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AN OCCUPATIONAL SAFETY AND HEALTH ASSESSMENT MODEL FOR LIBYAN IRON AND STEEL INDUSTRY

Abstract: *It is very certain that in the long and complex process of steelmaking, initiatives are accompanied by risk from the iron making to the final steelmaking. The industry also suffers from high accident rates, which results in absenteeism, loss of productivity, permanent disability, and even fatalities. The aim of this research is to suggest an efficient assessment criteria of occupational health and safety management (OHSM) practices which take into the complexity of the iron and steel industry. Indeed, there are several methods used in process management assessment but unfortunately, does not hold the interaction that can exist between the health and safety risks management process and the complexity of iron and steel industry. To remedy this disadvantage, this study proposed reducing the number of indicators down to several or major indicators.*

Keywords: *Occupational, Health, Safety, LISCO.*

1. Introduction

Occupational Health and Safety (OHS) covers employee health, safety and welfare in the workplaces. It is a basis to reduce the occupational accidents to an acceptable level. The occupational accidents can lead to permanent disabilities or deaths. Death of employees or their permanent disability causes economic loss and social problems for employers, employees and their families. Effective preventive measures through investing on safety equipments, process design, and training the employees can reduce the occupational accidents.

The modern industry is characterized by large-scale, high-level automation and also with complex processes. The accidents can cause serious impacts on the lives and health of employees and also may damage manufacturing facilities heavily. The new trends in safety management is to prevent accidents more than reacting to them when they happen. This prevention requires more knowledge about the exposer to hazardous situations, and in which ways the risks are associated with (Larsson and Field, 2002). It suggests that methods of risk and safety prediction should be developed along with injury and epidemiological studies.

Most of such incidents leads to a huge impact on production and economic activities of the industries, and have inconspicuous consequences. For this reason, the OHSM has appeared to be an essential topic globally. The iron and steel industries was found to be among the high-risk occupational area in modern society Due to the blend of many reasons, which may include the high-risk working environment, and low education level of unskilled menial workers, (Liao and Perng, 2008, Niza et al., 2008)..

The steelmaking process is very long and

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multifaceted. Such a complex enterprises normally go along with occupational health and safety risk and risk management issues that emanates from the stage of iron making to the final stage of steelmaking. The risk management influences the entire system through marketing, information and inventory, procurements and transportation, which is because of the immense uncertainties created by the variance in the midst of decision-makers with different background and interest, policies and market situation arise inevitably within such a complex system.

Thus, studies on occupational health and safety risk and risk management in iron and steel workplace are rare. Therefore, the aim of this study is to develop an efficient and reliable assessment model suitable for iron and steel making industry. Therefore, criteria for effective model development have been put forward.

2. Literature review

The major purpose of safety management is to preserve and promote personnel's health and safety. Hence, health and safety management is referred as an organized and prearranged activity that is governed by efficient management with a major objective for controlling health and safety risks (Burke et al., 2006). It is a total system ensuring proper planning and executing of safety activities and arranging follow up system. Since the major activities of safety management circled around risk analysis, safety training arrangements, accident investigations, near miss investigations, safety promotion and human reliability" (Booth and Lee, 1995).

Usually, the best productive approach to improve safety performance have to be by inhibiting accidents occurrence and decreasing uncertainty prior to its happening (Hinze and Gambatese, 2003, Abdullahi and Abdullah, 2015). Accordingly, safety and health risk study is a basis upon which safety management is build, and assessment becomes a critical task which forms a part of safety management systems (Tam et al., 2001, Zeng et al., 2008). In view of that, a review of methods and techniques that have been applied for assessment of safety and health management system was conducted and only the performance assessment methods that are typical of and very useful in the area of health and safety management practices were selected and discussed. Consequently, in line with the criterion of a holistic approach and in accordance to the recommendations by (Hale, 2009, Kjellén, 2009, Cambon and Guarnieri, 2008, Sgourou et al., 2010).

