of 1990 needs to be revised [6]. There are local and also international laws to deal with pollution due to maritime transport and the activities of unloading and loading docks in different countries, such as the International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC), which was approved by the IMO in 1990 and became enforceable in 1995 [20]. This convention mainly stresses taking quick and effective actions in the case of an oil pollution accident in order to prevent irreparable losses to ships, maritime installations, ports, oil unloading and loading equipment, and also to provide the necessary bases for international cooperation to deal with accidents due to oil pollution [21]. Massive accidents that culminate in enormous oil spills require fast preparation and response. Experience has shown that predicting and planning beforehand to encounter accidents can be considerably influential in preventing losses to the environment and property [22]. One of the most important ports in Iran is Imam Khomeini Port. This port has an unloading and loading dock with a length of 6.28 km, the depth along the dock is 9 to 13 m, and it plays a critical role in the country’s import and export [23]. A notable part of the shipments is oil derivatives. Considering the volume of goods transiting through this port, the incidence of oil pollution emergencies is very probable. Thus, it is necessary to compile a plan to deal with oil pollution emergencies. For this purpose, the difference between the current situation of environmental emergency management and the ideal situation should be determined by a gap analysis method. One of the widely used gap analysis methods is McKinsey’s method. McKinsey’s 7s model is a managerial framework and model suggesting seven factors to organize a company in a general and effective look [24]. On the other hand, prioritizing environmental management programs requires a multi-criteria decision-making technique. The technique for order performance by similarity to ideal solution (TOPSIS) or prioritization based on similarity to the ideal solution is among the multi-criteria decision-making methods [25]. The present research was carried out to determine the response priorities in oil pollution emergencies in the unloading and loading dock of Imam Khomeini Port.

1.1. The investigated site

Imam Khomeini Port is one of the most important and biggest commercial terminals in Iran, which is used to carry out half of the country’s exchanges of non-oil products. The nearest station, i.e., Mahshahr Port synoptic station, is located at 30 degrees and 29 minutes north latitude and 49 degrees and 56 minutes east longitude. The mean maximum temperature of this station is 35 °C, and its mean minimum temperature is 12 °C [26]. Imam Khomeini Port has 34 docks with a length of 6.28 km and a depth of 9 to 13 meters along the dock and is used for various types of vessels. At present, a considerable number of large ships (100 to 110 000 tons) harbor at these docks. The location of the investigated dock is shown in Figure 1.

2. Methods

The present descriptive-applied research was carried out to provide a method for determining response priorities in oil pollution emergencies in an unloading and loading dock in the south of Iran using McKinsey’s gap analysis method in 2020.

The criteria and sub-criteria effective in prioritizing responses in oil spill emergencies in the unloading and loading dock of Imam Khomeini Port were identified by the documentary method and prioritized based on the TOPSIS multi-criteria decision-making method. The

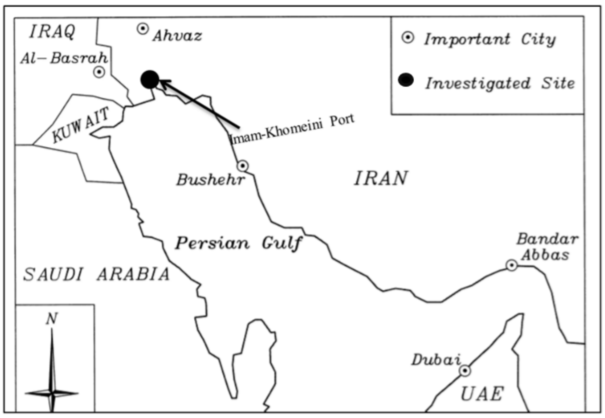

Figure 1. The investigated site

scoring of the criteria and sub-criteria was performed in this technique by a group of 10 experts (Table 1).

McKinsey's 7s method was used to analyze the gap between the current conditions of the management of oil pollution emergencies and the ideal situation. Collecting the data and identifying the activities that lead to oil pollution on the coasts were performed through library research methods, site visits, and collecting the documents available in the Department of Health, Safety, and Executive of the General Directorate of Port Organization. The TOPSIS and gap analysis calculations were performed by Topsis Solver 2015 software and Excel 2013 software, respectively.

2.1. Steps of prioritizing criteria and sub-criteria by TOPSIS method

2.1.1. Step 1: Creating a decision-making matrix

Data matrix was created based on *m* options and *n* indices through Equation 1:

$$A_{ij} = \begin{bmatrix} a_{11}a_{12},,,a_{1n} \\ a_{21}a_{22},,,a_{2n} \\ . \\ . \\ . \\ a_{m1}a_{m2},,,a_{mn} \end{bmatrix} \qquad \text{Eq. (1)}$$

where *A* is the decision-making matrix, and *a* denotes options [27].

