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Identifying and Prioritizing the Factors Affecting on the Human Errors and Ways to Reduce it in Oil and Gas Industry: Systematic Review

Mahdi Jafarinodoushan[1, *] , Fatemeh Tahmasbi Abdar [2]

1- B.Sc Student of Occupational Health Engineering, Faculty of Health, Yazd University of Medical Sciences, Iran

2- B.Sc Student of Occupational Health Engineering, Faculty of Health, Yazd University of Medical Sciences, Iran

*Corresponding Author: mjn495@gmail.com

Abstract

Background and Objectives: Despite continuous efforts to reduce human error in various systems, mistakes and unsafe behavior are the main cause of accidents in the workplace. The occurrence of human error and accidents in the oil and gas industry can have severe consequences for employees, industry and even society. Therefore, a systematic review of past studies is the best way to share useful study findings and make available future study trends in human error.

Materials and Methods: Electronic search of databases in Persian and English languages was carried out without time limit until 2020. These articles were searched from PubMed, Scopus, web of science databases, and using the (or human) OR (human errors) AND (Oil and Gas Plants), performance shaping factors.

Results: After searching, 583 article abstracts were searched. 409 articles were excluded because they were not in line with the study objectives and inclusion criteria. Then 174 abstract articles were independently studied by two researchers and the unrelated studies were excluded. 75 articles were independently reviewed by two researchers. Finally, 30 articles were fully in the study.

Conclusion: The lack of skills (16.2%), Lack of experience (14.7%) and inadequate and inadequate equipment (11.8%) are the three main factors influencing the incidence of human error. The results also showed three factors in the implementation of appropriate training programs (34.3%), developing appropriate work instructions (22.4%) and proper equipment design (20.9%) are the main strategies to reduce human error in the oil and gas industry.

Keywords: Human error, reduction of human error, oil and gas industry, systematic review

1. Introduction

Although human advances in information and communication technology have reduced the presence of human resources in the workplace, but by changing working methods, the role and importance of the human factor in controlling and directing work systems has increased so that people are inevitably Gather and process a huge amount of information in a short time and make decisions based on it. Obviously, the slightest human error in any of these stages in many industrial environments can lead to a catastrophic accident (1). Human error includes deviation of human performance from the specified tasks and rules, which exceeds the acceptable level of the system and has an adverse effect on the efficiency of the system (2). Unintentional failure of purposeful and planned activities to achieve a desired result is also considered a human error (3). Sensitive systems with advanced technologies are used today in many industries such as chemical, nuclear, military and medical industries. Because these systems are always interacting with humans, the potential for human error hazards in these processes is high (4). Despite advances and the use of automation in industry and the reduction of the human role in the workplace, human error can still lead to unfortunate accidents, which is due to the fact that human duties in the workplace are associated with increased psychological burden and complexity of work. Which increases the probability of error (5).

Human error is the main cause of 70 to 90% of work-related accidents in industry. Important historical events such as Chernobyl and Bhopal, which have occurred so far due to human error, show the importance of the human factor and human error (6). Studies on industrial accidents show that the human factor plays the most important and main role in the occurrence of accidents, so that 60 to 90% of accidents are directly caused by human errors and mistakes (7). An analysis of 2,000 accidents in Australia showed a human error

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rate of 83% (8). Studies have shown that more than 80% of accidents in the chemical and petrochemical industries are caused by human error (9). In this way, Mr. Henrich examined about 75,000 accidents and concluded that 88% of the causes of accidents are unsafe acts, 10% are unsafe conditions and 2% are unavoidable factors (10).

In almost all recent high-profile events, such as Chernobyl, Tri-Mile Island, southall, there are traces of human error (11). Since oil and gas refineries are among the vital industries of the country, the consequences of human error in economic, social and environmental dimensions will be adverse. Studies show that between 1985 and 1990, about 2 billion $ in damages were caused by human error (12). The 1994 Texas Refinery explosion and fire, which killed 26 people and caused 48 million Pound sterling in damage, is an example of human error (1). The Bhopal accident in 1948 was also caused by human error. The accident killed more than 3,000 people and caused genetic problems for more than 300,000 people (13). The Deepwater oil rig explosion in 2010 is one of the causes of human error. The accident killed 11 people and lost $ 44 billion in assets (14). In December 2009, a large fire broke out in the surface water canal under the maintenance of the ancillary service pipelines in the Mahshahr petrochemical area. One of the main reasons for this incident was a human error in the work permit system (15).

