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The Effect of Integrated Management System on Risk Priority Number of Environmental Assessment by FMEA Method in Yazd Persepolis Tile Factory

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ABSTRACT

Introduction: Considering the increasing trend of implementing integrated management system (IMS) in different industries to improve safety and health standards, environment and quality, this study aimed to evaluate the impact of IMS system on environmental indicators using FMEA method and risk priority number (RPN). Indicators were compared before and after the IMS implementation.

Methods: This is an interventional research that was carried out in a Persepolis tile factory during the years 2010-2011 (before the intervention) and the years 2012 to 2014 (when IMS system was implemented)**.** First, environmental pollution activities were identified, and then RPN was obtained using the product of the intensity, probability, and detection. Considering the acceptable level for the organization and the Pareto charts (80:20), unacceptable RPNs were identified and corrective actions were taken.

Results: The average RPN decreased from 2010 to 2014. Although activities has increased due to expansion of the production line, the results showed that in 2012 (the beginning of IMS implementation) and 2014, RPN was significantly decreased.

Conclusion: The results indicate that the implementation of the IMS has had a significant effect on the environmental assessment indicators by FMEA method and has improved environmental conditions.

Keywords: Integrated Management System, Risk Assessment, Environment, Risk Priority Number, Tile Industry

Introduction

Increasing industry growth and new working places has increased the importance of the environment and prevention of environmental accidents. The government expects factories to manage their environmental risks adequately and

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pay compensation for any damage caused by negligence in managing these risks; therefore, factories need to evaluate risk management processes. Industrial factories due to social responsibility should pay special attention to environmental standards and consider their environment and human resources as key stakeholders. Commitment to these professional standards leads to credibility and reflects factories responsibility (1, 2, 3, 4). To prevent environmental accidents, as industry and technology are growing, most organizations have recognized the role of the system in guiding and integrating activities and processes. Therefore, all management systems can use Quality Management Standard ISO 9000, Environmental Management Standard ISO 14000 and Occupational Safety and Health Management (OHSAS 18000) as an integrated management system (5). One of the key elements of integrated management system is the identification, assessment and control of the environmental aspect. By using a coherent environmental risk management, organizations can reduce environmental hazards and improve environmental indicators. Therefore, the current study was conducted in a tile factory aimed at identifying parts of the production line that produce more pollution, estimating the risk of contamination and controlling the pollution in order to maintain the health of personnel, equipment, capital and environment. The FMEA method, which is an organized and systematic risk assessment technique in identifying potential hazards, was used to manage and reduce the risk to the acceptable level (6-7). It was first used as a design method in the aerospace industry in the US army and over time, it evolved in terms of impact on the ultimate goal and safety of personnel and equipment (8-9). In this method, by considering severity, probability of occurrence and probability of detection and then weighting these factors the risk priority number (RPN) is calculated. For obvious aspects that are clearly high values of the RPN, a corrective action must be proposed (10). This research studies integrated management system (IMS) and performance indicators of this system at the mentioned factory. This study also investigates IMS impact on safety performance using the FMEA risk assessment method and the RPN over five consecutive years.

Materials and Methods

This is an interventional research that was carried out in a Persepolis tile factory in Yazd during the years 2010-2011 (before the intervention) and the years 2012 to 2014 (when IMS system was implemented**).** Initially, all activities of the tile company were evaluated and analyzed by the FMEA method, in the next step, a reassessment was made after corrective actions. Regarding the RPN before and after the intervention the effectiveness of corrective actions were evaluated.

FMEA Methodology

5.1) Identifying aspects: Initially, a list of all common activities in units was prepared then environmental aspects were identified. Results were recorded in the identification and classification table. Aspects were in normal, abnormal, and emergency modes.

5-2) scoring and recording aspects: The severity of injury was completed by the occupational health professionals and safety responsible.