The decision-making matrix involves determining the main indices influencing pollution, the number of options, and experts. Scoring in the mentioned indices was performed by experts based on numbers 1 (the lowest effect) to 9 (the highest effect).

2.1.2. Step 2: normalizing or de-scaling the matrix

De-scaling was performed in the present study based on the norm method. In this method, each entry of the matrix was divided by the root sum squares of its entries in the column or criterion. For this purpose, equation 2 was used,

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_k^m = 1^a kj}} \qquad \text{Eq. (2)}$$

where *rij* indicates the score obtained by option *i* in criterion *j* [27].

The de-scaled matrix is then multiplied by the diagonal matrix of weights (W N × N) (Equation 3):

$$WN \times N \times V = N \qquad \text{Eq. (3)}$$

2.1.3. Step 3: Weighting the normalized matrix

Equation 4 was used for weighting the normalized matrix,

$$\sum_i^n = 1 w_i = 1 \qquad \text{Eq. (4)}$$

where *wi* shows the Eigen weight vector and *n* represents the number of options.

It should be noted that to determine the weight of each index based on W_I, the indices with higher importance have higher weights. In fact, the matrix (v) is the product of the standard values of each index in its respective weights (Equation 5):

$$V_{ij} = \begin{bmatrix} w_1r_{11},,,w_nr_{1n} \\ w_1r_{21},,,w_3r_{2n} \\ . \\ . \\ . \\ w_1r_{m1},,,w_nr_{mn} \end{bmatrix} \qquad \text{Eq. (5)}$$

2.1.4. Step 4: Determining positive and negative ideal solutions

Positive and negative ideal solutions are defined as

Table 1. The list of experts participating in the scoring process

Row	Gender	Age	Education	Work Experience (y)	Organizational Level
Expert 1	Male	48	Master of Industrial Management	24	Senior manager
Expert 2	Male	39	Master of Occupational Health	12	Middle manager
Expert 3	Male	52	Bachelor of Industrial Management	28	Middle manager
Expert 4	Male	45	Master of Management	26	Consultant
Expert 5	Male	47	Bachelor of MBA	19	Middle manager
Expert 6	Female	37	Ph.D. in Environmental Sciences	9	Consultant
Expert 7	Female	33	Master of HSE	5	Technician
Expert 8	Male	46	Bachelor of Industrial Engineering	18	Middle manager
Expert 9	Male	52	Master of Industrial Engineering	23	Middle manager
Expert 10	Female	31	Master of Environment	4	Technician

follows:

(Vector of the best values of each index of matrix V) = positive ideal solution (V_J^+)

(Vector of the worst values of each matrix index V) = negative ideal solution (V_J^-)

The best values for positive indices are the smallest values, and for negative indices, the largest values [27].

2.1.5. Step 5: Determining the Distance Criteria for the Ideal Alternative (d_i^+) and the Minimum Alternative (d_i^-)

The Euclidean distance of each option from the positive ideal and the distance of each option to the negative ideal are calculated based on equations 6 and 7:

$$d_i^+ + \sqrt{\sum_j^n = 1(vij - v_j^+)^2} \qquad i = 1,2,\ldots..,m \qquad \text{Eq. (6)}$$

$$d_i^- + \sqrt{\sum_j^n = 1(vij - v_j^-)^2} \qquad i = 1,2,\ldots..,m \qquad \text{Eq. (7)}$$

2.1.6. Step 6: The ratio of the closeness of an option to the ideal solution

Determining the coefficient that is equal to the minimum alternative distance and dividing it by the sum of the minimum alternative distance and also the ideal alternative distance *Si**, which is shown by *Ci** and is calculated by equation 8.

$$C_-^* = \frac{S_i^-}{S_i^- + S_i^+} \qquad \text{Eq. (8)}$$

2.1.7. Step 7: Ranking the options

The ranking is based on the *Ci** value; the above value ranges from zero to one $1 \geq Ci^* \geq 0$. In this regard, $Ci^* = 1$ denotes the highest rank, and $Ci^* = 0$ indicates the lowest rank [27].

2.2. Gap analysis by McKinsey's 7s method

After identifying and prioritizing the risks, the current situation of environmental management concerning oil pollution emergencies was evaluated with the ideal situation using McKinsey's gap analysis technique. Waterman and Phillips believe that the organization's change and movement are influenced by the interaction between seven dimensions: Structure, strategy, systems, style, staff, skills, and shared values (superordinate goals) and called it the "7s framework"; since their research was carried out in McKinsey Consulting Company, this framework is also known as McKinsey's 7s [28]. The factors that altogether determine how an organization functions include the following:

Shared values: Shared values are located at the center of this model; opinions, beliefs, and goals are shared between different parts of the company.