Although the role of human error in accidents is very obvious and on the other hand the catastrophic results of not examining human error when calculating the risk, has been fully proven, but unfortunately in most industries when evaluating various parameters, human error is not considered (16). Studies show that human errors occur due to a combination of personal, managerial and organizational factors, job complexity, environmental conditions, equipment and device design, the presence or absence of instructions and monitoring, so that only one action cannot be done. Considered the main cause of human error (17). In recent years, the focus on human error in the field of industrial accidents has shown that in addition to lack of skills, decision-making, attitude, factors such as organizational culture and regulatory factors were also identified as factors involved in accidents (18, 19). According to Dekker's study, human errors are systematically dependent on the characteristics of operators' tools and tasks and are rooted in the organizational system (20).

A common feature of large technological systems such as the oil industry is that large amounts of potentially hazardous materials are concentrated in one unit and controlled by several operators, so human error and accidents in these units are not only a threat to equipment and people in They are working inside the unit, it is considered, but because of its effects on the adjacent areas, they are of great importance (21). Also, due to the increasing complexity of industrial systems and processes, the emergence of technology, the nature of error and unpredictability of human beings and that the most important cause of industrial accidents is human error, so the identification and analysis of errors Humanity or prevention of their dire consequences is essential (22). Since accidents can take on regional and even national dimensions with severe consequences, they cannot be neglected in order to prevent future accidents by learning from them after the occurrence of accidents. Therefore, the best and most practical way to prevent and reduce the occurrence of industrial accidents is to use appropriate methods to predict and identify possible human errors and investigate their root causes and seek appropriate solutions to control them (12). Since numerous, scattered and sometimes contradictory reasons for the occurrence of errors in the oil and gas industry have been reported, it is obvious that to reduce the risk of human error in the oil and gas industry, the causes are identified, evaluated and controlled. With this description, the main purpose of the present study, which is a systematic study, is to identify and categorize the main causes of error and appropriate solutions to reduce human error in the oil and gas industry.

2. Materials and Methods

Electronic search of databases in Persian and English languages was carried out without time limit until 2020. These articles were searched from PubMed, Scopus, web of science databases, and using the (or human) OR (human errors) AND (Oil and Gas Plants), performance shaping factors.

After searching the databases, first all the identified articles were entered into Endnote software and duplicate articles were removed. By reviewing the articles by two researchers independently, according to the title and summary of the articles, those articles that were not related were excluded from the study. In the next step, the full text of the remaining articles was examined to determine the articles that met the input criteria. After this stage, the remaining articles were re-examined and articles related to the purpose of the study were extracted and these articles were re-examined. Subsequently, some studies that did not investigate the factors affecting the incidence of human error and ways to reduce it were excluded from the study due to research questions and objectives.

In the next step, if a study had at least one systematic error according to its text (selection or information), it would be considered as low quality articles, otherwise it would be considered as a quality article. In the first stage, if it was stated in the study itself that the study has a possible bias, the existence of

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bias would be determined based on it. Also, if more than 40% of the study participants had refused to participate in the study or if several methods of data collection were used for the participants, the study would be considered biased and information, respectively. After reviewing the quality of articles and selecting high quality articles, the desired data were extracted from the articles to continue working (Figure 1).

