

ORIGINAL ARTICLE

The Effects of Implementing an Occupational Health and Safety Management System on Functional Indices: A Five-year Study in Casting Industry

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ABSTRACT

Introduction: Assessment of the performance of management systems is one of the main concerns of managers. The measure of success of an occupational health and safety management system is the extent of its effectiveness. The effects of implementing an OHSMS on health and safety performance indices in a casting site located in Iran between 2015 and 2019 were examined. **Methods:** A retrospective descriptive-analytical study was conducted over five years on 21 departments of a casting site. All the functional indices one year before the implementation of OHSAS 18001:2007 in 2015 until a year after the implementation (2019) were monitored and the data were analyzed using SPSS (v.19). **Results:** There was a significant decrease in occupational accidents after the implementation of OHSAS 18001:2007. Mechanical and ergonomic factors demonstrated significant improvements. There were improvements in the indices of opening health files for the personnel, personal protective equipment, education, instructions, legal requirements, commitment, and leadership. There was no significant change in chemical and physical factors. **Conclusion:** Implementation of the occupational health and safety management system was effective in the indices that needed managerial control with no or low expenses. However, it was not effective in indices in engineering and technical areas that needed more expenses.

Keywords: Occupational health and safety management system, Occupational health and safety indices, Occupational accidents

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INTRODUCTION

Human resources are the most valuable and important strategic resources in an organization (1). One of the main objectives of human resource management is to preserve capable human forces. Even if the recruitment, appointment, and other personnel management affairs are properly implemented, significant results from human resource management practices are not expectable without a sufficient attention to the Human resources management system (2). One of the factors in preserving work forces is occupational health and safety (OHS). Preventing occupational accidents and creating a healthy and safe work environment are essential. The importance of these lies with the necessity of lowering the rate of occupational accidents and creating a safe work environment for workers (3). Therefore, OHS

and investment in preserving and improving human resources' health are of the pillars of a sustainable development and the main issues for industry owners and policy makers (4). Millions of Dollars are incurred by businesses in the form of declines in human force productivity (5-6). A report by the UK health and safety executive committee titled "costs of accidents" noted that the costs of work accidents consumes 37% of annual profit of transportation business, 8.5% in construction sector, and 5% of running costs of hospitals. This report highlights the importance of OHS (7). According to the International Labor Organization (ILO, 2015), 317 nonlethal occupational accidents happened in the world in 2015. According to this organization, 6300 workers die every day due to occupational accidents. The cost of occupational accident is equal to 4% of global gross production (8). Industries all around the world are faced with new challenges such as profound changes in the economy. Therefore, managing health and safety risks of human resources at work is one of the major international concerns and challenges (9-11). Adopting a new approach to health and safety management

is inevitable (12). Preventing occupational diseases and accidents in line with improving productivity and observing health and safety of workers, contractors, and other individuals entails an efficient management structure (13). By avoiding OHS problems and taking into account health and safety of workers and other contributors in daily activities of the organization, such a management is a step towards cutting costs and improve productivity (14). In addition to the undeniable importance of human resources' health, another factor that motivates industries to adopt, implement, and improve occupational health safety management system (OHSMS) is the growing expectations in stakeholders with regard to safety and health. Along with legal requirements that industries have to respect, many industries have taken steps beyond the requirements standards as a way to outstand among the competitors (2). Therefore, industries can improve their image and position among customers, investors, and stakeholders who are more sensitive about social issues (15). Today, it is evident for many industries that health and safety management is an indispensable and essential part of their organization and as important as other types of managements (10). One of the main management systems is OHSAS-18001, which is an international standard of OHS management (16). The new version of ISO 45001 is a major step forward in OHS management. It entails specific requirements for an OHSMS so that by fulfilling these requirements, the organization can improve its performance through controlling health and safety risks (17-20). Since feedbacks assessment is the measure of success of any activity, assessment of the performance of health and safety department is essential (21). Assessment of performance of a management system including OHSMS is one of the main concerns for managers (22). It is important for the managers to make sure that all organs of a management system function properly and the system is as effective as it is expected. Several studies have emphasized on the necessity of an accurate performance assessment system in health and safety field (23-25). The main reason for selecting casting industry was the numerous work-related risk factors in this industry, which enabled us to have a better evaluation of the effectiveness of the OHSMS. Several studies have highlighted the necessity of OHSMS to monitor and ensure effective implementation of health and safety strategy in any industry and organization. Studies have also highlighted the necessity of periodical performance assessment (26). Among studies on the effects of OHSMS, Gholami (2015) and Mohammadfam (2016) are notable (27-28). While there are many studies on OHSMS, there are a paucity of studies on the effects of implementing OHSMS on performance indices. In light of this, the present study is an attempt to examine the effects of implementing an OHSMS on health and safety performance indices before and after the implementation in a casting site located in Iran between 2015 and 2019.

