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Identification and Prioritization of Grain Discharging Operations Risks by Using ORESTE Method

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Abstract

Exposing the acts of unloader, sucker and Grab in the grain terminal of Imam Khomeini port by manipulating ORESTE and Shannon's Entropy Methods in the three phases will lead to identification and prioritization of the grain discharging processes risks from the ship. In the first phase, by the analysis of the events and occurred incidents information bank about the surveyed matters and also setting brainstorming sessions with the terminal's experts, 22 risks were identified. In the second phase by using from the Shannon's Entropy, the criteria (occurrence frequency, severity and detection) were weighted. Then based on the mentioned criteria the identified risks were scored in form of a scale from 1 to 10. Finally according to the obtained scores of each risk, the ORSTE decision matrix was conducted and subsequently in the third phase by using this method, all of the identified risks were prioritized.

Keywords: Risk, grain discharging, Imam Khomeini port, ORESTE, grain terminal

Introduction

Nowadays the security management standard and the workplace hygiene, OHSAS 18001 is considered one of the management way for promoting the security level and the workplace hygiene in a lot of organizations using the unity IMS standard frame that is in the initializing and designing mood. The first step towards the implementation work should be the operational plans and designs due to detecting the risks and evaluating their dangers and developing some processes that concern to decrease the risks.

Hereby, the organizations, after this accomplishment should review the information and following to it, the personnel must be aware of the peripheral dangers that may occur alternatively.

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(Balmat *et al.*, 2011). According to the above mentioned matter, initializing and implementing the unity IMS management system in the dedicated grain terminal will enhance the necessity to detecting and analyzing the risks and evaluate their prioritization (Bartolomei *et al*., 2008).

This study, based to the vast activity of this terminal, exclusively probe the grain discharging processes from the ship by using unloader, sucker and Grab for detecting and evaluating the risks. In this study by using the ORESTE and Shannon's Entropy methods the identified risks were prioritized based on their frequency of occurrence, the impact which they will trace after the occurrence (severity) and the probability of the recognizing before the incident (detection).

Risks and risks evaluation's methods

Risk: In fact risk is the potential that a chosen action or activity (including the choice of inaction) will lead to an undesirable outcome, and in the security matter defines as the consequence and probability of a hazardous event or phenomenon (Brito *et al*., 2010).

Risk management: Without doubt, is one of the most important matters that human beings are involved in it and is continuous especially in the complex matters (Clothier & Walker, 2012).

So having the necessities and be a warring of these matters may help to the preciosity of the decision making and risk management is considered one of these important asset that can be a key of the solution for such matters (Fabiano *et al*., 2010).

So this will enhance particularly when a complex set of factors and consequences are responsible for external and internal vulnerabilities decision causes in the room and the demands of the customers and the nominee should be prepared according to their benefits. This matter is of high sensation.

Also a set of widespread activity is running in the room of the ports per se that these notions will implies an influence on the outcome.in the most of the times, these phenomenon are not carry a high stress but they are so numerous that cause the possibility of loss, injury, or other adverse or unwelcome circumstance (McGraw, 1982).

However, by cursory and slight glance on the matter of the ports security it may not understand the risk management to its profound meaning. Risk management is a dynamic system that includes a set of risk cause identification, risk values estimation, risk programming and how to reduce and control these risky actions (Fabiano *et al*., 2010).

It is notable to mention here, that risk management cannot eradicate the risk totally but it is an action that reduces it to the lowest point of the possibility (Sadounzadeh and Jafari, 2013).

Risk management is not superseding with the individuals' experience but it can only help the experienced individuals to use their experience in the optimal situation. Risk management with high quality prepared information in the management delivery can help the managers to select the cost of the organization in the economic way of budget and use it on its appropriate way. Risk management can provide a far-sighted prospect for the experts to foreseen the probable risks and in order to prevent such risks; they can plan and perform in a preemptions manner (Jafari, 2013).

