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Original Research

An Investigation of Safety Management Elements in Small and Non-Small-Scale Engineering Industries

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Abstract

Identification and analysis of human suffering and economic loss due to accidents plays an imperative role in preventing accidents by removing or controlling the hazards in industries. Despite improving accident prevention and providing safe and healthy work environments, workplace safety still needs improvement. Workplace safety means freedom from incidents that result in injury, damage, or loss of life. Accident prevention not only relies on formulating safe mechanisms, but also on skill and attitude development, knowledge enhancement, and morale of industrial workers. Many industries in the public sector, private sector, and even small-scale industries take steps to ensure worker safety. To make safety management elements more effective in engineering industries, an exhaustive and complete safety program is to be designed to better prevent industrial accidents. This paper attempts to design safety management systems for randomly selected industries in order to understand the level of prevalence of safety management elements in industries so as to ensure workplace safety.

Keywords: accidents, hazards, occupational health, risk, safety

Introduction

The industrial revolution and consequent industrialization lead to a great extent of hazards and risks to industrial workers. Industrialization has brought in several problems, viz. industrial accidents, occupational diseases, and environmental degradation. With rapid advances in industrial processes, new chemicals were used in production processes and they created newer types of dangers such as large-scale leakage of toxic and flammable chemicals. Mechanical, electrical, chemical, biological, and radiation hazards overwhelm us on all sides.

Every year millions of industrial accidents occur, causing immense suffering to the accident victim and their families, and enormous loss to the organization and ultimately to the nation. Industries are adopting new and innovative processes and approaches in view of technologies and the need to use new materials. This naturally brings in sophisticated equipment that works at high speed; intricate and revolving machines full of hazards. For example, the handling and manufacturing of hazardous chemicals have brought to focus safety, health, and welfare of the people. In the course of industrial production, an undesirable aspect in the industrial unit is accidents. The suffering caused to the victims of the accidents, the strain (both functional and psychological) to which the victims' family is subjected, and the loss in production time add to the cost of accidents. When victims die in accidents, the industry can become short of skilled, trained, and experienced employees.

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Table 1. Analysis of safety management elements in small scale industries.

Safety Management Elements	Good		Satisfactory		Poor	
	Numbers	Percentage (%)	Numbers	Percentage (%)	Numbers	Percentage (%)
Health and Safety Policy	44	22	106	53	50	25
Safety Department	40	20	52	26	108	54
Safety Committee	42	21	32	16	126	63
Safety Budget	28	14	42	21	130	65
Accident Reporting, Investigation and Analysis	28	14	66	33	106	53
Safety Inspection	10	5	34	17	156	78
Safety Training	22	11	36	18	142	71
Periodic Training/Retraining	12	6	50	25	138	69
Safety Communication/Motivation/Promotion	36	18	48	24	116	58
First Aid	14	7	16	8	170	85
Occupational Health Centre	8	4	48	24	144	72
House Keeping	58	29	104	52	38	19
Safe Operating Procedures	42	21	46	23	112	56
Waste Disposal System	14	7	56	28	130	65
Emergency Preparedness	34	17	42	21	124	62

It is important to adopt safety measures to prevent, mitigate, or control such hazards. Measures taken by way of safety management lead to the prevention of accidents and thus the losses involved [1]. Therefore, safety programs are implemented to reduce the risk for workers by removing hazards wherever possible, and where it is not by encouraging workers to use safe practices. Safety problems can result from any of several combinations of causes, which vary from one industry to another [2]. Various case studies and research indicate that every organization in which safety measures are in place shows good development in profit as well as in manpower. The main aim of this paper is to determine the level of safety measures prevailing in engineering industries and to identify the deficiencies in safety management elements in engineering industries. The paper correlates the safety management elements among randomly selected small-scale and non small-scale industries and as a consequence suggests various strategies to enhance safety measures in engineering industries.

