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A Short communication: Improving marine safety management system by addressing common safety program failures

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Abstract

Marine safety management system failures usually occur across the maritime sector. Many of these failures have enough potential for the occurrence of serious undesirable events, rare accidents, mishaps, or near misses. Such mentioned events can directly or indirectly cause several serious injuries like loss of human life, serious and immutable environment damage, loss of material and equipment assets and decrease forgot factor as the reputation of the company. This short communication discusses the main principle reasons of marine safety management system's shortcomings and drawbacks as the ten key essential factors. Most of such mentioned events traced their roots back to the lack of supports and well-understanding of the management system. Impractical expectations, insufficient resources, and inadequate metrics are some of the main reasons for the above-mentioned events. According to accident investigation history, most of the official safety management system audits commonly fail to reveal the reasons why marine safety management systems will not be able to provide its full planned benefits. Based on the UK Continental Shelf incidents and accidents data and floating production storage offloading (FPSO) vessel the number of particular ten key contributors is provided. The outcome can reduce the incidents, increase the quality of production and investor confidence, and considerably improve the production uptime. The opinions presented here are based on the current short communication study and relevant experience of the authors.

Keywords: Marine accidents; Safety management system; Operational discipline; FPSO; Safety performance.

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1. Introduction

The marine safety management system is the main concept of the modern and high-tech industry. In this regard, if it is properly implemented not only can reduce and completely eliminate such incidents related to loss of human life, but also it can improve the construction uptime. The outputs of an appropriate management system may increase the product quality, the confidence level of investors, and the profit. However, the number of accidents in recent years represented the high number of companies fail to understand the full scope of benefits from the marine safety management system and accordingly to short drop back of integrating it into all features of their business (Bhardwaj *et al*., 2017). The marine safety management system is usually considered as adoption to regulation or collection of operating procedures or standards instead of cultural changes like every worker of the company that they work for.

This paper is organized as follows. In the following, an example of the marine industry with a brief background of relevant accidents is provided. In section 3, the ten key contributors to come failures of marine safety management are notified. The conclusion, discussions, and future suggestions are provided in the last section.

1.1. Marine industry and background

In recent years, due to rapid development of industrial sectors which caused that the number of accidents, mishaps, near misses and any events relevant to high-tech industries has widely occurred (Kim *et al*., 2011; Yazdi *et al*., 2019b). As an example, regarding marine and offshore oil and gas industry towards deep-sea and ultra-deep-sea, a conventional fixed offshore platform like gravity and jacket one is no longer suitable for oil and gas production. Thus, floating production storage offloading (FPSO) vessel itself is defended to be the best to compare with the other available production process. Although according to common established health, safety, and environmental factors (Gentile *et al*., 2003; Kabir *et al*., 2020) that there has not been reported any major or catastrophic accidents related to FPSO in recent years, the high number of incidents and near misses are occurring. For this reason, many companies are much more concerned about reporting near misses by employees. FPSO, as a high-tech industry, has enough capability to face such catastrophic and disastrous accidents (Shimamura, 2002). Failure to provide an adequate solution to the reason for any incident related to the FPSO with high confidence is an invitation to more accidents in the near future.

As can be seen in Figure 1, the typical FPSO is based on a ship-shaped vessel with modular process components located on the deck. The fluid process either from one subsea oil reservoir or more is sent into the FPSO, and subsequently, the oil on the vessel deck is separated into three contaminants, including water, oil, and gas. Oil is stored inside the vessel hull and accordingly offloaded into an oil tanker periodically. Gas is depended on the amount of it commonly used as ship fuel, sent to the flare, or exported. Shimamura (2002) discussed that the advantages of FPSO over conventional production methods are faster to be built which is accordingly saved project cycle and production times; it can be adopted in different water depths and more remote area; and it can act as a storage vessel instead