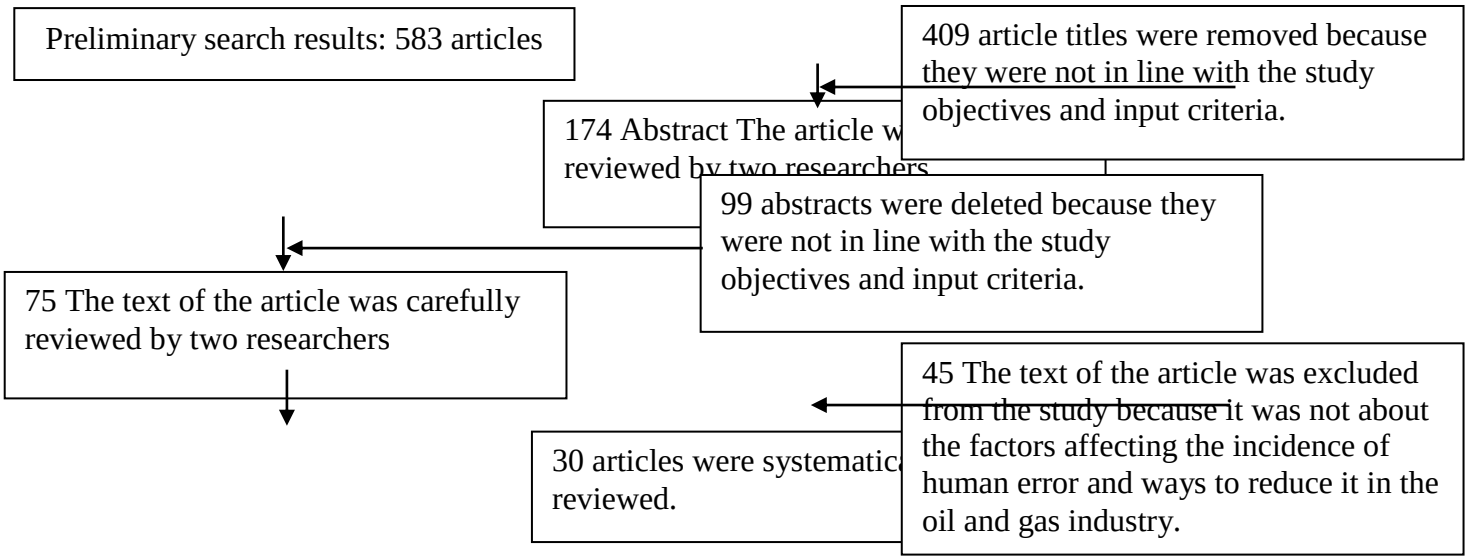

Figure 1. Article selection process

3. Results

Analysis of the obtained data showed that most studies were conducted in the period 2015 to 2020 and in recent years the frequency of studies has had an upward trend (Figure 2).

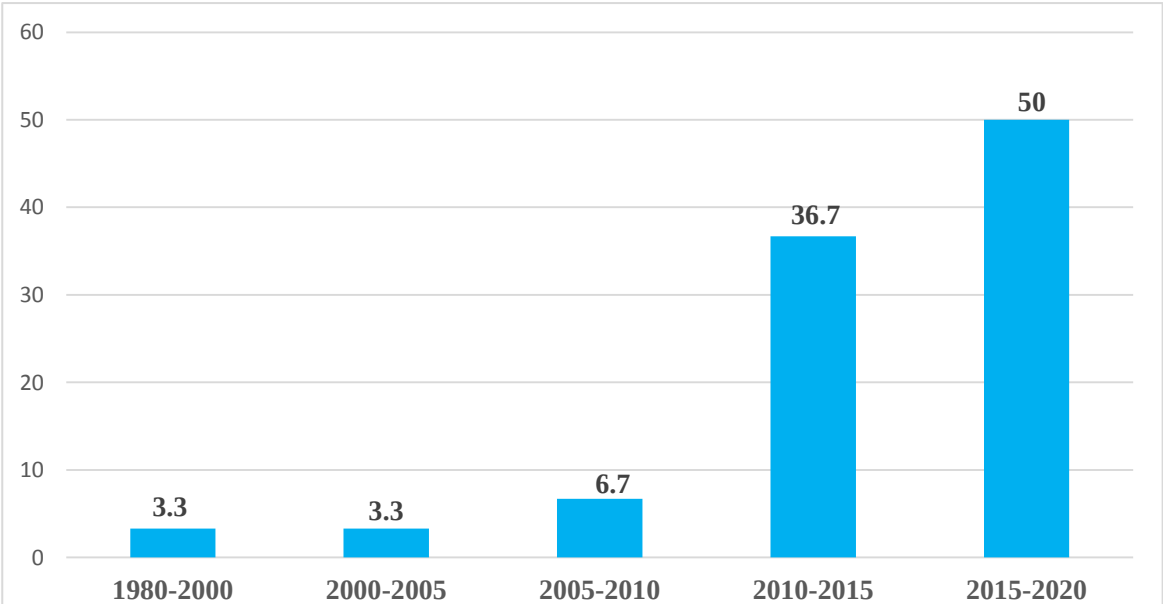

Figure 2. Percentage of articles published based on time period

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It was also found that most of the published articles are related to Iran (77.6%). Regarding the study unit, it was found that the highest percentage of studies was done in the control room (33.4%) and the lowest in the dehumidification unit (3.3%). Also, in terms of the method used in the studies, the highest frequency was related to SHERPA method and the lowest was related to HTA and PHEA methods (Figure 3).