Strategy: The plans of a company to use its limited resources in order to achieve its goals; goals regarding the environment, customers, and competition.

Structure: The communication method and structure through which various parts of the organization interact with each other; concentration, lack of concentration, matrix, network, etc.

System: Mechanisms and processes through which tasks are performed in the company, such as financial systems, staffing, staff promotion, and information systems.

Staff: The number and type of staff of the organization.

Style: Different management styles and methods of organizational culture are evaluated here.

Skills: Specific skills of staff individually or the special skills of the organization.

After determining the emergency response plan priorities, the gap between the current conditions and the desired conditions was finally determined, and solutions were provided to reduce the gap level.

3. Results

The main criteria for determining the response priority in oil pollution emergencies were identified. In fact, in order to distinguish emergencies from non-emergencies, we need some defined criteria obtained in the present research from the documentary method. These criteria include the extent of pollution (spreading coefficient) [29,30], the amount of pollution discharged into the sea [31], the controllability of pollution [32], the location of pollution [33], and the frequency of occurrence [34]. The categorization of each criterion is also based on documentary studies (Table 2). The criteria weights were determined based on the entropy method (Table 3).

3.1. The results of prioritizing criteria and options in the TOPSIS method

The most important environmental aspects leading to oil pollution emergencies in the sea were prioritized by the TOPSIS method. To do this, the following stages were performed:

3.1.1. Stage 1: The average opinion of experts and creating a decision-making matrix

The decision-making matrix involves determining the main criteria (5 criteria), options (18 possible emergencies), and experts (10 people). The options in the mentioned criteria were scored based on numbers 1 (the lowest effect) to 9 (the highest effect) presented in Table 4.

3.1.2. Stage 2: Normalization or de-scaling the matrix

In this stage, the de-scaled matrix was multiplied by the

Table 2. Categorization of indices based on the determined criteria

Crisis levels	Effective factors				
	The extent of pollution (spreading coefficient)	**Amount of oil pollution discharged into the sea**	**Controllability of pollution**	**Location of pollution**	**Frequency of occurrence**
4- Disastrous	More than 100000 square meters	Over 50000 gallons	Controllable with the help of international forces	Coastal waters	100% in one year
3- Critical	Between 10000 and 100000 square meters	Between 1000 and 50000 gallons	Controllable with the help of national forces	Continental shelf	10% to 99% in one year
2- Moderate	Local (between 100 and 10000 square meters)	Between 250 and 1000 gallons	Controllable with shared help	Free-living aquatic animals	10% to 100% in 10 years
1- Limited	Small and limited (less than 100 square meters)	Less than 250 gallons	Controllable without shared help	High seas	Unlikely

Table 3. Prioritizing the criteria based on the paired comparisons method

Option Name	Eigenvector
Extent of pollution	0.252143
Amount of oil pollution discharged into the sea	0.23881
Controllability of pollution	0.176905
Location of pollution	0.169405
Frequency of occurrence	0.162738

Table 4. The decision-making matrix for the selected environmental aspects

Matrix	Extent of pollution	Amount of oil pollution discharged into the sea	Controllability of pollution	Location of pollution	Frequency of occurrence
Discharge of oil wastes collected in sewage- diffusion of oil substances in soil and sea	2	2	1	1	4
On-shore installations-entering sewage and lubricating oil into the sea	2	1	2	1	3
Heavy cranes - oil and lubricant spill from the fuel tank	1	1	2	1	4
Operations of supply, transfer, and discharge of oil residue-spill and seepage during oil residue discharge	2	1	2	1	3
Pipelines- spillage of oil derivatives out of unloading and loading pipes	3	3	3	1	2
Oil reserves close to the earth's surface- natural seepage of coastal reserves and seepage	2	2	4	1	2
Storage of hydrocarbon substances- pouring due to the spillage of oil tanks	2	2	2	1	3
The activity of product transfer pumps between the tanks or transfer to the ship- oil hydrocarbons spill out of packing or pipeline connections at the pump's inlet and outlet	1	2	3	1	4
Accidents due to ship collisions- Accidents of ship collision/ fire/ wreck	4	4	2	1	2
Unloading and loading of oil substances using loading arm- oil substance spill	2	2	2	1	3
Guard and security boats - spilling oil and lubricant out of the fuel tank	1	1	3	1	4
Production wastes of unloading and loading of oil substances- wastes production	2	2	2	1	4
Operations of unloading and loading of oil substances-rupture of the ship's hull because of accidents due to failure of berth or ship standard separation	4	4	2	1	3
Perforation or rupture of the ship's hull due to a strong collision of the ship with the dock or other vessel during the berthing process and separating the ship to/from the dock- spilling oil substances out of the ship's hull	4	4	2	1	3
Not connecting to the pipes carrying oil substances to the tanker properly- spilling oil substances out of the tanker's connections	3	1	3	1	2
Transfer of substances to ships- spilling oil and lubricant derivatives	3	2	3	1	3
Tankers fueling the equipment- spilling oil and lubricant out of fuel tanks	2	1	2	1	2
Unloading and loading of oil substances from flexible hose-spilling oil substances	3	2	2	1	3
Type of criterion	Positive	Positive	Positive	Positive	Positive
Weight of criterion	0.2983	0.4365	0.1487	0	0.1165