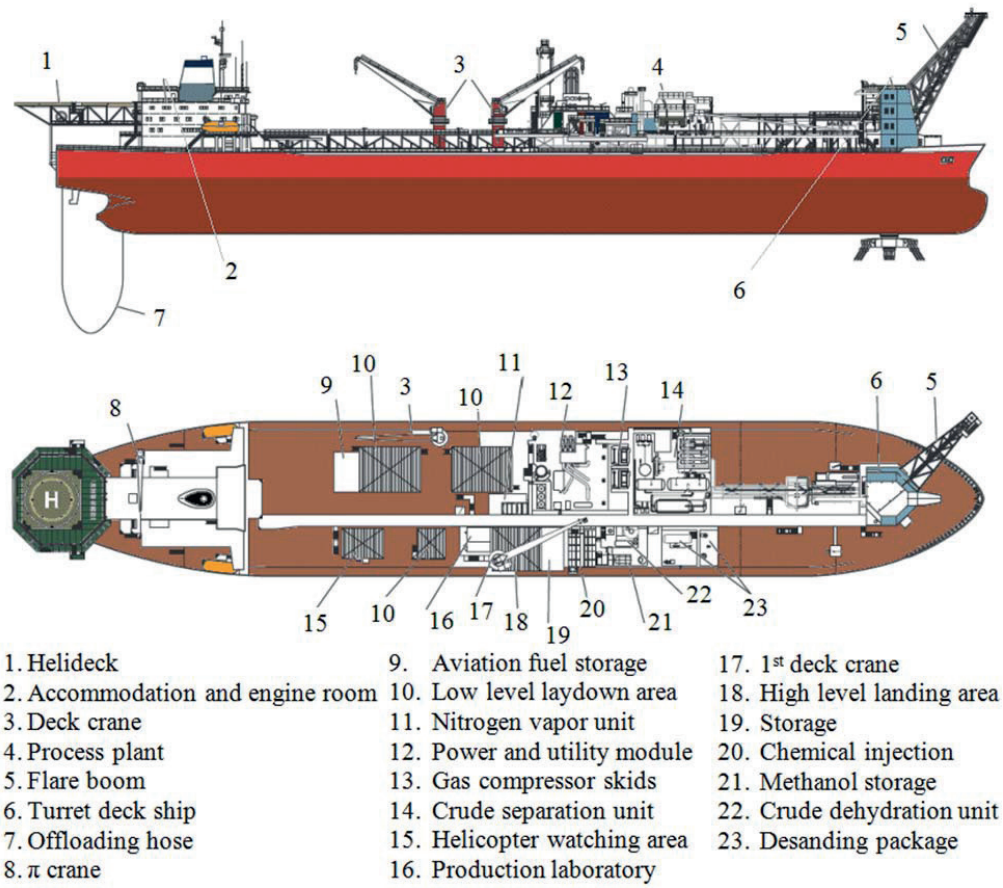

Figure 1. The typical FPSO module layout ("Floating production system," 2009)

of extensive oil pipelines into the onshore facilities.

According to the above-mentioned description of FPSO system attending to the accident, incidents, near misses, *etc*., are vital to make decisions on how we can improve safety performance by increasing the reliability of the system. There are numerous methods to identify failure modes in functional system (Liu, 2016; Yazdi, 2018; Daneshvar *et al*., 2020). As can be seen in Figure 2, such failure modes are recognized based on different types of FPSO system.

Several databases and reports are available in order to represent and analyze the number of minor and major incidents and accidents of FPSO, which are provided as a general list in (Shimamura, 2002). In this study, a brief descriptive set of UK Continental Shelf incidents and accidents data which have obtained from HSE (2008) are represented in Figure 3 to declare that FPSO has high possibility to face such disastrous accidents in upcoming future and insisting on understanding the importance of providing solution to reduce the relevant accidents. According to the HSE (2008), 508 incidents out of 3907 (total number of events) are related to FPSO. The mean frequency among all FPSO's units illustrated that crane accidents (63 times) and fire and explosion (44 times) are the main issues and spill/release (321times) is the significant and most frequent failure in