In whole it is performable in the quality and quantity forms.In fact, Qualitative Risk Management directly depends on experts experience and their own judgments during the process. However, such data and information during the process may fail to have correct and precise values and logic but they are better than nothing. Risk quality evaluation, in fact, is a degree and an outlet to the quantifying achievement. Albeit individuals' attitudes and views for such measures and criteria are different and have their particular effect but manipulating this methods can be very fruitful and impressive. Qualitative Risk management is highly dependent on the system subject's domain, judgments or acquired experience (Saeidi *et al.*, 2013). Hence this method for data analysis and mathematical processes of the information refer to the very simple calculation because it is based on uncompromising mental techniques.it is worth of mention that the research carry some numerical values and data, but all of its work is founded on mental and subjective methods even for quantity risk and this may lead on the research with a little uncertainty (Jafari and dadkhah, 2013).

Methodology

The present study in conducted on the descriptive nature and seek for the applied aims in which rest in the field and as the title suggest, its goal is to identify and prioritizing the following probable risks in the grain discharging processes from the ship by using ORESTE method and Shannon's Entropy.

Hence toward a successful achievability for its goal it has been accomplished in the three phases. Pursuantly In the first phase, by the analysis of the events and occurred incidents information bank about the surveyed matters and also setting brainstorming sections with the terminal's experts, these sessions were conducted to list the probable risks that they weren't occurred yet. In the second phase by using from the Shannon's Entropy, the criteria (occurrence frequency, severity and detection) were weighted. Then based on the criteria of determination of causes occurrence probability (occurrence frequency), the extent of its impact on process after occurrence (severity) and probability of its identification prior to having impact on the process (detection), the identified risks were scored in form of a scale from 1 to 10.on which 1 is the least class rank and 10 is the highest class rank. Finally according to the obtained scores of each risk, the ORESTE decision matrix was conducted and subsequently in the third phase by using this method, all of the identified risks were prioritized.

ORESTE

If we consider A as a limited m set, these alternative shall be analyzed by the set C including k. in this method, the relative importance of each index is not specified by their weight, but it is stated by a superiority structure on the index C, which is described under a weak level. The so called weak level is stated in a full and transition Equation of S, which is consisted of P and I Equations. P or superiority show discrepancy and I shows incuriosity, which the representative of superiority coordination among the criteria. Also for each of the criteria of j=1 … k, a superiority structure in the set A is described, which is similar to C criteria of the superiority structure is transitional and consisting of a set of P and I relationships (Jafari *et al.*, 2013). Thus, the 1st superiority structure is established based on criteria' relative importance to each other and the 2nd superiority structure also created on the optional set and according to each one of them individually. After formation of the abovementioned 2 superiority structures, we should pay attention to the preliminary ranking of these structures. To do so, we may use Besson average ranking method. In such a way to refer to the superiority structure 1st and according to its rank in comparison to all other criteria, dedicate numbers 1-K (k index) and for all alternative numbers 1-m (m criteria). Then we obtain the mean from the maximum or the minimum dedicated number which is constructed based on the superiority structure enjoys similar superiority or I (Equation1). In other words, instead of dedicating grades 1and 2 to the so called two criteria (alternative), we shall grant it to both ranks (1/5); therefore, with Besson average ranking, the priorities shall turn to ranks. The obtained rank for criteria shall be represented by r_k and the gained rank for each option in each index shall be represented by $r_{k(m)}$ (Brans et al., 1986).

$$\frac{x_1 + x_2}{2} = \bar{x} \qquad (2)$$

X_1 is the maximum amount while X_2 is the minimum amount and $\bar{x}$ is regarded the average distance.

ORESTE Method to perform the ranking process has 3 phases as the following.

Projection of alternative intervals $d(o,m_k)$: Estimating in ORESTE method is based on using the hypothetical matrix called position-matrix that in all its columns the decision alternative are organized from the best to the worst and accordingly the columns are arranged based on the criteria ranks. By scanning matrix's members eventuating from the main diameter, the best situation are listed on the left side of the diameter and the worst are at the right side. Then a zero offset is located at the very end of the left side of the diameter and all the formed pictures are considered and their intervals are determined from the zero offset which is shown by $d(o,m_k)$ as it is shown below (Brans and Mareschal, 2005).