diagonal matrix of weights (W N×N) in such a way that each value was divided by the size of the vector related to the same index. The results of this process are provided in Table 5.

3.1.3. Stage 3: Weighting the normalized matrix

The weight of each option was specified based on equation 4. In this regard, events culminating in emergencies with greater importance have higher weights. Indeed, the matrix (v) is the product of the standard values of each criterion in its related weights. The results of weighting the normalized matrix are presented in Table 6.

3.1.4. Stage 4: Determination of positive and negative ideal solutions

Positive and negative ideal solutions were calculated through equations 6 and 7 (Table 7). The two virtually created options are indeed the worst and best solutions.

3.1.5. Stage 5: Determining the distance of the positive and negative ideal solutions

The coefficient calculated based on the distance of each option from the intended desirability was calculated through Equation 8, the results of which are shown in Table 8.

3.1.6. Stage 6: Calculating the Closeness to the Positive and Negative Ideal solutions and Ranking the Options (Table 9).

3.2. The results of gap analysis by McKinsey's method

Determining the current situation of environmental management and the gap between the current situation and the ideal conditions under investigation is necessary to determine the response plan priorities in oil pollution emergencies in the unloading and loading dock of Imam Khomeini Port. In the present study, McKinsey's method was used for gap analysis. In this method, 43 items in 7

Table 5. Normalizing or de-scaling the matrix for the selected environmental aspects

De-Scaled matrix	Extent of pollution	Amount of oil pollution discharged into the sea	Controllability of pollution	Location of pollution	Frequency of occurrence
Discharge of oil wastes collected in sewage- diffusion of oil substances in soil and sea	0.1833	0.2052	0.0971	0.2357	0.305
On-shore installations-entering sewage and lubricating oil into the sea	0.1833	0.1026	0.1943	0.2357	0.2287
Heavy cranes - oil and lubricant spill from the fuel tank	0.0917	0.1026	0.1943	0.2357	0.305
Operations of supply, transfer, and discharge of oil residue-spill and seepage during oil residue discharge	0.1833	0.1026	0.1943	0.2357	0.2287
Pipelines- spillage of oil derivatives out of unloading and loading pipes	0.275	0.3078	0.2914	0.2357	0.1525
Oil reserves close to the earth's surface- natural seepage of coastal reserves and seepage	0.1833	0.2052	0.3885	0.2357	0.1525
Storage of hydrocarbon substances- pouring due to the spillage of oil tanks	0.1833	0.2052	0.1943	0.2357	0.2287
The activity of product transfer pumps between the tanks or transfer to the ship- oil hydrocarbons spill out of packing or pipeline connections at the pump's inlet and outlet	0.0917	0.2052	0.2914	0.2357	0.305
Accidents due to ship collisions- Accidents of ship collision/ fire/ wreck	0.3667	0.4104	0.1943	0.2357	0.1525
Unloading and loading of oil substances using loading arm- oil substance spill	0.1833	0.2052	0.1943	0.2357	0.2287
Guard and security boats - spilling oil and lubricant out of the fuel tank	0.0917	0.1026	0.2914	0.2357	0.305
Production wastes of unloading and loading of oil substances- wastes production	0.1833	0.2052	0.1943	0.2357	0.305
Operations of unloading and loading of oil substances-rupture of the ship's hull because of accidents due to failure of berth or ship standard separation	0.3667	0.4104	0.1943	0.2357	0.2287
Perforation or rupture of the ship's hull due to a strong collision of the ship with the dock or other vessel during the berthing process and separating the ship to/from the dock- spilling oil substances out of the ship's hull	0.3667	0.4104	0.1943	0.2357	0.2287
Not connecting to the pipes carrying oil substances to the tanker properly- spilling oil substances out of the tanker's connections	0.275	0.1026	0.2914	0.2357	0.1525
Transfer of substances to ships- spilling oil and lubricant derivatives	0.275	0.2052	0.2914	0.2357	0.2287
Tankers fueling the equipment- spilling oil and lubricant out of fuel tanks	0.1833	0.1026	0.1943	0.2357	0.1525
Unloading and loading of oil substances from flexible hose-spilling oil substances	0.275	0.2052	0.1943	0.2357	0.2287