By using the following formula, effects of the aspects were calculated:

RPN = Severity (A) × Probability of occurrence (B) × Detection (C)

Parameters were determined in Table 1. Acceptable level is calculated based on the Pareto chart (80% of the results arising from 20% of the causes).

5-3) Corrective actions: All obvious aspects were recorded and monitored in order to carry out control actions.

Table 1: FMEA Environmental Assessment Parameters

Parameters	Effects on the environment	Score
Severity (A)	Considerable and severe environmental effects/ Threats to the life and health of man and other living beings/ Wasting or high consumption of resources and energy	4
	Moderate environmental effects/ short term effects/ Wasting or moderately consumption of resources and energy	3
	Low environmental effects/ Causing minor disturbance/ Inconsiderable consumption of resources and energy	2
	Negligible environmental effects - no waste of resources and energy	1
Probability of occurrence (B)	**Probability of occurrence**	**Score**
	Definitely happens / Possibility: more than 90%	5
	It is likely to happen / Possibility :70% to 90%	4
	It is possible to happen / Possibility: 40% to 70%	3
	Rarely happens / Possibility: 10% to 40%	2
	It is unlikely to happen / Possibility: 1% to 10%	1
Detection (C)	**Recognition, detection and control activities**	**Score**
	Not detected and no action taken.	5
	Detected, but controls are not sufficient	4
	Detected, people were trained, but conditions are not under control.	3
	Detected, people were trained and conditions are moderately under control.	2
	Immediately detected and necessary reaction was carried out/ conditions are under control.	1
Level of aspect	**Risk criteria**	**Proposed actions**
	Unacceptable level (organization acceptable RPN ≤)	Corrective actions to reduce risk
	Acceptable level (organization acceptable RPN ≥**)**	Controlling activity

In the following cases, regardless of RPN, is c onsidered significant aspect.

- ✓ The aspects that are legally binding regardless of the RPN
- ✓ When the score in table A (injury severity) is the highest which is 4.
- ✓ When the score in table B (probability of occurrence) is the highest, which is 5.

Results

(Figure 1) shows the organization acceptable RPN over the years 2010 to 2014.

According to the figure, after the implementation of IMS in 2012, RPN has decreased.

Figure 2 shows the average RPN between 2010 and 2014.