Background of Accidents and Risks in Engineering Industries

Accidents occur frequently in engineering industries that are characterized by different operational conditions in the workplace and, consequently, different risk types [3]. Engineering industries are socially technical complex systems of dynamic nature, whose properties depend not only on their components, but also on the inter-relations among them [4]. Current accidents seem almost always the result of a combination of organizational issues, lack of competency, and technical failures of equipment.

The Bhopal tragedy was a defining moment in the history of the chemical industry. On December 3, 1984, a runaway reaction within a methyl isocyanate storage tank at the Union Carbide India Limited pesticide plant released a toxic gas cloud that killed thousands and injured hundreds of thousands [5]. In 2004, a gas explosion in Daping coal mine in Henan province, China, killed 56 people and left dozens more missing and 148 trapped. In the same year, ICL Plastics, plc's Stockline Plastics plant in Glasgow, Scotland, exploded, killing nine and injuring more than 40.

In 2001, a September 21 explosion took place at Azote de France (AZF) agricultural chemicals factory near Toulouse causing 31 deaths and some 650 people to be hospitalized. In 1976, the “Seveso” disaster, an explosion at ICMESA chemical plant on the outskirts of Meda, a small town about 20 km north of Milan, Italy, released a toxic cloud containing TCDD dioxin. In 1968, an explosion and fire killed 78 men at the Consol No. 9 mines in Farmington, West Virginia. In 1996, a toy factory accident in Thailand killed 188 women and injured more than 400.

A number of hazardous releases have resulted in fires, explosions, toxic and high-energy events when intentional or unintentional chemical reactions have occurred. Methodologies used to assess these risks tend to be engineering-based and include, for example, hazard identification and event rate estimation techniques.

Table 2. Analysis of safety management elements in non-small-scale industries.

Safety Management Elements	Good		Satisfactory		Poor	
	Numbers	Percentage (%)	Numbers	Percentage (%)	Numbers	Percentage (%)
Health and Safety Policy	74	37	84	42	42	21
Safety Department	62	31	108	54	30	15
Safety Committee	54	27	86	43	60	30
Safety Budget	44	22	128	64	28	14
Accident Reporting, Investigation and Analysis	22	11	66	33	112	56
Safety Inspection	70	35	64	32	66	33
Safety Training	38	19	142	71	20	10
Periodic Training/Retraining	36	18	138	69	26	13
Safety Communication/Motivation/Promotion	48	24	116	58	36	18
First Aid	52	26	146	73	2	1
Occupational Health Centre	26	13	152	76	22	11
House Keeping	42	21	118	59	40	20
Safe Operating Procedures	70	35	80	40	50	25
Waste Disposal System	36	18	130	65	34	17
Emergency Preparedness	28	14	124	62	48	24

Safety Management

Safety management activities and processes are the result of increasing scrutiny through the development of approaches for safety management and safety culture assessment [6]. Implementing a safety management system is the most efficient way of allocating resources for safety as it improves working conditions and also positively influences safety attitude and behavior of the employees, consequently improving the safety climate [7]. Increased understanding of various organizational phenomena is mandatory for systematic safety management [8]. At the same time, an understanding of typical human performance biases gives better insight into human behavior in complex socio-technical systems [9].

As per the 1948 Factories Act, every factory with a minimum of 1,000 employees must have a separate safety department. Where the number of employees is less than 1,000, it is generally observed that safety issues are handled by the human resources department. Generally, safety is inbuilt into the machines and equipment both at the time of manufacture and installation. Protective devices are operational in some industries. Maintenance and repair work may also be adequate. However, employees – even when provided with safety devices – do not always use them because of perceived inconveniences.