Table 6. Weighting the normalized matrix for the selected environmental aspects

Weighted matrix	Extent of pollution	Amount of oil pollution discharged into the sea	Controllability of pollution	Location of pollution	Frequency of occurrence
Discharge of oil wastes collected in sewage- diffusion of oil substances in soil and sea	0.0547	0.0896	0.0144	0	0.0355
On-shore installations-entering sewage and lubricating oil into the sea	0.0547	0.0448	0.0289	0	0.0266
Heavy cranes - oil and lubricant spill from the fuel tank	0.0273	0.0448	0.0289	0	0.0355
Operations of supply, transfer, and discharge of oil residue-spill and seepage during oil residue discharge	0.0547	0.0448	0.0289	0	0.0266
Pipelines- spillage of oil derivatives out of unloading and loading pipes	0.082	0.1344	0.433	0	0.0178
Oil reserves close to the earth's surface- natural seepage of coastal reserves and seepage	0.0547	0.0896	0.0578	0	0.0178
Storage of hydrocarbon substances- pouring due to the spillage of oil tanks	0.0547	0.0896	0.0289	0	0.266
The activity of product transfer pumps between the tanks or transfer to the ship- oil hydrocarbons spill out of packing or pipeline connections at the pump's inlet and outlet	0.0273	0.0896	0.0433	0	0.0355
Accidents due to ship collisions- Accidents of ship collision/ fire/ wreck	0.1094	0.1791	0.0289	0	0.0178
Unloading and loading of oil substances using loading arm- oil substance spill	0.0547	0.0896	0.0289	0	0.0266
Guard and security boats - spilling oil and lubricant out of the fuel tank	0.0273	0.0448	0.0433	0	0.0355
Production wastes of unloading and loading of oil substances- wastes production	0.0547	0.0896	0.0289	0	0.0355
Operations of unloading and loading of oil substances-rupture of the ship's hull because of accidents due to failure of berth or ship standard separation	0.1094	0.1791	0.0289	0	0.0266
Perforation or rupture of the ship's hull due to a strong collision of the ship with the dock or other vessel during the berthing process and separating the ship to/from the dock- spilling oil substances out of the ship's hull	0.1094	0.1791	0.0289	0	0.0266
Not connecting to the pipes carrying oil substances to the tanker properly- spilling oil substances out of the tanker's connections	0.082	0.0448	0.0433	0	0.0178
Transfer of substances to ships- spilling oil and lubricant derivatives	0.082	0.0896	0.0433	0	0.0266
Tankers fueling the equipment- spilling oil and lubricant out of fuel tanks	0.0547	0.0448	0.0289	0	0.0178
Unloading and loading of oil substances from flexible hose-spilling oil substances	0.082	0.0896	0.0289	0	0.0266

Table 7. Determining positive and negative ideal solutions for the selected environmental aspects

Ideal solution	Extent of pollution	Amount of oil pollution discharged into the sea	Controllability of pollution	Location of pollution	Frequency of occurrence
-	0.1094	0.1791	0.0578	0	0.0355
-	0.0273	0.0448	0.0144	0	0.0178

dimensions, including strategy (4 items), structure (6 items), systems (19 items), skills (2 items), management style (5 items), staff (4 items), and shared values (3 items), were evaluated and analyzed. The criteria of each dimension were collected from different references, compiled with the help of 10 people from the experts' team mentioned in Table 2, and scored on a five-point Likert scale (very ideal, ideal, moderate, weak, and very weak).