The challenge as described by Podgórski (2015) is the complexity of the measurement system due to large volume of information that is needed to be collected and processed, where more time and personnel to perform measurements is required. The need for KPIs selection became inevitable as recommended by (Keeble et al. (2003), Chan and Chan (2004), Change (2003), Øien et al. (2011)) indicate the need for reducing the number of indicators down to major KPIs.

Studies were carried out to unravel the reason hindering the effective functioning of OHSM in many companies. The results of such studies, lead to some proposed factors that are considered to be the bottleneck to having a functioning systematic OHSM system. Researchers like (Arocena and Núñez (2010), Biggs et al. (2013)) mentioned the lack of commitment as a factor, while the early work of Salminen (1998), saw that lack of knowledge as the inhibiting factor. Although, the report by Nordlöf et al. (2017) has revealed that at present, adequate awareness on OHSM has been achieved. Nonetheless, the lack of formalized routines for effective auditing and improvement of the safety and health management system has been reported by quite a large number of literatures reviewed (Arocena and Núñez, 2010, Holte and

Kjestveit, 2012, Hurst and Jee-Hughes, 2001). (Karltun (2004), Nordlöf et al. (2015)) commented that such a situation where formalized practice for assessment and improvement is neglected, it will translate to failure of the OHSM system.

3. Frame work for assessment of health and safety practice

The Libyan iron and steel industry was established in 1979 and situated around the coastal area of Misurata which is 210 Km away from Tripoli. The company has the capability of producing 1,324,000 tons of liquid steel annually (Abdulshahed et al., 2017), (Badi, 2017). Abusa (2011) reported that, the industry also suffers from high accident rates, which results in absenteeism, loss of productivity, permanent disability, and even fatalities.

In order to achieve the number of KPIs that would be sufficient for proper evaluation of OSHM system, the selection of most significant and representative indicators out of the relatively large number of initially defined Process Performance Indicators PPIs is proposed. An analysis of the available studies on the application of Multi Criteria Decision Making (MCDM) methods for the selection of KPIs from a huge set of PPIs indicates that there are many MCDM methods that can be applied (Pamučar and Ćirović, 2015), (Roy et al., 2018), (Vesković et al., 2018). The method for the criteria selection and indicators showed in figure 1. In brief, it consists of: (1) a comprehensive review of the literature and data collection about accidents in LISCO; (2) the development of an initial list of criteria related to the three main criteria; (3) The final step is an evaluation of the validity and reliability of criteria by a selected sample of 10 OHS managers from different departments at LISCO.

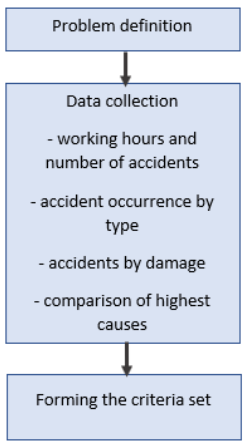

Figure 1. The frame work for OSHM KPIs

To indicate the current state of occupational accidents in LISCO, data for the last 10 years is collected. Figure 2 shows the actual working hours versus the number of accidents for the period of 10 years starting from the year 2008 through 2017

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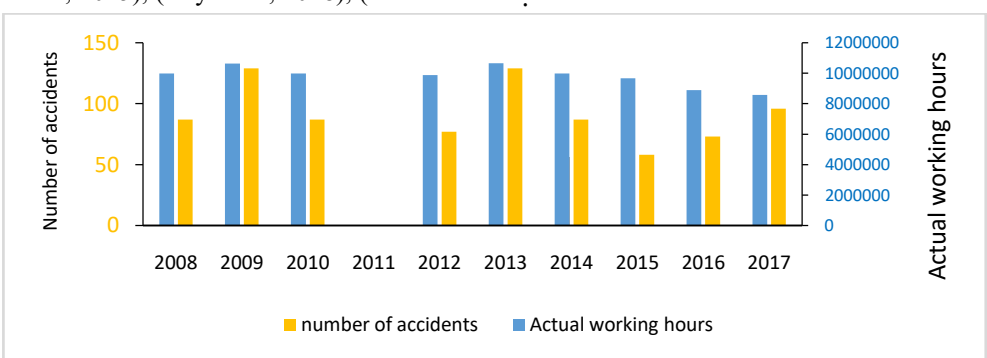