The interval estimation d (o,m_k), which was explained above is executed for different modes including:

Direct linear estimation: In this mode to perform the interval estimation d (o,m_k) from r_k and $r_k(m)$ for option m in k index we shall comply to Equation (4).

$$d(o,m_k) = \frac{1}{2}\left[r_k + r_{k(m)}\right] \quad (4)$$

Indirect linear estimation: In this mode, pictures' intervals from the offset point are computed as the following using Equation (5):

$$\acute{d}(o,a_k) = ar_k + (1-a)r_{k(m)} \quad (5)$$

Non-linear estimation: In non- linear scanning mode to determine the pictures distances from the desired origin we use Equation (6)

$$d''(o,m_k) = \sqrt[2]{(r_k + r_k(m)^2)} \quad (6)$$

To achieve more general conditions, Equation (6) shall change as follows.

$$d''(o,m_k) = \sqrt[R]{(r_k{}^R + r_k(m)^R)} \quad (7)$$

And finally if we add the normal weights of $(1-a)\alpha$, Equation (8) shall be gained.

$$d''(o,m_k) = \sqrt[R]{(a.r_k{}^R + (1-a).r_k(m)^R)} \quad (8)$$

In this regard, with respect to some amounts, the R distance of d shall be illustrated.

Mean of balanced arithmetic	$R = 1 \rightarrow d''$	$R = -1 \rightarrow d''$	Geometry mean
Mean of squares	$R = 2 \rightarrow d''$	$R = -\infty \rightarrow d''$	$\min\left(r_k, r_k(m)\right)$
		$R = +\infty \rightarrow d''$	$\max\left(r_k, r_k(m)\right)$

Global ranking of the alternative interval $R(m_k)$: By determining the interval of the scans pertaining to matrixes' members, the sources' position and the global ranking shall be implemented by one of the abovementioned styles. Generally speaking, selecting every mode or different R amounts for scanning and determining intervals $d(o,m_k)$ with the solemn intention of creating an impact on their position in comparison to each other which in progress, the intervals with the assistance of Besson average ranking method and consequently the issue shall revert to its original sequential essence. The result of this ranking equals to the obtained rank by Besson method and the intervals of $d\ (o,m_k)$ is $R(m_k)$ in a way that we shall have the following e.g (Goumas and Lygerou, 2000)

$$R(a_1) \leq R(a_2) \quad \text{if} \quad d(o,a_1) \leq d \quad (9)$$

The obtained ranks are called the total ranks and all exist in the following scope:

$$1 \leq R(m_k) \leq m.k \tag{10}$$

Thus an incremental sequential structure is modified based on $R(m_k)$ and with regard to the following Equations:

$$\text{if } R(a) < R(b) \quad \text{then} \quad a\,Pb \tag{11}$$

$$\text{if } R(a) = R(b) \quad \text{then} \quad a\,Pb \tag{12}$$

An option that the relative $R(m_k)$ is smaller is more appropriate and a better rank shall be awarded to it; in other words, it is the top option in which the total sum of all its criteria is less than the others.

Shannon entropy and objective weights

Shannon and Weaver proposed the entropy concept, which is a measure of uncertainty in information formulated in terms of probability theory. Since the entropy concept is well suited for measuring the relative contrast intensities of criteria to represent the average intrinsic information transmitted to the decision maker, conveniently it would be a proper option for our purpose. Shannon developed measure H that satisfied the following properties for all pi within the estimated joint probability distribution P (Jafari et al., 2013):

It is proved that the only function that satisfied these properties is:

$$H_{shannon} = -\sum_i p_i \log(p_i) \tag{14}$$

Shannon's concept is capable of being deployed as a weighting calculation method, through the following steps:

Step 1: Normalize the evaluation index as:

$$p_{ij} = \frac{x_{ij}}{\sum_j x_{ij}} \tag{15}$$

Step 2: Calculate entropy measure of every index using the following equation:

$$e_j = -K \sum_{i=1}^{m} P_{ij}\, 1n\,(P_{ij}) \tag{16}$$

$$\text{Where } K = (1n(m) \tag{17}$$

Step 3: Define the divergence through:

$$div_j = 1 - e_j \tag{18}$$

The more the div_j is the more important the criterion jth

Step 4: Obtain the normalized weights of criteria as (Brans and Mareschal, 2005):