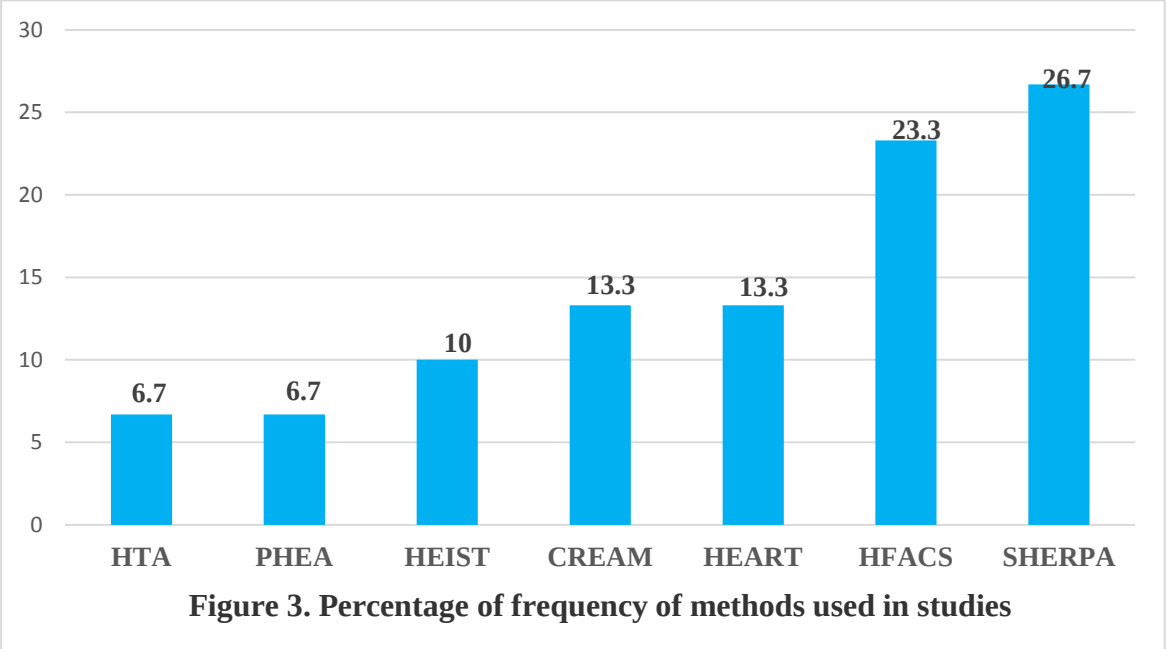

Figure 3. Percentage of frequency of methods used in studies

Then, by carefully examining the studies, it was found that in all studies, a set of factors have been identified as the causes of errors (Table 1).

Table 1

row	Title	Factors affecting human error	Solutions to reduce human error
1	Risk assessment of human error among Mohr City, Parsian Gas refinery company control room operators using systematic human error reduction and prediction approach SHERPA in 2016	- Lack of skills - Lack of experience	- Implement appropriate training programs - Proper monitoring
2	Investigation of the causes of human error in the case study process units of phase 13 of South Pars	- Lack of skills - Insufficient training	- Implement appropriate training programs
3	Human Errors Assessment in the one of the control rooms of a petrochemical industrial company using the extended CREAM method and BN	- Lack of time to do work - Inadequate equipment - Inadequate working conditions	
4	Identification and Analysis of Human Errors in the Maintenance Activities of Molecular Sieve Replacement in the Dehydration Unit of Gas Refineries Using Predictive Human Error Analysis Method	- Insufficient training - Poor work instructions	- Proper monitoring - Implement appropriate training programs - Proper design of equipment
5	Identification of human errors by HEIST and Heart methods in Assaluyeh Petrochemical	- Lack of experience - Insufficient training	- Implement appropriate training programs