Figure 2. Working hours and number of accidents

From the figure, it can be deduced that year 2009 and 2013 has recorded the higher number of accidents. The explanation to this increase in accidents can be made in accordance to previous studies by Wigglesworth (Wigglesworth, 2006), which reported that occupational injuries occurred most frequently on Mondays, with highest of the weekly total. Similarly, in this study the number of accidents is recorded in the years with high working hours.

Figure 3 shows the total number of accidents reported for the period of 10 years. As earlier mentioned, the year 2011 has no substantial data for analysis due to the disruption of production as a result of the Libyan uprising. The figure shows that a non-uniform pattern of accident occurrence exist. This suggests that there are numerous factors that might be responsible for the increase or reduction of accident cases. Nonetheless, looking at the data at hand, it shows that consecutively through the years 2008 -2010, there is more causality related to industrial accident against the other type of accident

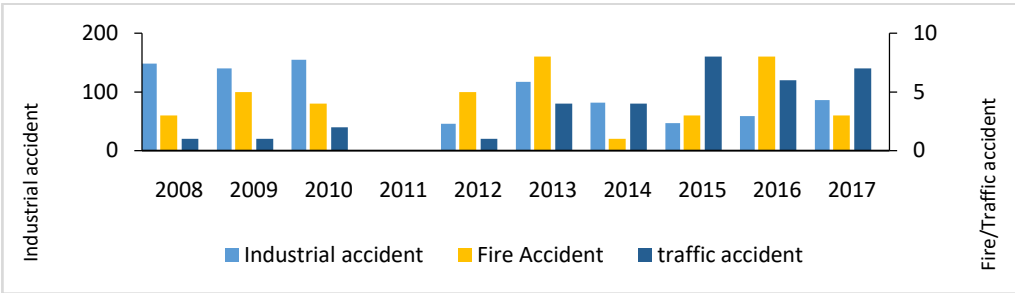

Figure 3. Rate of accident occurrence according to type

Considering the percent rate of accident occurrence according to type, figure 3 shows that industrial accident occurrence maintained a stepwise decrease from 12% in the year 2008 to 11% in 2012 through the year 2014. A continuous decrease was achieved to 10% in the year 2015 until 2016. Based on the foregoing, it can be claimed that favourable strategies have been adopted towards managing industrial accident and such strategies have been effective as earlier mentioned. However a slight increase in the percentage of industrial accident occurrences was observed in the year 2011. Thus, suggesting that a renewed effort is required for better results.

Figure 4 shows the number of accidents recorded for the period 2008 to 2017, categorized according to damage type. Physical damage took the largest portion throughout the period studied.

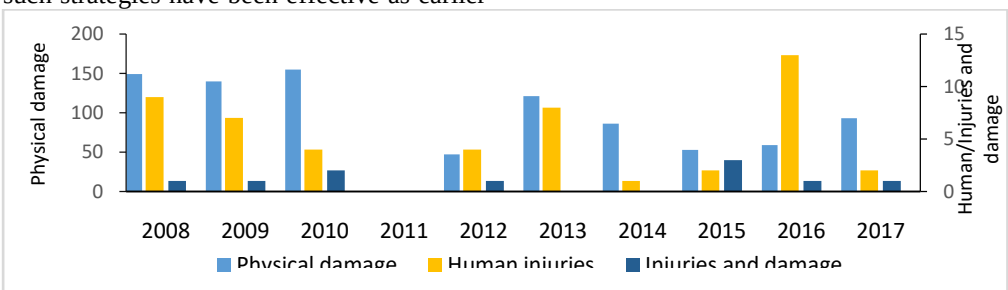

Figure 4. Accidents classification by type

Figure 5 shows the two highest causes of accidents and injuries as obtained from the secondary data sources. The figure revealed that the lack of attention has been the leading cause of accident and injuries more than the effect of liquid metal and other burning materials.