MATERIALS AND METHODS

The study was carried out as a retrospective descriptive-analytical work on 21 departments of casting site in 2019. The site has 21 departments and the samples were collected from all them. The casting site under study had 180 workers at different departments like administrative, in-spection, laboratory, kitchen, warehouse, and production (modeling, forming, molding, sand works, core works, assembly, melting, chill vent, and grinding). Inclusion criterion was implementation of OHSMS and exclusion criterion was failure to implement OHSMS. Information gathering was done using checklist by two occupational health experts. The reports by the auditor agency were used to calculate the indicators of work-related risk factors. Information gathering was conducted between 2015 and 2019. Ethical approval was obtained from Ardabil University of Medical Sciences Research Ethics Committee (IR.ARUMS.REC.1398.132).

The variables under study included occupational accidents, mechanical factors, chemical factors, physical factors, ergonomic factors, opening health file for workers, PPE, education, instruction, legal requirements and commitment and leadership.

Implementation of OHSMS (OHSAS 18001:2007) was initiated in 2016 and by the end of the 2018 all the requirements of the system were met. The steps of implementation of OHSMS are shown in Figure 1.

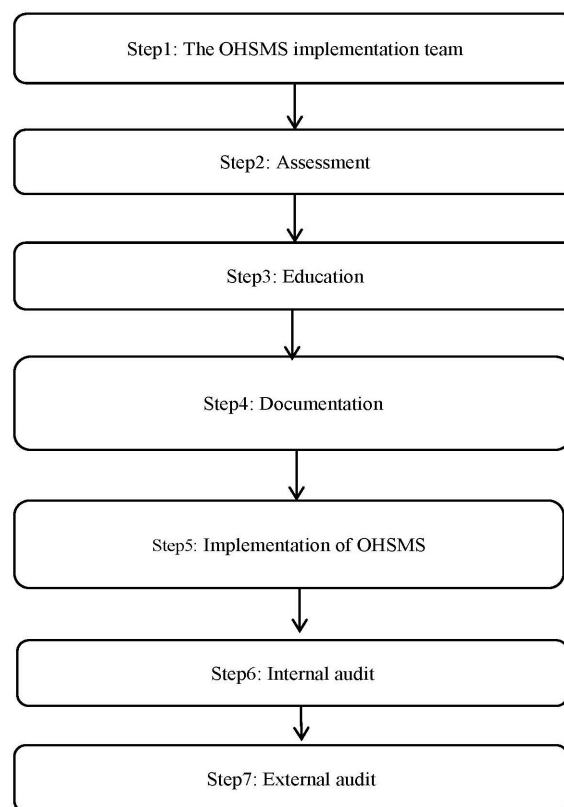


Figure 1: The Implementation of OHSMS

To assess the health and safety impacts of OHSMS implementation, the indices were calculated for five consecutive years, one year before OHSMS implementation, and one year after OHSMS implementation (2015 to 2019). Eleven indices were studied for all units (Table I). The table lists 11 indices for assessment in casting industry that are based on various scientific sources (7, 26, 29-32) and confirmed by five university professors (23).

Normality of data was evaluated using Kolmogorov–Smirnov test. Paired sample T-Test was used for the normal data. To compare the results and assess the effectiveness of OHSMS on assessment indices, Paired sample T-Test was used in SPSS 19 with $P < 0.05$ and two ranges.