6	Night shift effects on Cognitive executive functions and alertness among petrochemical control room operators	- Fatigue - High workload	- Execute the appropriate work schedule - Development of appropriate work instructions
7	Investigating the causes of human error-induced incidents in the maintenance operations of petrochemical industry by using HFACS	- Lack of skills - Lack of experience	- Implement appropriate training programs - Proper monitoring
8	Quantitative Human Error Assessment Using Engineering Approach in Permit to Work System in a Petrochemical Plant	- Lack of skills - Insufficient training - Poor work instructions	- Development of appropriate work instructions - Implement appropriate training programs
9	Human error analysis among petrochemical plant control room operators with human error assessment and reduction technique	- Fatigue - High workload - Insufficient training - Inadequate equipment	- Implement appropriate training programs - Development of appropriate work instructions - Proper design of equipment
10	Control of Human Error and comparison Level risk after correction action With the SHERPA Method in a control Room of petrochemical industry	- Poor work instructions - Insufficient training - Lack of experience	- Proper design of equipment - Implementation of appropriate training program - Proper monitoring
11	Human Error Assessment and Management among Isfahan Oil Refinery Control Room Operators by SHERPA Technique	- Fatigue - High workload - Inadequate working conditions	- Proper monitoring - Development of appropriate work instructions - Execute the appropriate work schedule
12	Human Error Classification for the Permit to Work System by SHERPA in a Petrochemical Industry	- Lack of skills - Lack of experience - Insufficient training	- Implement appropriate training programs - Development of appropriate work instructions
13	Identification of the Human Errors in Control Room Operators by Application of HEIST Method (Case Study in Oil Company)	- Poor work instructions - Inadequate equipment - Lack of time to do work - Lack of experience	- Development of appropriate work instructions - Implement appropriate training programs - Proper design of equipment
14	Analysis of Indicators Affecting the Faulty Behavior Risk with Fuzzy Multiple	- Fatigue - Lack of skills - Lack of motivation	- Implement appropriate training programs - Selecting capable people
15	Identification and Assessment of Human Error Due to design in damaging to the Sour Water Equipment and SRP Unit of Control Room in A Refinery Plant using SHERPA Technique	- High workload - Inadequate working conditions - Inadequate equipment	- Proper design of equipment - Development of appropriate work instructions
16	Using CREAM to identify and assess Human Errors in Control Rooms of Arya Sasol Polymer Company	- Lack of experience - Lack of time to do work - Poor work instructions	- Implement appropriate training programs - Development of appropriate work instructions - Selecting capable and worthy people
17	Identification and Evaluation of Human Errors leading to incidents in a gas refineries using Human Factors Analysis and Classification System	- Lack of skills - Low accuracy - Lack of motivation	- Implement appropriate training programs
18	Ergonomic study (detection, prediction and control) of human errors in one of the control rooms of petrochemical industry using SHARPA method	- Poor work instructions - Improper management - Inadequate working conditions - Lack of motivation	- Proper design of equipment - Development of appropriate work instructions - Implement appropriate training programs
19	Investigating the causes of human error-	- Poor work instructions -	- Proper monitoring

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	induced incidents in the maintenance operations of petrochemical industry by using HFACS	Low accuracy - Inadequate equipment	- Development of appropriate work instructions - Implement appropriate training programs
20	Risk Assessment and Management Impacts on Humans in the Control Room, Desalting Unit and Compression Station at Maroon using the Human Hazop Method	- Lack of time to do work - Lack of experience - Improper communication	- Proper design of equipment - Development of appropriate work instructions - Implement appropriate training programs
21	Identification and evaluation of performance indicators affecting human error, based on fuzzy logic (An operation center of Gas transmission company)	- Lack of time to do work - Lack of skills - Lack of experience	- Implement appropriate training programs
22	Identification of the human factors contributing to maintenance failures in a petroleum operation	- Improper communication - Inadequate equipment	- Implement appropriate training programs - Proper design of equipment
23	Identification of Human Errors and Effective Intra-organizational Factors in Failure Occurrence in Gas Industry	- Improper communication - Lack of skills - Inadequate equipment -Insufficient training	- Proper monitoring - Proper design of equipment - Implement appropriate training programs
24	Applying HFACS approach to accident analysis in petro-chemical industry in China: Case study of explosion at Bi-benzene Plant in Jilin	- Lack of skills - Inadequate working conditions - Low accuracy	- Proper design of equipment - Implement appropriate training programs
25	Fatigue and Human Errors Analysis in Petrochemical and Oil and Gas Plant's Operation	- Fatigue - High workload	- Execute the appropriate work schedule - Selecting capable and worthy people
26	Assessing and comparing human errors in technical operations in petroleum wells using extended CREAM technique	- Lack of skills - Lack of experience - Improper management	- Implement appropriate training programs - Development of appropriate work instructions
27	Determination of human error probabilities in maintenance procedures of a pump	- Inadequate equipment - Inadequate working conditions - Improper management	- Proper design of equipment - Development of appropriate work instructions
28	Human reliability analysis of an offshore emergency blowdown system	- Inadequate equipment - Improper communication	- Proper design of equipment - Development of appropriate work instructions
29	Determination of human error probabilities for offshore platform musters	- Lack of experience - Inadequate working conditions - Improper management	- Proper design of equipment - Implement appropriate training programs
30	Study of the Role of Latent Variables in the Trip Gas Sweetening unit by using Human Factor Analysis and Based on Fuzzy Hierarchy Theory: a Case Study in the Gas Refinery	- Lack of skills - Lack of experience - Low accuracy	- Proper monitoring - Implement appropriate training programs - Development of appropriate work instructions

Analysis of the results revealed that the three factors of lack of skills (16.2%), lack of experience (14.7%) and inadequacy and inadequacy of equipment (11.8%) are the three main factors affecting the incidence of human error (Figure 4).