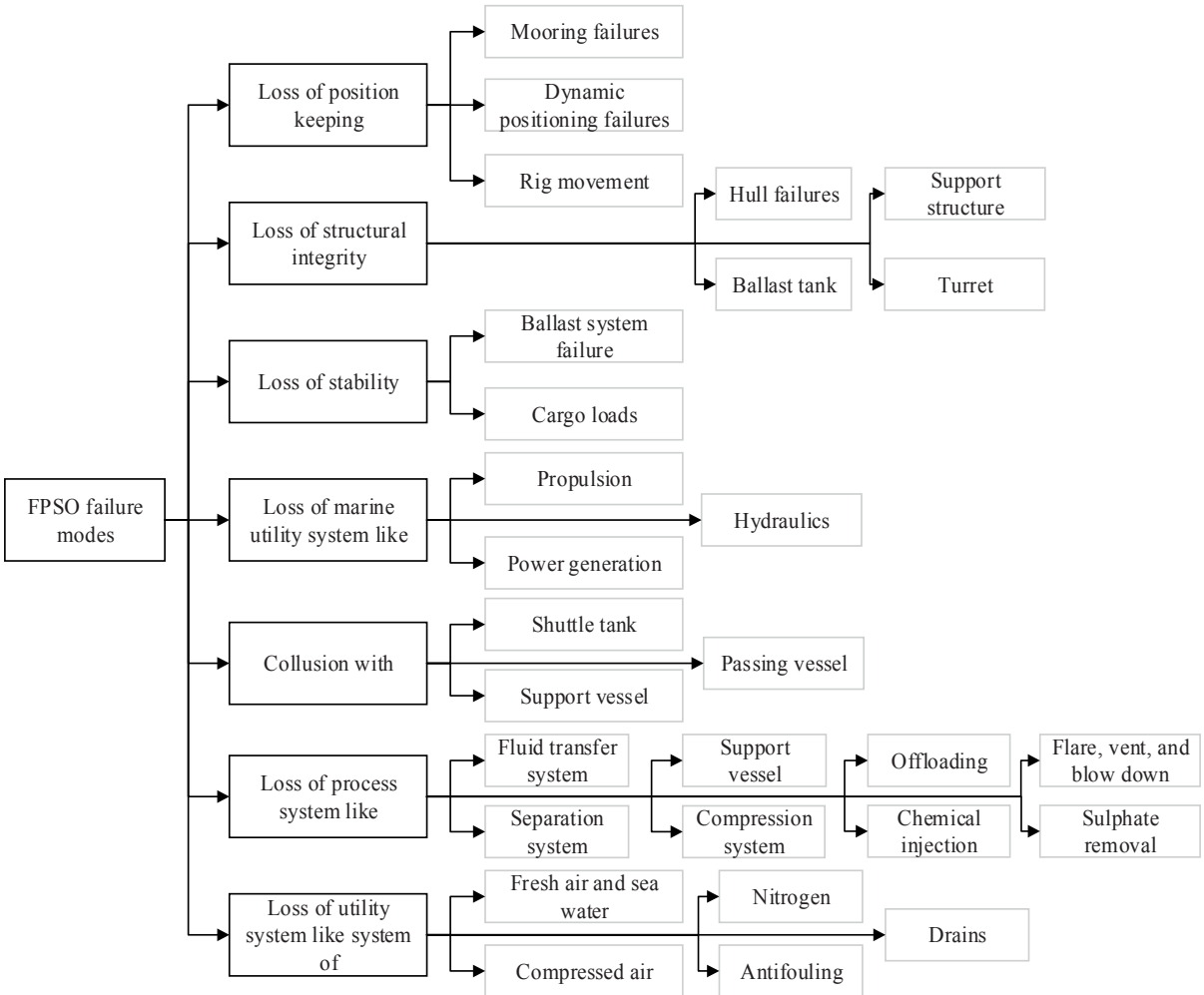

Figure 2. The common failure modes of FSPO system (Bhardwaj *et al*., 2017)

FPSO's unit. However, HSE (2008) had not been considered the corresponding domino effects of such accidents. As an example, fire and explosion can bring unavoidable effects for FPSO's system and even more; considerable pollutions for the environments (Gholamnia *et al*., 2015; Guan *et al*., 2016; Wang *et al*., 2017). Figure 4 shows the number of incidents that occurred in FPSO's system based on the different event types. In the next section, it is attempted to find out the different lack of marine management systems as ten key contributors using industrial sectors' experience, obtaining interviews with marine workers, and several meetings with senior managers, operation supervisors, safety experts and etc.