The mean scale method was used to interpret the scores of the questionnaire. In this method, the mean scores obtained for each questionnaire were calculated based on the following formula:

$$M = \frac{NK + 1K}{2}$$

In this formula, M is the scale mean score, K is the number of respondents (n = 20), and N is the number of response levels (5 points). Accordingly:

$$M = \frac{5 \times 20 + 20}{2} = 60$$

Hence, the questions whose total score is less than 60 are categorized as unacceptable. The scores obtained for each component in McKinsey's method are shown in

Table 8. Determining the distance of the positive and negative ideal solutions for the selected environmental aspects

Distance	+	-
Discharge of oil wastes collected in sewage- diffusion of oil substances in soil and sea	0.01135	0.0554
On-shore installations-entering sewage and lubricating oil into the sea	0.1482	0.0322
Heavy cranes - oil and lubricant spill from the fuel tank	0.16	0.0229
Operations of supply, transfer, and discharge of oil residue-spill and seepage during oil residue discharge	0.1482	0.0322
Pipelines- spillage of oil derivatives out of unloading and loading pipes	0.0573	0.1088
Oil reserves close to the earth's surface- natural seepage of coastal reserves and seepage	0.1064	0.068
Storage of hydrocarbon substances- pouring due to the spillage of oil tanks	0.1092	0.0551
The activity of product transfer pumps between the tanks or transfer to the ship- oil hydrocarbons spill out of packing or pipeline connections at the pump's inlet and outlet	0.1223	0.0562
Accidents due to ship collisions- Accidents of ship collision/ fire/ wreck	0.0339	0.1581
Unloading and loading of oil substances using loading arm- oil substance spill	0.1092	0.0551
Guard and security boats - spilling oil and lubricant out of the fuel tank	0.1581	0.0339
Production wastes of unloading and loading of oil substances- wastes production	0.1088	0.0573
Operations of unloading and loading of oil substances-rupture of the ship's hull because of accidents due to failure of berth or ship standard separation	0.0302	0.1583
Perforation or rupture of the ship's hull due to a strong collision of the ship with the dock or other vessel during the berthing process and separating the ship to/from the dock- spilling oil substances out of the ship's hull	0.0302	0.1583
Not connecting to the pipes carrying oil substances to the tanker properly- spilling oil substances out of the tanker's connections	0.139	0.0619
Transfer of substances to ships- spilling oil and lubricant derivatives	0.0952	0.0769
Tankers fueling the equipment- spilling oil and lubricant out of fuel tanks	0.149	0.0309
Unloading and loading of oil substances from flexible hose-spilling oil substances	0.0984	0.0727

Table 9. Calculating the closeness to positive and negative ideal solutions and ranking the options for the selected environmental aspects

Result	Closeness Coefficient
Perforation or rupture of the ship's hull due to a strong collision of the ship with the dock or other vessel during the berthing process and separating the ship to/from the dock- spilling oil substances out of the ship's hull	0.8397
Operations of unloading and loading of oil substances-rupture of the ship's hull because of accidents due to failure of berth or ship standard separation	0.836
Accidents due to ship collisions- Accidents of ship collision/ fire/ wreck	0.8234
Pipelines- spillage of oil derivatives out of unloading and loading pipes	0.6553
Transfer of substances to ships- spilling oil and lubricant derivatives	0.4468
Unloading and loading of oil substances from flexible hose-spilling oil substances	0.4249
Oil reserves close to the earth's surface- natural seepage of coastal reserves and seepage	0.39
Production wastes of unloading and loading of oil substances- wastes production	0.3447
Storage of hydrocarbon substances- pouring due to the spillage of oil tanks	0.3355
Unloading and loading of oil substances using loading arm- oil substance spill	0.3324
Discharge of oil wastes collected in sewage- diffusion of oil substances in soil and sea	0.3279
The activity of product transfer pumps between the tanks or transfer to the ship- oil hydrocarbons spill out of packing or pipeline connections at the pump's inlet and outlet	0.3147
Not connecting to the pipes carrying oil substances to the tanker properly- spilling oil substances out of the tanker's connections	0.3079
On-shore installations-entering sewage and lubricating oil into the sea	0.1784
Operations of supply, transfer, and discharge of oil residue-spill and seepage during oil residue discharge	0.1767
Guard and security boats - spilling oil and lubricant out of the fuel tank	0.1732
Tankers fueling the equipment- spilling oil and lubricant out of fuel tanks	0.1719
Heavy cranes - oil and lubricant spill from the fuel tank	0.1252

Figure 2.

The gap analysis results by McKinsey's method demonstrated that the mean score of the 7 investigated dimensions was 2.22, having a significant difference with the ideal limit determined in this method equal to 4 [35]. These results indicate the unacceptable environmental