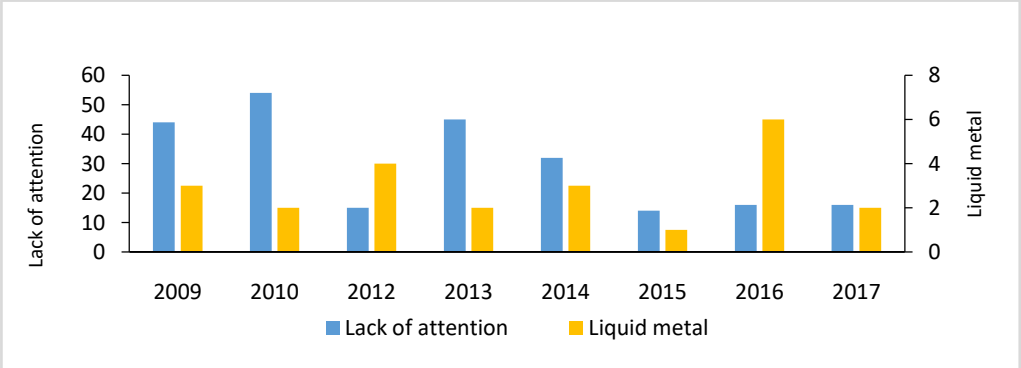

Figure 5. Highest causes of accidents

Looking into the individual effect of the two major causes of accident and injuries, figure 5, it can be noticed that accidents resulting from lack of attention has contributed the highest of 96.4% in 2010, while the highest recorded accident due to liquid metal has the highest contribution at 31% in 2016.

Table 1 shows the proposed indicators for occupational health and safety assessment in iron and steel industry. The indicators based on 31 sub-criteria grouped in three groups of criteria.

4. Conclusion

criteria that can be used to assess occupational safety and health management in Libyan Iron and Steel Company. These criteria were selected based on previous researches and opinions of group of experts. Thirty-one criteria grouped in three main categories were proposed as measures for occupational and health assessment. The study's visible contribution is their contributions for the effective management of health and safety risks in the Libyan iron and steel industry. The vision of improving the Libyan iron and steel industry with respect to adequate safety and health management practices can be fully realized only when the leadership, health professional and the workers take the full responsibility and work together to attain this goal.

As future research, a questionnaire survey will be conducted in order to validate the initial indicators and to confirm how important they are as measures of occupational health and safety performance.

Table 1. The proposed indicators for occupational health and safety assessment in iron and steel industry

No.	Criteria	sub-Criteria
1	**work injuries (physical hazards)**	Risk of electric shock
		Risk of falls from height
		Risk of falling objects
		Risk of working in confined spaces
		Risk of unguarded machinery
		Risk of chemical leaks
		Risk of contact with hot molten metal
		Risk of inadequate illumination
		Risk of inadequately trained health and safety professionals
		Risk of human error or unsafe acts
		Risk of slips and trips
		Risk of safety issues
2	**Occupational Diseases**	Diseases caused by noise
		Diseases caused by indoor emissions
		Diseases caused by vibration
		Diseases caused by inadequate ventilation
		illness resulting from exposure to magnetic filed
		Diseases caused by thermal stress
		Diseases caused by radioactive contamination
		Skeletal and muscular diseases
		diseases related to higher stress level at workplace
		diseases caused by inhalation of mineral dust like the sensitivity of chest and nose
3	**natural hazards**	Risk of floods
		Risk of earthquakes
		Risk of windstorms
		Risk of snowstorms
		Risk of raw material supply
		Risk of theft and burglary
		Risk of business interruption
		Risk of fires and explosions
		Risk of economic crisis

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