$$p_{ij} = \frac{div_j}{\sum_j div_j} \tag{19}$$

Table 1: Identified risks

No	Activity	Hazard	Harm	Those At Risk	Detection	Occurrence	Severity
A1	Unloading through the suction	falling from height or form suction device into the vessel s hold	Fractures or minor injury	Suction operators and its workers	3	3	10
A2		risk of the grain discharging dust and vacuuming the filters	Injury to the lungs.	Suction operators and its workers	5	4	6
A3		Falling in the sea	Bodily injury or Fractures	Suction operators and its workers	3	3	8
A4		operator's chair shaking	Bodily injury	Suction operators and its workers	4	4	7
A5		Noise of suction engine	Hearing loss	Suction operators and its workers	4	3	7
A6		sunshine's reflection toward the operator cabin	Poor eyesight	Suction operators and its workers	4	3	6
A7		thermal stress of Working on the quay	Sunstroke	Suction operators and its workers	4	5	6
A8	Discharge through unloader	Slipping form (Falling) vertical ladders or stairs of ships	Sinking	unloader operators and its workers	3	3	10
A9		Noise pollution	Hearing loss	unloader operators and its workers	4	4	7

A10		Fire	Property damage and personal	unloader operators and its workers	4	3	8
A11		Excessive pressure to the muscles.	Musculoskeletal Complications	unloader operators and its workers	5	3	5
A12		Vibration	Injury to the body.	unloader operators and its workers	5	3	6
A13		Falling from height	Injury to the body.	unloader operators and its workers	3	3	10
A14		Collision with moving parts of machinery	Disability	unloader operators and its workers	4	3	7
A15		Electric shock	Burn Death	unloader operators and its workers	3	3	10
A16		Slipping (Falling) when climbing stairs	Bodily injury or Fractures	crane operators and its workers	4	4	8
A17	**Unloading by crane and grab**	Working alone and monotonous	Psychological injury	crane operators and its workers	4	3	7
A18		Falling from height	Bodily injury or Fractures	crane operators and its workers	3	3	10
A19		Sitting Too much on a chair	Musculoskeletal Complications	crane operators and its workers	5	4	5
A20		Operator chairs vibration	Injury to the body.	crane operators and its workers	5	4	6
A21		Fire in the Engine Room	Property damage and personal	crane operators and its workers	4	3	7

In the second phase by using from the Shannon's Entropy, the criteria (occurrence frequency, severity and detection) were weighted. The result presented in the table 2.

Table 2: Weight of research criteria

criteria	detection	occurrence	severity
weight	0.26	0.42	0.32

Then based on the criteria of determination of causes occurrence probability (occurrence frequency), the extent of its impact on process after occurrence (severity) and probability of its identification prior to having impact on the process (detection), the identified risks were scored in form of a scale from 1 to 10.on which 1 is the least class rank and 10 is the highest class rank.

Finally according to the obtained scores of each risk, the ORESTE decision matrix was conducted and subsequently in the third phase by using this method, all of the identified risks were prioritized in the following steps.

Forming a superiority structure on alternative & criteria' set

For ranting purposes using this method, 1st of all there should be 2 superiority structures for the set of alternative & criteria. To establish the superiority structure for criteria out of the obtained weights we have used Shannon entropy method. Similarly, for the set of alternative & based on the criteria individually & by using the decision- making matrix's data, the superiority structure as it is illustrated in table 3, is formed.

Table 3: Superiority structure of alternative & criteria' set

	MAX S	MAX O	MAX D
A1	14.5	3	18.5
A2	4.5	17	3
A3	14.5	7	18.5
A4	4.5	11.5	10.5
A5	14.5	11.5	10.5
A6	14.5	17	10.5
A7	1	17	10.5
A8	14.5	3	18.5
A9	4.5	11.5	10.5
A10	14.5	7	10.5
A11	14.5	20.5	3
A12	14.5	17	3
A13	14.5	3	18.5
A14	14.5	11.5	10.5
A15	14.5	3	18.5
A16	4.5	7	10.5
A17	14.5	11.5	10.5
A18	14.5	3	18.5
A19	4.5	20.5	3
A20	4.5	17	3
A21	14.5	11.5	10

Specifying the primary rating on the alternative- criteria set

By having the abovementioned relations & structures & using Besson average rating, the primary rating of the alternative & criteria is computed. Accordingly, no. 1-15 was given to index & the r_k is formed. The mentioned processes are applicable for alternative, too. Table 4 presents the primary indexes & options.