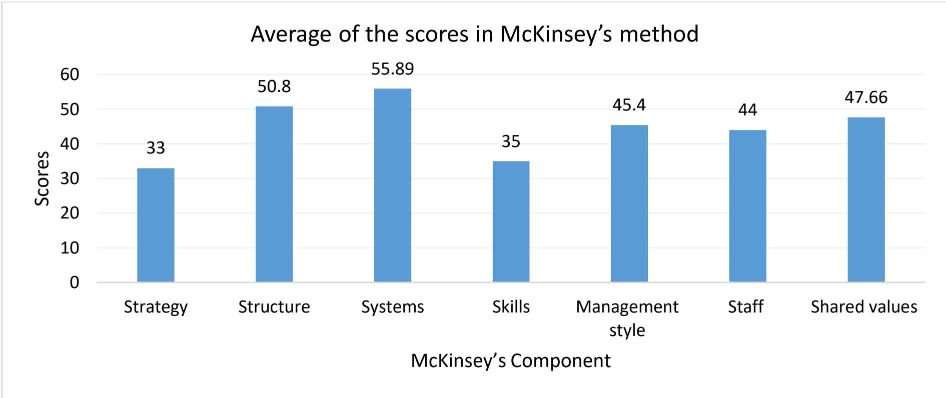

Figure 2. The mean scores of the items in each of McKinsey's dimensions

management conditions for the oil pollution emergencies in the zone of the loading and unloading dock of Imam Khomeini Port. The lowest mean score is related to the "strategy" dimension (1.65). The "skills" dimension is also at a weak level of efficiency, with a mean score of 1.75. The highest efficiency was obtained in the "systems" dimension (2.79). The overall results of the gap analysis are presented in Figure 3.

The spider web model of emergency response plan priorities is presented in Figure 4. The efficiency status of each of McKinsey's dimensions in the environmental management of the unloading and loading dock of Imam Khomeini Port has been specified in this diagram. The emergency response plan priorities are based on gap and factor analysis results.

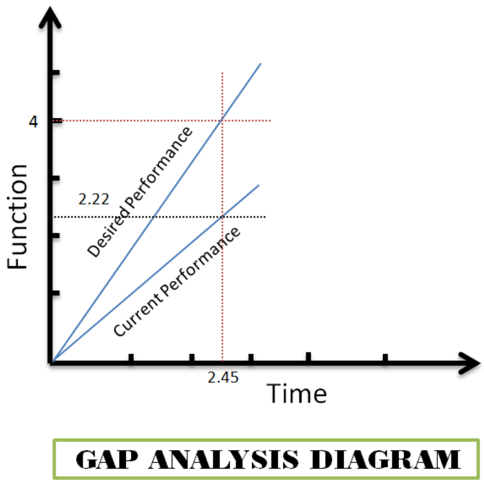

Figure 3. The results of the gap analysis between the current situation and the ideal situation in the management of oil pollution emergencies

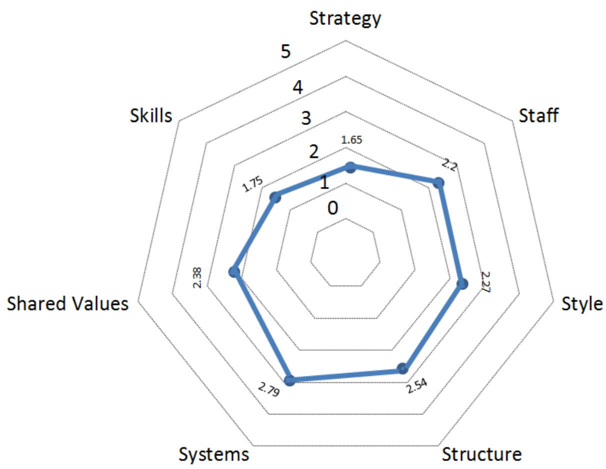

Figure 4. The spider web model of emergency response plan priorities

4. Discussion

By looking at the history of accidents occurring in bodies of water that have led to oil pollution on a large scale, we can perceive the necessity to prepare for emergency response at the time of occurring an accident. The traffic amount of large ships in the unloading and loading docks of Imam Khomeini Port and the ecosystem sensitivity show the importance of carrying out such a study. Ceyhun mentioned the main causes of maritime accidents as collisions of ships with each other, fires, and ruptures of ships' hulls [36]. In the present study, the perforation or rupture of the ship's hull caused by the ship's strong collision with another dock or vessel during the berthing process and separating the ship from the dock with a closeness coefficient of 0.839, rupture of the ship's hull because of accidents due to the failure of berth or standard ship separation with a closeness coefficient of 0.836, the accident due to the collision of ships with a closeness coefficient of 0.8224, and spilling oil derivatives out of unloading and loading pipes with a closeness coefficient of 0.6553 were considered the main factors in the occurrence of accidents that culminated in the oil pollution emergencies in the loading and unloading dock of Imam Khomeini Port.