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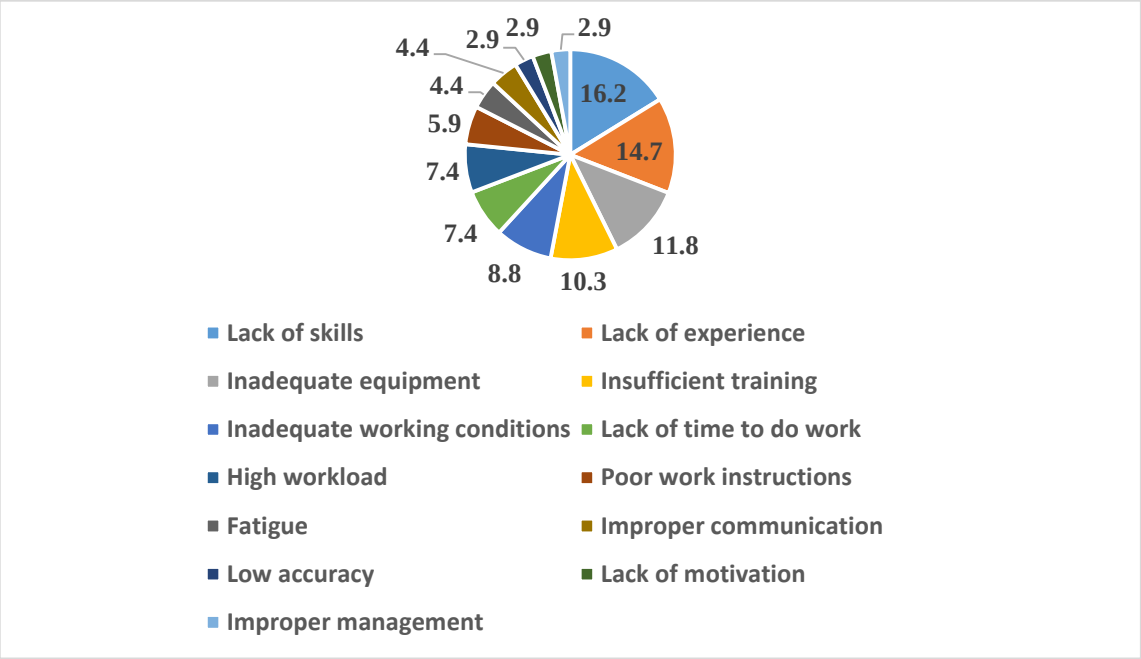

Figure 4. Classification of factors affecting the incidence of human error

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e results also showed that the three factors of implementing appropriate training programs (34.3%), developing appropriate work instructions (22.4%) and proper equipment design (20.9%) are the main strategies to reduce human error in the oil and gas industry (Figure 5).