2. Ten key contributors to marine safety management system failures

Learning from experiences and backgrounds across a wide range of accidents in different industrial sectors, including maritime, chemical process, nuclear, automotive, and etc., highlights several major contributors to marine safety management system failures. As an example, Kelly (2011) highlighted ten and only ten key contributors into the process safety. In

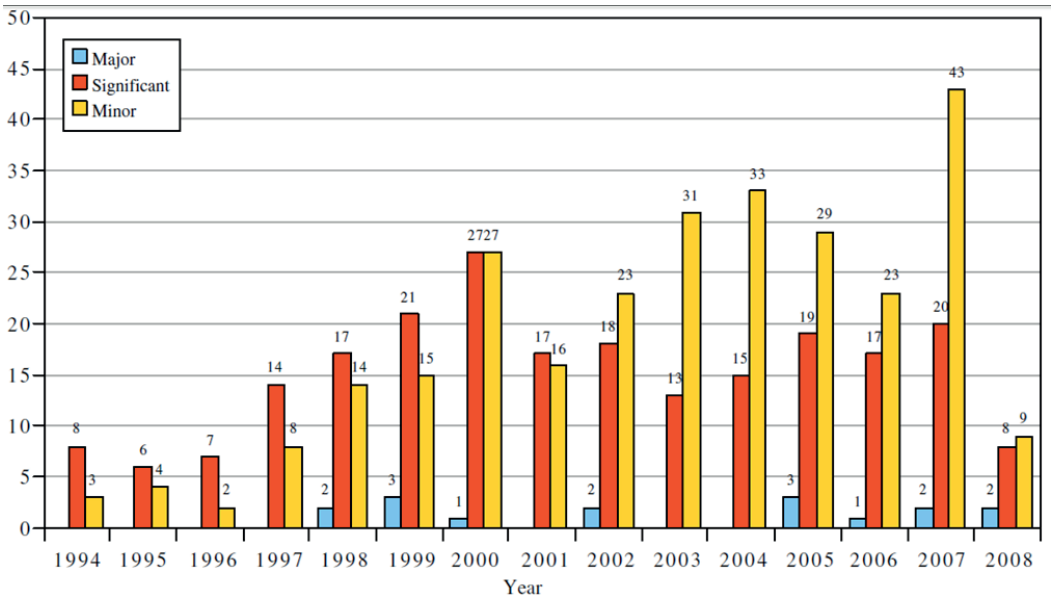

Figure 3. Total number of major, significant, and minor releases of oil and gas on FPSOs from 1994 to 2008 (Kim *et al*., 2011)

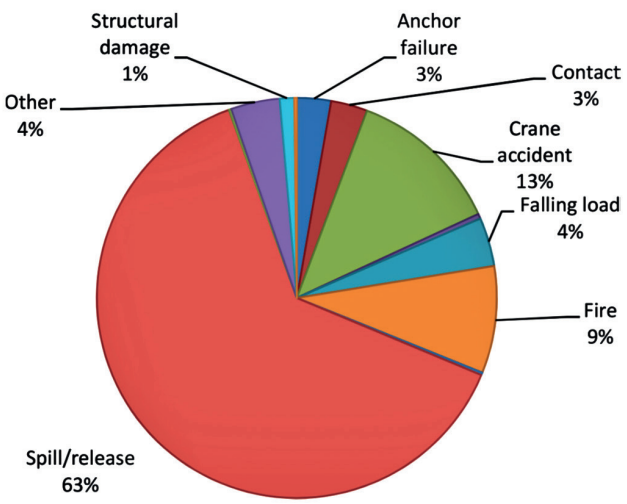

Figure 4. Number of incidents based on different types (Bhardwaj *et al*., 2017)

addition to the Kelly's study, literature, and the authors experiences (Yazdi, 2019a; Yazdi, 2019b; Yazdi *et al*., 2019a; Yazdi *et al*., 2019c; Yazdi, 2020; Yazdi *et al*., 2020), the number of particular ten key contributors in marine environment are further developed which are provided as follows:

1) Marine safety management system activities are commonly concentrated on the exiting regulatory adoption. Such operations that drop back under the authority of a marine safety management system; existing regulations sometimes focus on most of their attempts on attaining adoption with the written regulation. However, this fact may be predominantly signified the following issue as a reference. Marine safety is proposed to improve the integrity

of operation; thus, it should have enough capability and flexibility to address all operational issues and the particular site hazards. An efficient and effective safety system must highlight or meet all regulatory necessities and prepare benefits to the local operations.