Table I: OHSMS indices

No.	Index	Formula
1	Occupational accidents	Accident Frequency Rate (AFR) = $\frac{\text{(number of accidents} \times 200000)}{\text{(total work hours)}}$
		Accident Severity Rate (ASR) = $\frac{\text{(total lost work days} \times 200000)}{\text{(total working hours)}}$
		Frequency Severity Indicator (FSI) = $\sqrt{(\text{AFR} \times \text{ASR}) / (1000)}$
2	Mechanical factors	Risk assessment units to all units ratio
		Controlled risk to all identified risks ratio
3	Chemical factors	Workers exposed to safe fumes and vapors to all exposed workers ratio
		Workers exposed to safe chemical particles to all exposed workers ratio
4	Physical factors	Workers exposed to safe noise to all exposed workers ratio
		Workers to safe thermal stress to all exposed workers ratio
		Workers exposed to safe light to all exposed workers ratio
		Works exposed to safe radiations to all exposed workers ratio
5	Ergonomic factors	Workers exposed to safe ergonomic factors to all exposed workers ratio
6	Opening health file for workers	Health files to all workers ratio
7	PPE	Workers with PPE to all workers in need of PPE ratio
8	Education	Total number of educational courses multiplied by the number of participants in the courses
9	Instruction	Units with health and safety instructions to all units ratio
10	Legal requirements	Implemented health and safety legal requirements to all legal requirements ratio
11	Commitment and leadership	Number of managers and supervisors with healthy and safety education
		Number individuals in charge of working in area of health and safety
		Number of health and safety meetings with top managers

RESULTS

The study was carried out in three main units namely administrative and financial, technical and engineering, and production and 21 department in a casting mill. Totally, the mill under study had 180 workers at different departments.

Occupational accidents

Comparing with years 2015 and 2016, the mean score of accident frequency ratio (AFR) decreased by 58% in 2017, 2018, and 2019, which was a significant decline ($P < 0.001$) (Table II). Comparing with years 2015 and

Table II: Occupation accident indices and mechanical, chemical, physical, agronomic factors

No.	Index	Mean	N	Std. Deviation	P-value	
1	Occupational accidents	AFR-2015	8.74	21	0.31	<0.0001
		AFR-2019	3.35	21	0.18	
		ASR-2015	166.08	21	0.37	
		ASR-2019	34.96	21	0.18	
		FSI-2015	1.21	21	0.06	
		FSI-2019	0.34	21	0.06	
2	Mechanical factors	Risk assessment -2015	0.00	21	0.00	<0.0001
		Risk assessment -2019	1.00	21	0.49	
		Controlled risk -2015	0.00	21	0.00	
		Controlled risk -2019	0.82	21	0.13	
		Fumes-2015	0.43	21	0.10	
		Fumes-2019	0.43	21	0.11	
3	Chemical factors	Chemical particles -2015	0.60	21	0.12	0.10
		Chemical particles -2019	0.60	21	0.13	
		Noise -2015	0.74	21	0.13	
		Noise -2019	0.73	21	0.13	
		Thermal stress -2015	0.77	21	0.13	
		Thermal stress -2019	0.760	21	0.13	
4	Physical factors	Light-2015	0.83	21	0.10	0.08
		Light-2019	0.85	21	0.15	
		Radiation-2015	0.94	21	0.12	
		Radiation-2019	0.94	21	0.12	
		Ergonomics-2015	0.46	21	0.13	
		Ergonomics-2019	0.59	21	0.33	

2016, the mean score of accident severity ratio (ASR) and frequency severity indicator (FSI) decreased by 74% and 70% respectively in 2017, 2018, and 2019, which were significant declines ($P < 0.001$) (Table II). Table III indicates indices of occupational incidents.

Mechanical factors

Table III indicates the indices of mechanical factors. There was no documentation about risk assessment and control before the OHSMS (the index was equal to zero). However, along with the implementation of OHSMS in 2016, the risk trend became descending and the indices increased from 0 in 2015 to 0.82 in 2016 and 1 in 2017 -i.e. 100% of the units were assessed. The 100% increase is a significant increase ($P < 0.001$). The risk control trend is also indicated in Table III and clearly the changes in controlling risks are significant ($p < 0.001$) (Table II).

Ergonomic factors

Ergonomic factors showed an improvement in ergonomic condition after the implementation of OHSMS and the

Table III: Trend of indices of occupational accidents, mechanical factors, chemical factors, physical factors, ergonomic factors, opening health files for workers, using PPE, instruction education, legal requirements, and commitment and leadership before and one year after the implementation of OHSMS (2015-2019)

No.	Index	2015	2016	2017	2018	2019	
1	Occupational accidents	8.74	7.23	2.93	3.78	3.35	
		166.08	173.61	38.14	57.63	34.96	
2	Mechanical factors	Risk assessment	0	0.82	1	1	1
		Controlled risk	0	0.30	0.70	0.78	0.82
3	Chemical factors	Fumes and Vapors	0.43	0.43	0.43	0.43	0.43
		Chemical particle	0.60	0.60	0.60	0.60	0.60
4	Physical factors	Noise	0.74	0.74	0.74	0.74	0.74
		Thermal stress	0.77	0.77	0.77	0.77	0.77
		Light	0.83	1	1	1	1
		Radiations	0.94	0.94	0.94	0.94	0.94
5	Ergonomic factors	0.46	0.62	0.90	0.91	0.94	
6	Opening health file for workers	0.85	0.93	1	0.99	1	
7	PPE	0.21	0.43	0.78	0.64	0.71	
8	Education	60	154	288	264	420	
9	Instruction	0.27	0.73	1	1	1	
10	Legal requirements	0.33	0.60	0.80	0.80	0.80	
11	Commitment and leadership	Number of supervisors educated in HSE field	4	18	18	19	22
		Number of individuals in charge of HSE	1	2	2	2	2
		Number of meetings in HSE field	2	5	11	10	15