Executives and senior managers give less importance to safety in the industry. Safety is only attempted to meet legal requirements. Industries view safety as a corollary for accidents and presume that accident prevention and the non-occurrence of accidents is the only measure of safety. Safety education and training are given to employees occasionally. Safety slogans, posters, and pamphlets are distributed among the employees. Effective safety education programs are necessary as specific accident causes cannot be determined, and such programs are the only means of creating awareness about safety measures among the workers. Hence, safety education in industries must be given more importance. Industrial accidents are not truly accidental incidents; they have causes that are ascertainable and controllable. Since a considerable proportion of industrial accidents are attributed to human error, it is only natural to expect that human factors and personality profiles would have a marked influence on the frequency of industrial accidents. In such a situation the need for consideration of ways and means for reducing accidents through safety management systems and safety education are required.

Safety management is a very important element within an effective manufacturing organization. One of the most important components of safety management is to maintain the safety of work systems in the workplace. Safety of work systems is a function of many factors that affect the system, and these factors affect the safety of work systems simultaneously. For this reason, measuring work system safety needs a holistic approach. Dağdeviren studied the work safety issue through the analytic hierarchy process approach, which allows both multi-criteria and simultaneous evaluation [10].

Assessing health and safety management systems has two innovative characteristics that bring together the three main auditing approaches to health and safety: the structur-

al approach, the operational approach, and the performance approach [11]. It emphasizes the resilience engineering perspective on health and safety, which takes into consideration the four major principles of flexibility, learning, awareness, and top-management commitment. A new approach to reliability, availability, maintainability, and safety engineering and management as outlined by [12] covers all phases of the new product development process and is aimed at producers of complex products like safety instrument systems. Lai presented a comparative study of human resource practices adopted for safety management on construction projects in the United States and Singapore and investigated the relationship between human resource practices and construction safety management [13]. Mcintyre explored the feasibility and desirability of developing a high-level, generic safety risk assessment standard with a horizontally applied capability across multiple industries [14]. The presentations stressed the need to define clearly the purpose of risk assessment, so as to tailor the depth and breadth precisely to this. It also stressed the importance of basing risk assessment on clear functional models of aviation. Bellamy described preparatory groundwork for the development of a practical holistic model to help key stack holders understand how human factors, safety management systems, and wider organizational issues fit together [15]. The process was to break down the three areas into simpler components and to use these smaller components as building blocks in an integrated reconstruction. To guide the reconstruction for a major hazard context, the taxonomy was used to analyze a small sample of major chemical accidents. The results were used to look for logical patterns of association that could form a basis from which to develop further guiding principles of integration. Saurin emphasized improvement and interpretation of five safety management practices, namely process transparency, safety planning, proactive performance measurement, accident investigations, and identification and monitoring of pressures and performance migrations based on the three principles of flexibility, learning, and awareness [16].

Methodology

Every research study begins with certain basic assumptions. A hypothesis is always tested. The hypotheses of the present study are that engineering industries would not have adequate safety measures and small-scale engineering industries have poor safety management systems compared to non-small-scale engineering industries. A research tool consisting of 15 major safety management elements and with each major element consisting of five sub elements was designed. In order to secure accurate information, the research tool should be clear, easy to understand, and should keep the respondents interest and motivated. Bless and Higson Smith pointed out that the main aim of the research tool is to obtain information from every member in the sample [17]. The research tool used for the purpose of this research was constructed to meet the criteria [18].

The research tool was divided into two sections:

Section 1 Required respondents to provide data related to individuals and organizations.

Section 2 Based on safety management systems to determine if respondents were in good, satisfactory, or poor agreement with each statement.

Field studies were conducted and the data were randomly collected from 200 engineering industries. Safety management elements covered under the research tool are: health and safety policy, safety department, safety committee, safety budget, accident reporting investigation and analysis, safety inspection, safety training, periodic training/retraining, safety communication/motivation/promotion, first aid, occupational health centre, housekeeping, safe operating procedures, waste disposal system, and emergency preparedness.

Data Analysis and Presentation

Data analysis is the process of arranging the raw data into meaningful information. In the present study the relevant data obtained from the administered research tool have been analyzed. The collected data on safety management elements from 200 engineering industries were used for descriptive analysis.

The 15 safety management elements taken into consideration were compared between small-scale and non-small-scale industries and the results are summarized below.