2) Assignment of incorrect resources in order to support maritime safety, In this regard, when additional maritime safety resources are recognized as an important requirement by management, the recourses are commonly assigned to the safety and engineer departments of the company. In general, engineers have the high capability and skill-worked to solve the technical problem on-site tasks and to manage in a short period of time, like an on-time shaping structure project. Besides, there is a high possibility of facilitating proper adoption with maritime safety regulations. However, the organization has difficulty to well recognize the benefits of such regulations with respect to consideration of maritime safety hold at the front line. On the other side, a safety engineering department is usually ineffectual at impressing how activities take place on a day-to-day foundation in the field. Similar comments could be made concerning the assignment of engineering specialists to maritime safety management. Job tenure, education level, experience, and backgrounds, and in some contexts, age and confidence level in the safety field can perform as a significant barrier to the creative thinking which necessitated in maritime safety. It is worthwhile to mention that maritime safety management is not a project or one-time activity; thus, it is a role of doing business that needs more supports and resources at the front line and in all ranks of leadership and management. However, holistic scrutiny of a site's organization chart is a necessity to state maritime safety management resource requirements.

3) The marine safety management system is not well adapted to the types of operations. The elements of marine safety are common across all industrial sectors; thus, the particular operations and process used, the type of equipment, and the related hazards can distinguish the associated concentration of marine safety and the thoroughness required in all the elements. It can be mentioned that such operations which required as an example the chemical reaction has a high necessity to proper training as well as an appropriate procedure based on good technology. For an instant, the operation of a pump station should set a much more powerful highlight on mechanical integrity and reliability. On the other hand, it is common that a company invite outside consultants and resources; however, it should be realized that they must understand the nature of business before recommending some suggestions.

4) The high-level managers failed to support and well understand the goal of a marine safety management system. Marine safety is a comprehensive framework of activities that should utilize the whole of the workforce on industrial project sites. It statements the integrity of an operation; besides, it shares a typical set of principles with occupational safety. It should be noted that the marine safety system is not only a sequence or extension of conventional safety systems. It is obviously a discrete regularity which has the high necessity of technical and

operational skills. The problem is that the high-level decision-makers, because of failing to understand the differences, usually will attempt to implement a marine safety system with the same resources and tools used in occupational safety. However, marine safety has requirement further resources commonly due to an operating facility. In addition, the specified standards have to be implemented in order to determine the safety and integrity of the operation. High-level managers usually establish a lack of well-understanding the mentioned principles using media reports and other available communications. In practice, this may need a production drawback to keep away from a loss of controlling the event, and such comments like "safety is the first priority of system as it can be seen from monthly statistics reports". Obviously, represented this fact that there is a considerable knowledge gap between marine safety and occupational safety system.

5) Disciplinary measures are the outputs of human error or participation in a serious event. Marine safety excellence is the consequence of several management systems or marine safety management elements functions in a balance. The main purpose of such management systems is minimizing human and mechanical failures; however, it sets an irregular human error without contrary effects. Some kinds of methods like root cause analysis concerns the fundamental importance of management systems in the situation of things that are not well active. It is important that employees, like staff, workers, engineers, operators, and etc. have to be well-controlled and preserved responsibility for the direct failure of system policy and available safety protocols. Subsequently, when employees are properly controlled with high discipline or in other words ended as a direct output of such mentioned errors, willingness and the marine safety culture to report hazards and unsafe conditions will be negotiated and discussed more.
6) All of the employees are commonly employed or forced to accept marine safety management systems. That is, while marine safety is considered as a collective ingenuity that needs the contributions and supports of all industrial sector personnel that works for. It is clear that finding a person who respect to safety system with high excellence which can be considered as a "safety person of month" is common in the industrial sectors; however in opposite side, there will always be some employees who believe that safety, in general, is not a big deal and it is like as routing task without any output. Therefore, it should be noted that the latter group has highly needed to be well supervised and properly instructed because it causes that the new employees may be influenced and adopted by similar conditions and such attitudes.
7) Marine safety managements system needs to have a challenge with other management systems like as health, safety, and environmental management system (HSEMS) or process safety management system (PSM) in order to provide more ingenuity. All procedures, instructions, and operations which meet changes have to manage as "management of change (MOC)" on a continual basis. As an example, it can be noted that administrative policies are a

