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

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Abstract

Identification and analysis of human agony and economic loss owing to accidents plays an imperative role in preventing accidents by eliminating or controlling the hazards in industries. Despite improving accident avoidance and providing safe and healthy work environments, workplace safety still desires improvement. Workplace safety implies freedom from incidents that ends with injury, damage, or loss of life. Accident prevention not only depends on formulating safe mechanisms, but also on skill and attitude development, knowledge enhancement, and morale of industrial workers. Several industries in the public sector, private sector, and even small-scale industries take initiatives to ensure worker safety. To enhance safety in engineering industries, an exhaustive and full safety program is to be designed to avoid industrial accidents. This paper aims to design safety technical systems for arbitrarily selected industries in order to recognize the level of prevalence of safety in industries so as to make workplace safe.

Keywords: Accidents, Hazards, Occupational Health, Risk, Safety

INTRODUCTION

The industrial revolution and subsequent industrialization lead to a huge extent of hazards and threats to industrial workers. Industrialization has put in several problems, viz. industrial accidents, occupational diseases, and environmental deprivation. With rapid advances in industrial processes, new chemicals were applied in production processes and they developed newer types of dangers such as large-scale leakage of toxic and flammable chemicals. Mechanical, chemical, biological, electrical and radiation risks overwhelm us on all angles. Every year millions of industrial accidents happen, causing immense suffering to the accident sufferer and their families, and massive loss to the organization and finally 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 adds to the cost of accidents. When victims die in accidents, the industry can become short of skilled, trained, and experienced employees.

Safety in industries defines the protection of labours from the risks of industrial accidents. Safety is freedom from the occurrence of hazards, loss or injury (Akpan 2011). Accident can be said as an unpredicted event that occurs suddenly which may lead to human injuries, permanent death or hazard, loss of development time, disease (Burns 2006). Most of the accidents happen due to unsafe circumstances at working place and also human factor is the major cause in several situations (Adebiyi et al 2007). Several categories of accidents were identified among labours in different kinds of industries. Still, small scale industries are met with more number of accidents very commonly (Ezenwa 2001) since the items which are involved in performing the works involve improper transfer and physical works (Adeyemi et al 2016). Small scale industry can be considered as a manufacturing industry or service industry working with production kind of operations (Ayozie 2013).

It is important to adopt safety measures to prevent, mitigate, or control such hazards. Measures taken by way of safety technical lead to the prevention of accidents and thus the losses involved (Gunasekera et al. 2008). 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 (Badri et al 2012). 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 technical elements in engineering industries. The paper correlates the safety technical 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 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 (Marono et al 2006). 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 (Joseph et al 2007). 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.

SAFETY TECHNICAL ELEMENTS

Safety technical activities and processes are the result of increasing scrutiny through the development of approaches for safety technical and safety culture assessment (Kennedy & Kirwan 1998). Implementing a safety technical 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 (Beatriz et al 2007). Increased understanding of various organizational phenomena is mandatory for systematic safety management (Reiman & Rollenhagen 2011)|. At the same time, an understanding of typical human performance biases gives better insight into human behavior in complex socio-technical systems (Schonbeck et al 2010)|.

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 in-built 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 technical systems and safety education are required.

Safety technical is a very important element within an effective manufacturing organization. One of the most important components of safety technical 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. Dagdeviren studied the work safety issue through the analytic hierarchy process approach, which allows both multi-criteria and simultaneous evaluation (Dagdeviren &Yuksel 2008).

Assessing health and safety technical systems has two innovative characteristics that bring together the three main auditing approaches to health and safety: the structural approach, the operational approach, and the performance approach (Costella et al 2009|). 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 (Lundteigen et al 2009)| 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 technical on construction projects in the United States and Singapore and investigated the relationship between human resource practices and construction safety technical (Lai et al 2011). Mcintyre explored the feasibility and desirability of developing a high-level, generic safety risk assessment standard with a horizontally applied capability across multiple industries (Mcintyre 2002). 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 under-stand how human factors, safety technical systems, and wider organizational issues fit together (Bellamy et al 2008). 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 technical 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 (Saurin et al 2008).

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 technical systems compared to non-small-scale engineering industries. A research tool consisting of 15 major safety technical 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 (Bless & Higson 2004). The research tool used for the purpose of this research was constructed to meet the criteria (Salkind 2000).

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 technical 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 technical elements from 200 engineering industries were used for descriptive analysis. The 15 safety technical elements taken into consideration were compared between small-scale and non-small-scale industries and the results are summarized below.

The study revealed the condition of safety technical elements in non-small scale and small-scale industries. Figure 1 shows the condition of the fifteen safety technical elements in non-small scale and small-scale industries. On the whole, the non-small scale industries have sufficient safety technical 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 technical elements. On considering the small-scale industries, the results indicated that they do not have satisfactory safety technical elements. Knowing the existing level of safety for various technical elements will be helpful in suitably upgrading the safety technical elements up to the required standard.