The level of health and safety policy of small-scale and non-small-scale industries are shown in Fig. 1. It shows that health and safety policy was found to be good in non-small-scale industries when compared to small-scale industries. Fig. 2 shows the condition of the safety department among small-scale and non-small-scale industries. From Fig. 2, it is indicated that the safety department, one of the safety management elements taken in to consideration, was found to be good among non-small-scale industries when compared to small-scale industries.

Fig. 3 shows the efficiency of a safety committee among small-scale and non-small-scale industries. The safety committee management element was found to be good among non-small-scale industries when compared to small-scale. The levels of safety budget of small-scale and non-small-

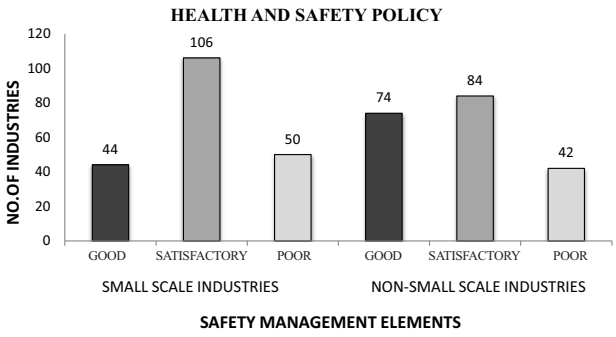

Fig. 1. Health and safety policy among small-scale and non-small-scale industries.

scale industries are shown in Fig. 4. The safety budgets of non-small-scale industries were found to be good when compared to small-scale industries.

The conditions of accident reporting, investigation, and analysis of small-scale and non-small-scale industries are shown in Fig. 5. From Fig. 5, it is seen that accident reporting, investigation, and analysis of small-scale industries were found to be good when compared to non-small-scale. Fig. 6 shows the efficiency of safety inspection among small- and non-small-scale industries. Safety inspection – one of the safety management elements conducted by the non-small-scale industries taken into consideration – was found to be good when compared to small-scale industries.

The implementation of safety training among small- and non-small-scale are shown in Fig. 7. Safety training

Fig. 2. Health and safety departments among small-scale and non-small-scale industries.

Fig. 3. Safety committees among small-scale and non-small-scale industries.

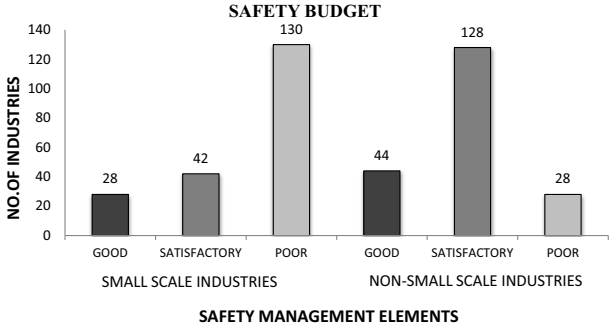

Fig. 4. Safety budgets among small-scale and non-small-scale industries.

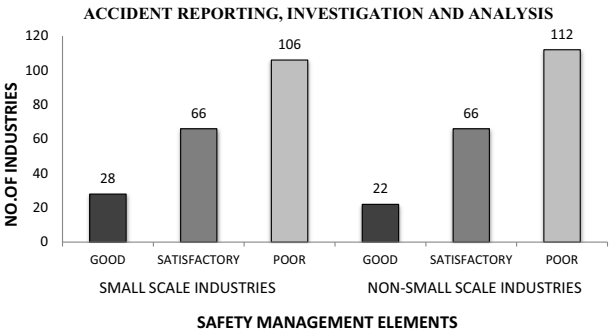

Fig. 5. Accident reporting, investigation and analysis among small-scale and non-small-scale industries.

Fig. 6. Safety inspection among small-scale and non-small-scale industries.