considerable category of change. Clearly, all companies in order to gain more progressive always try to find out the roots of overall productivity improvement, which have this ability to compete on the worldwide face to presenting novel inventions and initiatives. Health and environmental planes are such common examples in this regard. In addition, any conflicts between marine management programs have this capability to diminish the efficiency and effectiveness of marine safety programs; that is because such novel inventions and initiatives cannot be consistent and reliable to marine safety.

8) The middle managers and supervisors who have succeeded to accountable for marine safety management are changed their position. The fact is that marine safety programs must have a measurable procedure to obtain the progress of the systems, which may be based on significant factors and monthly reporting. In this regard, the progressive areas can be noted, including MOC closeout, updating procedure and instructions, recording repair of equipment, providing missed manuals and more documents, following-up and responding to audit findings, and etc. Putting excellent marks in order to show the finalization of each mentioned area may significantly measures in the construction period of industry; however, it does not at all mean the health of the marine safety system on the whole of the plant site. Besides, in some cases, high level managers are interested in the specific satisfaction of the above-mentioned areas with their technical details, which subsequently means that the marine safety program will only default to the meaningless numbers without any scale of the actual values. Consequently, the general quality of the marine safety system will be weakened and completely failed.

9) A high level of managers is commonly failed to well-understanding the existed risks of formally registered risks. There are many companies that file the ranking of all important risks on formal risk registry sheets. This is regularly reviewed by senior managers to make sure that a proper action is occupied and risk cannot be increased. The risk acceptance criterion for an organization needs a strictly secure foundation. However, this foundation is rarely illustrated in the risk matrix. The confusion can easily arise for decision-makers when the number of risk data is represented to the management in the lack of comparable and well-proven risk values. In addition, essential risks maybe failed to notice at the site plant level. Marine safety issues have not the possibility to receive a suitable level of consideration. Therefore, the risk communications have to take the time to make sure that the high-level managers completely realize the situation and background of what is being stated.

10) The high level of managers is commonly failed to learn the lessons from previous accidents. The root cause analyses like tripod beta, fault tree, and event tree, are usually engaged as a reasonable act for investigating and analyzing the marine safety accidents by varieties of industrial sectors. However, it is required that much attention from mangers perform in order to follow-up the corresponding individual actions directed to accidents, which can be named as a classic management role. Moreover, many of the high levels and even

more senior managers have operation and engineering backgrounds, which are not on the consistent foundation. This fact causes the mangers to rarely allocate time to ask examining technical and deep questions, which may clear the path for upcoming changes in the occupational and technical practices. In other words, allocating time for this purpose may cause a better understanding of marine safety issues, which permit managers to provide more effective and efficient supports.

Conclusion

In this paper, some of the main principal's reasons as ten key contributors to marine management system shortcomings, which may send an invitation to more accidents in the near future, were presented, and discussed. For instance, one of the significant problems is distinguishing between marine process safety and occupational safety. It means that insisting on occupational safety programs cannot prevent marine process accidents. The explained ten key contributors listed in this paper have high possibility of reducing the incidents relevant to the containment and asset loss, the production quality will increase, and production uptime will face considerable improvement. Besides, investor confidence increases, and accordingly, higher profit can be achieved. All of the mentioned results of an improved safety culture can improve the safety performance of the system. In the current short communication paper, only ten key contributors are signified based on industrial sectors of developing countries due to make a similar trend with process safety. It is a huge challenge to say such marine management system failures are limited to the above-mentioned ones. As a direction for further study, we have a plan to improve it by estimating the contribution of all mentioned failures in order to recognize which one has the high necessity for our system and prioritize them based on the highest importance to the lowest one.

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