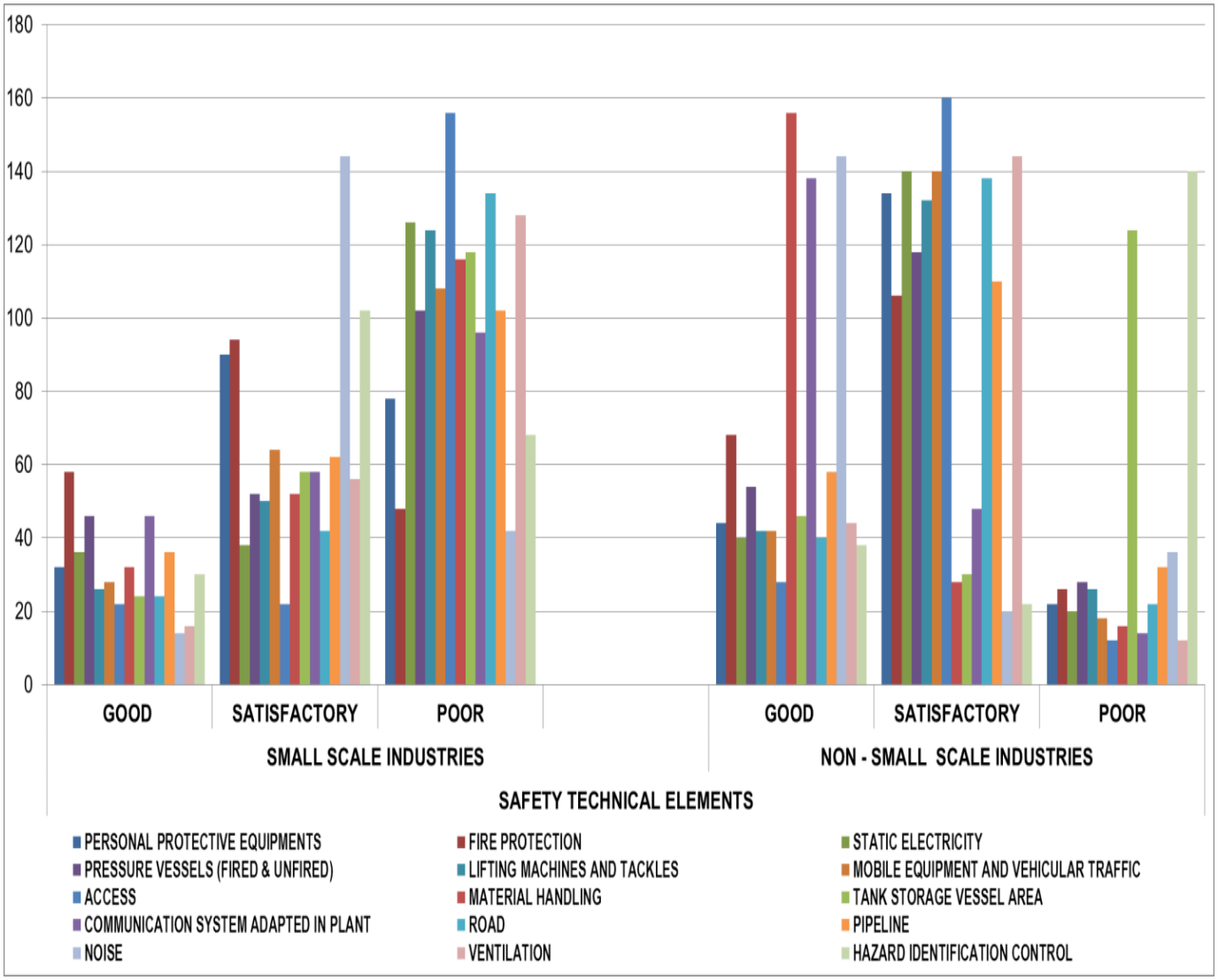

Figure 1. Safety Technical Elements in Small Scale and Non Small Scale Industries

Figure 2 shows the number of industries in terms of effective usage of Personal Protective Equipments. It was inferred that among small scale industries, 32 industries possessed good usage, 90 industries satisfactory usage and 78 industries possessed poor usage of Personal Protective Equipments. Among non-small scale industries, only 22 industries possessed poor usage whereas a total of 178 industries possessed good and satisfactory usage of Personal Protective Equipments. The effectiveness of Fire Protection measures taken in small Scale Industries and Non-Small Scale Industries are shown in Figure 3. It was inferred from Fire Protection element that among small scale industries, 58 industries had good, 94 industries had satisfactory and 48 industries had fire protection measures. It can also be seen that 68 industries had good, 106 industries had satisfactory and 26 industries had poor fire protection measures among Non-Small Scale Industries.

Figure 4 revealed that, among selected small scale industries, 36 industries possessed good, 38 industries possessed satisfactory and 126 industries possessed poor control over Static Electricity among small scale industries. In the case of Non-Small scale industries, 40 industries showed good, 140 industries showed satisfactory and 20 industries showed poor control over Static Electricity.

Figure 5 shows that among selected small scale industries, 46 industries exhibited good, 52 industries exhibited satisfactory and 102 industries exhibited poor safety in handling of Pressure Vessels (Fired & Unfired). 54 industries with good, 118 industries with satisfactory and 28 industries with poor safety conditions were noticed among non small scale industries in handling of Pressure Vessels (Fired & Unfired).