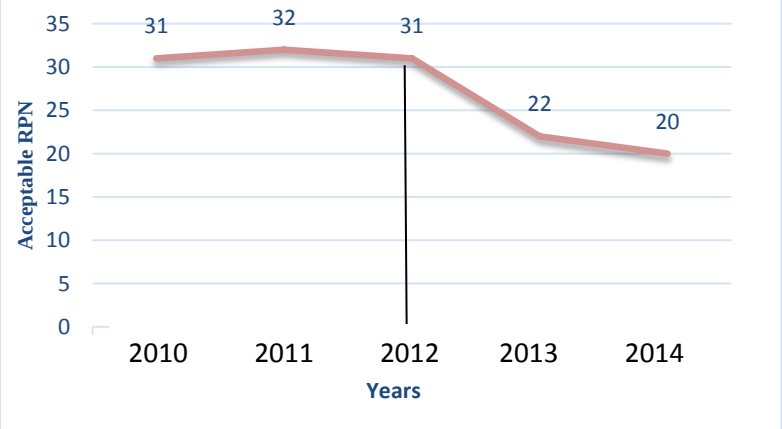

Figure 1: organization acceptable RPN over the years 2010 to 2014

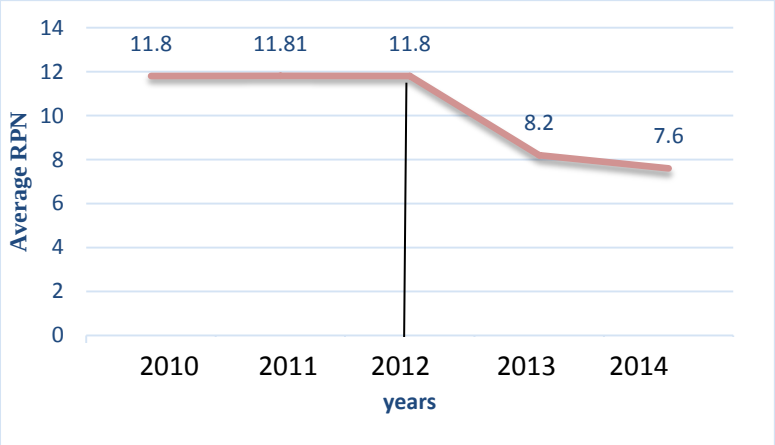

Figure 2: Average RPN between 2010 and 2014

According to the figure, after IMS implementation in 2012, RPN has been significantly decreased. (P value <0.05)

Discussion

The results showed that the establishment of an integrated management system had a positive effect on RPN and improved the assessment indicator. Risk management by providing appropriate and practical solutions can lead to environmental protection and corrective actions. Figure 1 shows the acceptable RPN has decreased. Organizations define their acceptable RPN depending on financial and economic resources, management decisions and Pareto charts (80:20). According figure 2; RPN due to the following Integrated Management System (IMS) has been significantly reduced.

- Installing air purification and control systems such as industrial cyclone, separators
- Iimplementing a waste recycling system and a waste management program
- Management of energy consumption such as insulation of cooling and heating pipes, the use of natural light throughout the day
- Implementing the unit's environmental management system and obtaining environmental certificates
- Developing green space
- Training managers and staff to enhance the level of environmental knowledge
- Reducing solid waste by recycling or selling them
- Construction, upgrading and maintenance of the industrial wastewater treatment system where refined water returns to the production line
- Construction, upgrading and maintenance of a human wastewater treatment system that uses refined water to irrigate the green space
- Control and preventing leakage of petroleum products
- Establishing an environmental office or the HSE unit
- Seasonal monitoring of environmental pollutants by a reliable environmental company
- Launching On Line Monitoring

In developed countries, organizations are trying to implement the IMS system to protect and enhance workplaces health and to prevent incidents and pollution. Goldenhar study in 2001 have indicated that integrated management systems in a long-lasting period (about 2-3 years) will be effective (12). Ziaeian et al. emphasized on deploying integrated management systems for sustainable development and continuous improvement (13). In Bastida, Curkovic and Chiarini's studies, the effects of environmental standards on physical factors have been proven (14, 15, 16). The findings of Chen et al., Vent Garrett et al, and Winder showed the effects of environmental standards on the control of chemical factors (18-17). Charyini in a study conducted in

Mexico, concluded that the establishment of standards would control physical and chemical factors (19). Zangha et al., in a study entitled "Environmental Management in Factories in China" concluded that establishment of the environmental management system makes it easy to enter the global market, standardizing environmental procedures, reducing waste and saving resources, and enhancing the company image (20). Lee in a study conducted in Malaysia, found similar results in improving environmental impacts, reducing waste, and creating a good image of the company (21). The evaluation of the aspect is an appropriate tool to measure the impact of integrated management systems. Identification and evaluation techniques mentioned in this article and the corrective actions are in accordance with integrated management system requirements that can be generalized to most ceramic tile factories.

Conclusion

The results indicate that the implementation of the integrated management system has a significant effect on the aspects assessment indicators by FMEA method and improve environmental factors. Furthermore, this system by improvement of environmental conditions, indirectly leads to the employee's satisfaction and neighboring factories.

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Conflict of interest

None declared.

Authors' contribution

Rohollah Fallah Madvari and Fereydoon Laal conceived of the presented idea. Rohollah Fallah Madvari, Alireza Fallah Madvari and Kamran Najafi developed the theory and performed the computations. Sarsangi Vali, Fereydoon Laal and Yosef Mohammadian verified the analytical methods.

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