Fig. 7. Safety training among small-scale and non-small-scale industries.

provided by the non-small-scale industries was found to be good when compared to small-scale. Fig. 8 shows the efficiency of periodic training/retraining among small-scale and non-small-scale industries. Among safety management elements, periodic training/retraining given to the workers of non-small-scale were found to be good when compared to small-scale.

The condition of safety communication, motivation/promotion among small scale and non-small-scale industries are shown in Fig. 9. Safety communication, motivation/promotion in non-small scale were found to be good when compared to small-scale. Fig. 10 compares first aid facilities. The first aid provided to non-small-scale labourers were found to be good when compared to their small-scale counterparts.

The existence and condition of small- and non-small scale occupational health centres are shown in Fig. 11. Non-small-scale centres were found to be good when compared to small-scale. Fig. 12 compares the efficiencies of housekeeping, which was good when compared to small-scale industries.

Fig. 13 compares safe operating procedures, which were found to be good when compared to small-scale industries. The existence and condition of waste disposal systems are shown in Fig. 14, which were found to be good when compared to small-scale industries.

Fig. 15 shows emergency preparedness, which were found to be good when compared to small-scale industries.

The results of the present investigation revealed that the non-small-scale industries have sufficient safety management elements. From the analysis, it was inferred that the small-scale industries do not have satisfactory safety management elements. The non-small scale industries were equipped with adequate safety management elements. Furthermore, it was inferred that the small-scale industries were equipped with poor safety management elements.

The study revealed the condition of safety management elements in non-small scale and small-scale industries. On the whole, the non-small scale industries have sufficient safety management elements. However, through the study, some poorly managed safety elements were also identified in non-small-scale industries. This helps in improving the weaker areas of safety management. On considering the small-scale industries, the results indicated that they do not have satisfactory safety management elements. Knowing the existing level of safety for various management elements will be helpful in suitably upgrading the safety management elements up to the required standard.

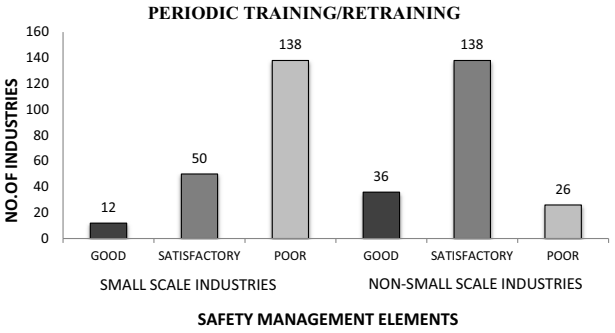

Fig. 8. Periodic training/retraining among small-scale and non-small-scale industries.

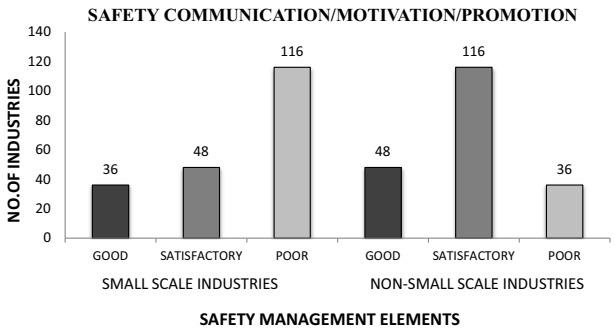

Fig. 9. Safety communication and motivation/promotion among small-scale and non-small-scale industries.

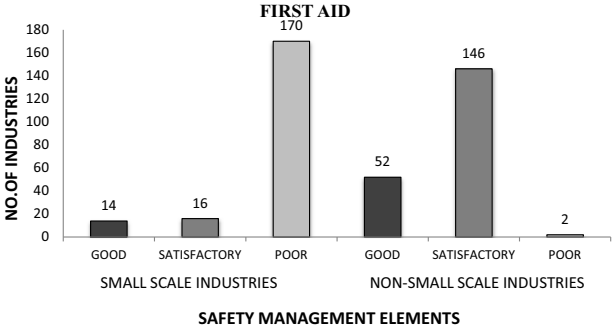

Fig. 10. First aid among small-scale and non-small-scale industries.