Table 4: The primary rating on the alternative- criteria set

	MAX S	MAX O	MAX D
A1	11.510	2.596	14.704
A2	3.585	13.500	3
A3	11.510	5.599	14.704
A4	3.585	9.144	8.398
A5	11.510	9.144	8.398
A6	11.510	13.500	8.398
A7	1	13.500	8.398
A8	11.510	2.596	14.704
A9	3.585	9.144	8.398
A10	11.510	5.599	8.398
A11	11.510	16.276	3
A12	11.510	13.500	3
A13	11.510	2.596	14.704
A14	11.510	9.144	8.398
A15	11.510	2.596	14.704
A16	3.585	5.599	8.398
A17	11.510	9.144	8.398
A18	11.510	2.596	14.704
A19	3.585	16.276	3
A20	3.585	13.500	3
A21	11.510	9.144	8.398

Projection of alternative' intervals $\mathbf{d(o, m_k)}$

By obtaining the primary levels for the set of criteria & alternative based on each index, we have used direct linear evaluation method for gaining the intervals.

The evaluated intervals for all alternative & based on the criteria are presented in table 5.

Table 5: Evaluated intervals for all alternative

	MAX S	MAX O	MAX D
A1	43.5	4	58.5
A2	14.5	53	9
A3	43.5	19	58.5
A4	14.5	33.5	25.5
A5	43.5	33.5	25.5
A6	43.5	53	25.5
A7	1	53	25.5
A8	43.5	4	58.5

A9	14.5	33.5	25.5
A10	43.5	19	25.5
A11	43.5	62.5	9
A12	43.5	53	9
A13	43.5	4	58.5
A14	43.5	33.5	25.5
A15	43.5	4	58.5
A16	14.5	19	25.5
A17	43.5	33.5	25.5
A18	43.5	4	58.5
A19	14.5	62.5	9
A20	14.5	53	9
A21	43.5	33.5	25.5

Aggregation phase

By obtaining $R(m_k)$ for all the alternative of the criteria, the aggregating step should be taken; in other words, to be computed for all alternative that its amount equals the general sum of the computed $R(m_k)$ for each option regarding each index. Thus, $R(m\ )$is shown for all alternatives in table 6.

$$1 \leq R(m_k) \leq 63 \qquad 3 * 21 = 63$$

Table 6: Aggregation results

Ranking	Alternative	Sum
1	A16	59
2	A4	73.5
2	A9	73.5
3	A2	76.5
3	A20	76.5
4	A7	79.5
5	A19	86
6	A10	88
7	A14	102.5
7	A17	102.5
7	A5	102.5
7	A21	102.5
8	A12	105.5
9	A15	106
9	A1	106
9	A8	106
9	A18	106
9	A13	106
10	A11	115
11.	a3	121
12.	a6	122

Comparing the results & specifying the top choice in ORESTE method

Finally to determine the top choice, we compare the aggregation results from the decision- making phase. In this section the less the total sum, the higher the rank will be.

Conclusion

Exposing the acts of unloaded, sucker and Grab in the grain terminal of Persian Gulf by manipulating ORESTE method and Shannon's Entropy in the three phases will lead to identification and prioritization of the grain discharging processes risks from the ship. In the first phase, by the analysis of the events and occurred incidents information bank about the surveyed matters and also setting brainstorming sessions with the terminal's experts, 22 risks were identified. In the second phase by using from the Shannon's Entropy, the criteria (occurrence frequency, severity and detection) were weighted.

Then based on the criteria of determination of causes occurrence probability (occurrence frequency), the extent of its impact on process after occurrence (severity) and probability of its identification prior to having impact on the process (detection), the identified risks were scored in form of a scale from 1 to 10. Finally according to the obtained scores of each risk, the ORSTE decision matrix was conducted and subsequently in the third phase by using this method, all of the identified risks were prioritized. According to the final result, the risk of being slippery (falling) from the stairs, operator chair shaking and the risk of the dust of the discharging grain and vacuuming the filters were obtained the highest priority respectively and the risk of the sunshine's reflection toward the operator cabin and the risk of the manifold pressure toward the muscles and the risk of the falling into a sea were obtained the least priority respectively.

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