In determining the priorities of compiling a plan based on the gap analysis, the "strategy" dimension, with a score of 1.65, was determined as the weakest factor in the management of the dock's emergency response. Weakness in the compilation of environmental management strategies resulted in weak performance of all elements of environmental management in the loading and unloading docks of Imam Khomeini Port. So, compiling and implementing an emergency response plan seem necessary. Thus, the most important component in McKinsey's dimensions is "strategy". Compilation of strategies and a comprehensive plan for the dock environmental management, setting macro and micro environmental goals by the Free Zone Organization, obligation of all organizations and companies active in the zone to observe the requirements, and annual environmental self-declaration are suggested as solutions to improve the conditions of this component. Foster suggests the compilation of long-term inhibition strategies as the most important step in developing emergency response plans [10]. The "skills" component, with a score of 1.75, was also determined as the second component in McKinsey's dimensions. "Staff" is considered the core of implementing environmental management programs, and in order to achieve the goals of the response plan in oil pollution emergencies on the coasts of Imam Khomeini Port, things such as employing expert staff through the recruitment process management and using up-to-date technologies for quick detection of oil pollution in the dock area are recommended. Nouri et al. have introduced the staff as the most important root of occurring massive accidents and emergencies [16]. The "staff" component has obtained a mean score of 2.2. This component is the most important operational advantage of any organization. Therefore, it is essential to deal with this factor strategically. Accurate and favorable administration of the emergency response plan requires recruiting staff with adequate abilities. To improve the conditions of this component, implementing things such as compiling and implementing training programs for dock workers at all levels, administrating staff's competency audits at all stages from recruitment to functioning, performing practical training maneuvers according to standard and defined scenarios, and providing necessary access to information and equipment are recommended for staff.

The fourth priority in McKinsey's gap analysis method is "management style", with a score of 2.27. Using a correct management method and principles such as being responsive, being responsible, using expert counseling, and collaborative management are the main elements of successful and favorable management. Environmental management for oil pollution emergencies also requires the application of favorable management by the Free Zone Organization and all those involved in the complex at all levels of prevention, preparation, and response. Patterson et al both emphasize the role of management in designing crisis management systems and their role in quick responses to them [13]. The "shared values" component, with a mean score of 2.38, was determined as the fifth factor in McKinsey's gap analysis method for the conditions of the loading and unloading dock of Imam Khomeini Port. Environmental issues have a deep social meaning and also cultural origins. Therefore, it is necessary to deal with the issue structurally to accept the cultural contexts of society. Explaining the necessity to prevent the occurrence of environmental disasters such as oil pollution for staff and indigenous people in a coastal area such as Imam Khomeini Port should be one of the main goals in compiling an emergency response plan. In order to improve the environmental culture concerning oil pollution in the region scope, culture development for the staff and indigenous people of the region is necessary to maintain the environmental conditions of the sea and beach ecosystem. The "structure" component, with a score of 2.54, was determined in the gap analysis as the sixth factor needing improvement. The implementation of many measures to prevent, prepare, and respond in oil pollution emergencies in the unloading and loading dock of Imam Khomeini Port requires creating an organizational structure. Actions such as controlling climatic conditions and other systemic activities require the organizational structure and responsibilities to be defined. To cover this component in compiling an emergency response plan, items such as controlling meteorological and tidal patterns continuously and according to the specified responsibilities, determining ecosystem sensitivities against oil pollution emergencies, conducting research to evaluate the outcomes of oil pollution in various scenarios, and notification of laws related to the prevention of oil pollution and the structure of monitoring the proper enforcement of laws are recommended. Banerjee and Singh reported structural weakness as the most important factor that culminates in the lack of proper control of these conditions in Indian social events [14]. Wang et al also expressed the investigation of the climatic and ecosystem conditions of the region as an important factor in preventing the occurrence of emergencies in ship transport [37]. The results of the current research can be a basis for compiling a comprehensive plan for emergency environmental management in Imam Khomeini Port.

5. Conclusion

Investigating the present weaknesses and ranking the oil pollution sources showed that the management and control of dock traffic and the characteristics of cargo ships in an obviously defined structure and responsibility, the compilation of maritime transport guidelines, dealing with spills, unloading and loading, ship's ballast water, discharge of waste substances, painting and repair activities, ships' arrival and departure, response time in emergencies, response time domain in emergencies, preparation of anti-pollution equipment and constant control of equipment in certain time intervals, and constant control of warning systems the docks for the oil pollution time can lead to the improvement of system conditions.

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Authors' Contribution
All authors contributed to conceptualization: data management: formal analysis: funding acquisition: review: methodology: project management: resources: software: monitoring: validation: visualization: writing - original draft: writing - review and editing.

Competing Interests
The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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The ethical issues have been completely observed by the authors including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy.

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