increase was significant ($p>0.05$) (Table II). Table III indicates ergonomic factors index.

Physical and chemical factors

Table III indicates that the implementation of OHSMS was not that effective in physical and chemical indicators. That is, among the six sub-indices, only two indices of physical and chemical factors about lighting improved in the work place and the improvement was not significant ($P>0.05$) (Table 2). There was no change in the rest of indices; for more information see Table III.

Other factors

The change trend of the rest of the indices is listed in Table III. The improvements of commitment and leadership indexes are quite notable.

DISCUSSION

Occupational accidents

The effects of implementation of an OHSMS on functional indices were studied. The indices of occupational accidents (AFR, ASR and FSI) demonstrated a significant and notable improvement after the implementation. These findings are consistent with Tremblay et al. (2018) who showed that OHSMS was effective in preventing occupational accidents (33). In addition, our findings are consistent with Coleman and Kerkering (34), Goldenhar et al. (35), Hamidi et al. (36), Omidvari et al. (37), Fernandez-Muniz et al. (38), and Feridoun Lal et al. (39).

Mechanical factors

Following the implementation of OHSMS, identification of the health and safety risks was improved and the number of controlled risks increased notably. In this area, our results are consistent with Gilberto Santos et al. who argued that the implementation of OHSMS improved risk identification and management performance (40). Probably, one of the main reasons for the decline in accident rate was the improvement in identifying and controlling the risks; as accidents are the outcomes of risks.

Ergonomic factors

Ergonomic factors showed an improvement in ergonomic condition after the implementation of OHSMS. The ratio of employees exposed to safe ergonomic factors was increased.

Physical and chemical factors

Implementation of OHSMS was not effective in improvement of physical and chemical indexes and there was no significant change in the sub-indices like fume, particles, noise, thermal stress, lighting, and radiation before and after the implementation of the OHSMS. One of the main reasons for this was the dependence of any improvement in these areas to the primary design and layout of the production line. That is, physical and chemical indexes were not taken into account in procuring and laying out the equipment and allocating space to the equipment and workers. Any change in the

primary layout causes heavy costs for the organization including the costs of procuring new equipment, turning off production line to make changes and install new equipment, losing clients because of the delay in production, and similar expenses. On the other hand, the mixture of legal requirements and the structures that promote implementation of OHSMSs by organization are essential but not enough. In fact, without the authorities' pressure to eliminate or attenuate occupational risks, implementation of OHSMS and obtaining licenses are no guarantee for attenuating occupational risks and improving health and safety at work (41).

Other factors

The implementation of OHSMS increased the number of hours of education, the number of directors and supervisors who received education about health and safety, and the number of health and safety meetings in presence of top managers. In this regard, our findings are consistent with Kewgyir-Afful et al. (2017) who showed that OHS systems was effective in increasing the educations received by personnel in health and safety field (42). Ghahramani et al. (2018) showed that the mere ISO certificate is not enough to ensure a good performance in OHS area. The personality of an organization plays a key role in implementation of the requirements of a management system; and these requirements are determinant factors in the effectiveness of the system (43).

Failure to include large industries is a limitation that should be taken into account. Further works can cover a larger sample group and larger factories as well.

CONCLUSION

The occupational accidents indices (AFR, ASR, and FSI) had a significant decrease after the implementation of OHSMS. In addition, there was a significant improvement in the indices of mechanical and ergonomic factors after the implementation. In addition, improvement in indices opening health file for personnel, use of PPE, instructions, and legal requirements was confirmed. There was a notable increase in the number of meetings about HSE and number of supervisors received education about HSE. However, there was no significant change after the implementation of OHSMS in terms of chemical factors indices (fume and particles) and physical factors (noise, thermal stress, and radiation). The implementation was effective in the indices that needed managerial control; still, improvements in technical and engineering sector that needed more spending were not notable.

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