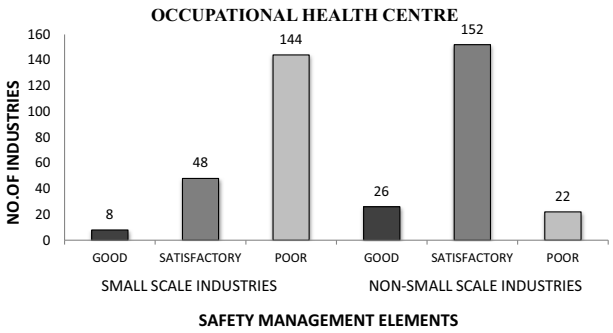

Fig. 11. Occupational health centres among small-scale and non-small-scale industries.

Fig. 12. Housekeeping among small-scale and non-small-scale industries.

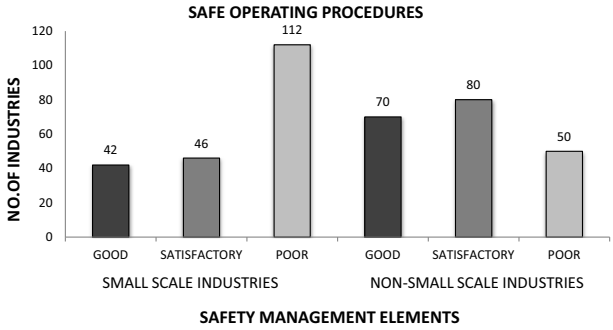

Fig. 13. Safe operating procedures among small-scale and non-small-scale industries.

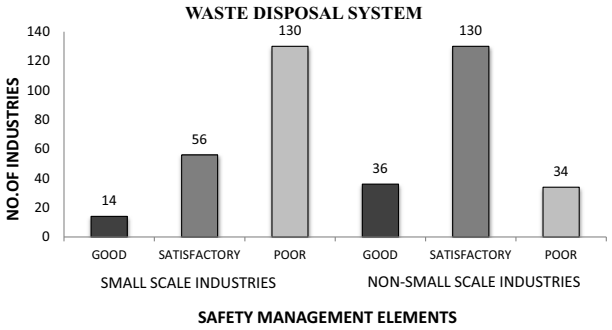

Fig. 14. Waste disposal system among small-scale and non-small-scale industries.

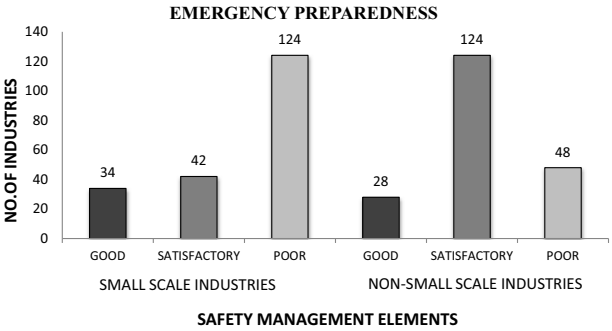

Fig. 15. Emergency preparedness among small-scale and non-small-scale industries.

Conclusions

The safety management system of any engineering industry is very important for its effective functioning. These management systems are essential because of the increased risk in industries coupled with public awareness and cost toward compensation against damages. It becomes imperative for Indian industries regardless size to adopt safety management system elements as a measure toward social commitment, legal compliance, and meeting supplier and end-user requirements. Industrial accidents are not truly accidental incidents; they have causes that are ascertainable and controllable. Since a considerable proportion of industrial accidents are attributed to human error, it is only natural to expect that human factors and personality profiles would have a marked influence on the frequency of industrial accidents.

In such a situation the need for consideration of ways and means for reducing accident safety management systems and safety education are required in engineering industries. This study provides a detailed report on the existing condition of various safety management elements in non-small-scale and small-scale industries, which can aid in successfully enhancing safety management elements.

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