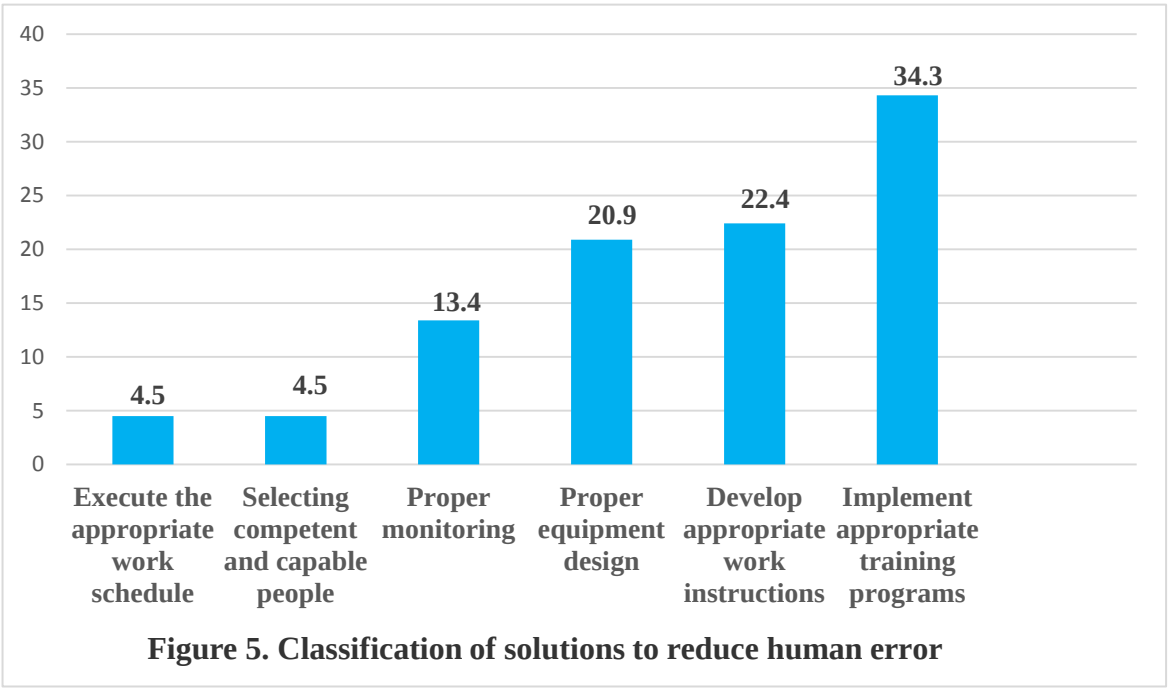

Figure 5. Classification of solutions to reduce human error

4. Discussion and conclusion

In an analysis of 75,000 accidents in 1931, Henrich concluded that 88% of accidents occur due to unsafe practices (10). The results of various studies also show that 80% of accidents in high-risk systems such as nuclear, petrochemical and chemical industries are rooted in human error (23). Human error is one of the most important types of unsafe behaviors. Therefore, the human factor was raised as a very important priority in the occurrence of accidents and caused the focus on the issue of human error (24). Human error is one of the important factors in the occurrence of accidents and disruption of planned performance. For example, in the oil and petrochemical refining industry, where (electrical) work is very high, human error is about 50% (25). A 2004 study by Lowe et al. Found that 64% of accidents are the result of human error (26). Reisen believes that human error is not a cause but a consequence in which workplace and organizational factors play a role (27). Older models of accident investigation focused only on unsafe practices and considered their occurrence to be direct and immediate (28). But unlike the old models, contemporary approaches to the causes of accidents are considered a combination of active operator errors and environmental background in the system, which benefits from these approaches is a deeper insight into the causes of human error and accidents (29). But other studies have shown that a number of external factors such as economic, social, regulatory and even cultural factors can affect a person's behavior and lead to human error (30). Recent studies on human error have shown that in addition to lack of skills and attitudes, factors such as regulatory factors and organizational culture are also involved in the occurrence of accidents (31). According to Dekke's study, human error systematically depends on the tasks of operators and the characteristics of tools (20). According to Reason, errors are divided into active errors and hidden errors. Active errors are the same as user errors, and hidden errors are organizational flaws that can remain hidden for a long time and cause an accident in an acute situation (32).

The oil and gas industry is one of the most important economic hubs of any country, and damage or cessation of these industries can lead to significant losses. On the other hand, oil and gas industries are among the critical and sensitive industries, which due to their nature and operational conditions, include high-risk activities and the potential for catastrophic accidents is very high in it, so pay attention to safety issues in this Industries are of special importance. Based on the findings of this study, it was found that the major studies conducted in the field of human error in the oil and gas industry have been conducted on control room operators. It is also suggested that in order to reduce the risk of human error, more studies should be conducted on the role of factors that shape people's performance such as stress, human-machine interaction, education and experience. The studies of this study showed that most of the studies conducted are limited to identifying and evaluating human errors and the role of various engineering and management controls in reducing the risk of human errors has not been studied much. Therefore, in order to reduce the risk of human error and prevent accidents, such as promoting a safety culture throughout the industry, designing equipment to reduce the probability of error, quantifying the identified errors by determining the type and amount of factors affecting them and implementing thinking. Infallibility (Poka Yoke) is suggested.

5. References

1. Wilkinson J, Lucas D. Better alarm handling—a practical application of human factors. Measurement and control. 2002;35(2):52-4.
2. Ramiro JS, Aisa PB. Risk analysis and reduction in the chemical process industry: Springer Science & Business Media; 2012.
3. Edmondson AC. Learning from mistakes is easier said than done: Group and organizational influences on the detection and correction of human error. The Journal of Applied Behavioral Science. 2004;40(1):66-90.
4. Hollnagel E. Human Reliability Analysis: Context and Control. 1993. Google Scholar.159-202.
5. Hollnagel E. Cognitive reliability and error analysis method (CREAM): Elsevier; 1998.
6. Ramin Z. Human Error Assessment in Cement Factory With HRMS Method. Master science Thesis, University of Tehran. 1375.
7. Kletz TA. An engineer's view of human error: IChemE; 2001.
8. Daramola AY. An investigation of air accidents in Nigeria using the Human Factors Analysis and Classification System (HFACS) framework. Journal of Air Transport Management. 2014;35:39-50.
9. Mustafa H. The Study of Human Errors in an Industrial Petrochemical Control Rooms Adopting CREAM Method with a Cognitive Ergonomics Approach. Master science Thesis, University of social welfare and rehabilitation sciences Tehran. 2010.
10. Brauer RL. Safety and health for engineers: John Wiley & Sons; 2016.

11. Feyer A-M, Williamson AM, Cairns DR. The involvement of human behaviour in occupational accidents: errors in context. Safety Science. 1997;25(1-3):55-65.
12. Petersen D. HUMAN ERROR REDUCTION AND SAFETY MANAGEMENT. 1981.
13. Gupta J. The Bhopal gas tragedy: could it have happened in a developed country? Journal of Loss Prevention in the process Industries. 2002;15(1):1-4.
14. Taber MJ, McCabe J, Klein RM, Pelot RP. Development and evaluation of an offshore oil and gas Emergency Response Focus Board. International Journal of Industrial Ergonomics. 2013;43(1):40-51.
15. Iliffe R, Chung P, Kletz T. More effective permit-to-work systems. Process safety and environmental protection. 1999;77(2):69-76.
16. Habibi A. Applied Safety And performance indicators. Hamadan: Fan Avaran Publication 2004.
17. Ghasemi M, Saraji G, Zakerian A, Azhdari M. Control of human errors and comparison of risk levels after correction action with the SHERPA method in a control room of petrochemical industry. Iran Occupational Health. 2011;8(3).
18. DIEHL A, editor The effectiveness of training programs for preventing aircrew'error'. International Symposium on Aviation Psychology, 6 th, Columbus, OH; 1991.
19. Jensen RS. The boundaries of aviation psychology, human factors, aeronautical decision making, situation awareness, and crew resource management. The international journal of aviation psychology. 1997;7(4):259-67.
20. Dekker SW. The disembodiment of data in the analysis of human factors accidents. Human Factors and Aerospace Safety. 2001;1(1).
21. A H. Human Error Assessment in Sulphur Recover Refinery of Tehran. University of Tehran. 2004.
22. Ghalenoei M, Asilian H, Mortazavi S, Varmazyar S. Human erroranalysis among petrochemical plant control room operators with human errorassessment and reduction technique. Iran Occupational Health. 2009;6(2):38-50.
23. Garrett J, Teizer J. Human factors analysis classification system relating to human error awareness taxonomy in construction safety. Journal of Construction Engineering and Management. 2009;135(8):754-63.
24. Sanders M, McCormick E. Human factors in engineering and design McGRAW-HILL book company. 1987.
25. Park J. Scrutinizing inter-relations between performance influencing factors and the performance of human operators pertaining to the emergency tasks of nuclear power plant–An explanatory study. Annals of Nuclear Energy. 2011;38(11):2521-32.
26. Kariuki SG, Löwe K. Increasing human reliability in the chemical process industry using human factors techniques. Process Safety and Environmental Protection. 2006;84(3):200-7.
27. Reinach S, Viale A. Application of a human error framework to conduct train accident/incident investigations. Accident Analysis & Prevention. 2006;38(2):396-406.
28. Gong Y, Fan Y. Applying HFACS approach to accident analysis in petro-chemical industry in China: Case study of explosion at Bi-benzene Plant in Jilin. Advances in Safety Management and Human Factors: Springer; 2016. p. 399-406.
29. Lenné MG, Salmon PM, Liu CC, Trotter M. A systems approach to accident causation in mining: an application of the HFACS method. Accident analysis & prevention. 2012;48:111-7.
30. Wiegmann DA, Shappell SA. A human error approach to aviation accident analysis: The human factors analysis and classification system: Routledge; 2017.
31. Wong D, Lee S. Modelling the predictors of intention in workplace safety compliance of a multi-ethnic workforce. Safety science. 2016;88:155-65.
32. Reason J. Human error: Cambridge university press; 1990.