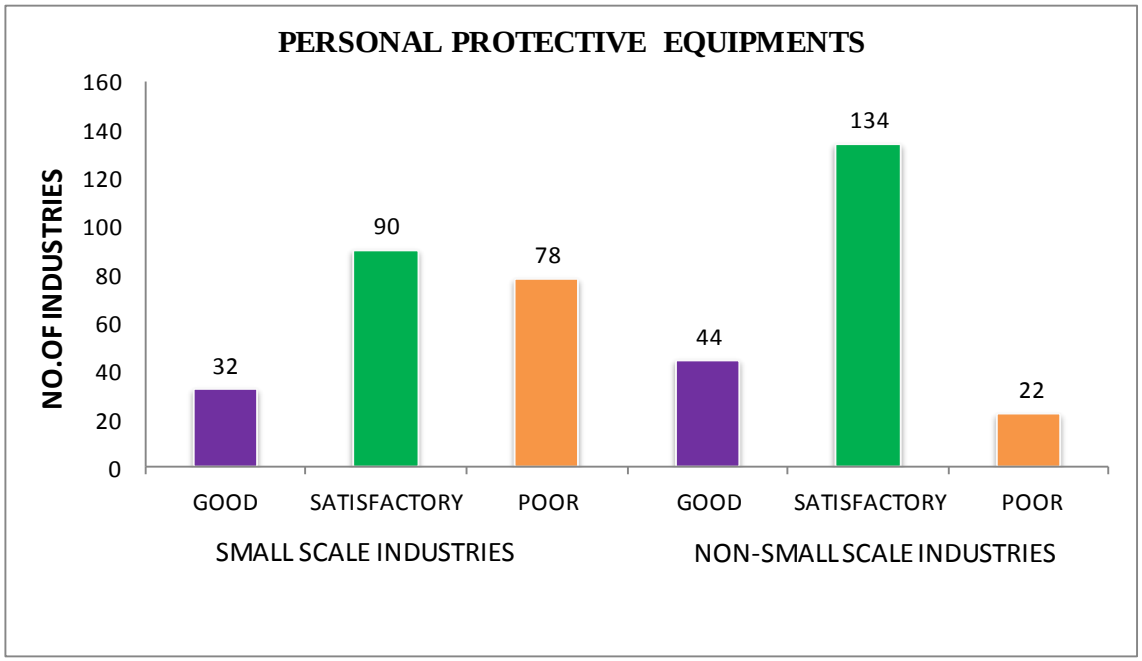

Figure 2. Usage of Personal Protective Equipments

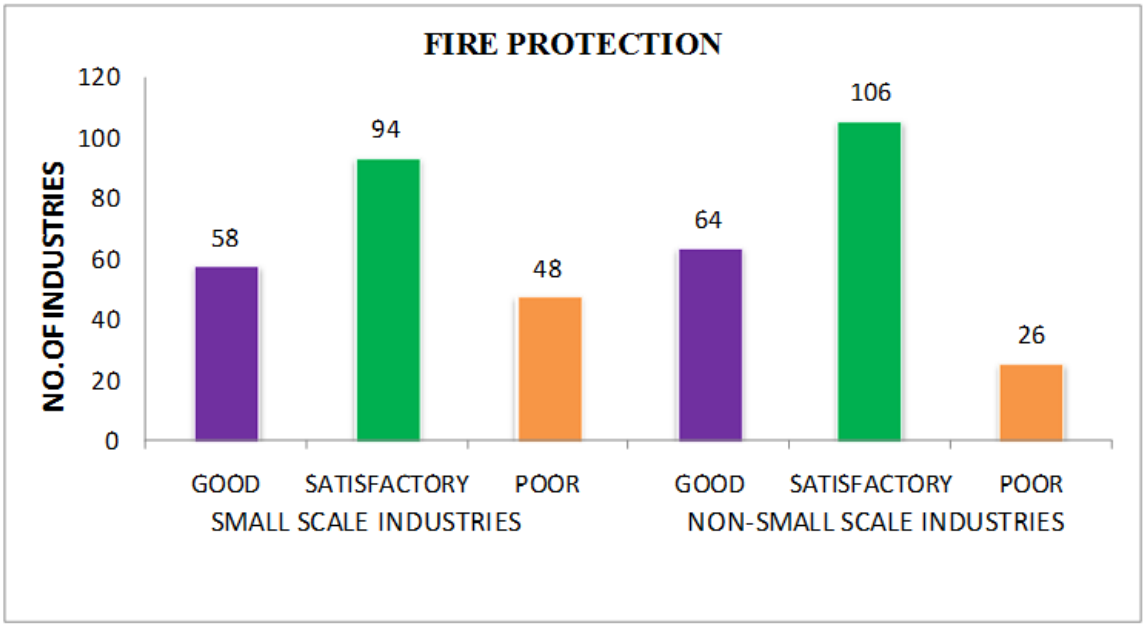

Figure 3. Fire Protection among Small Scale and Non Small Scale Industries

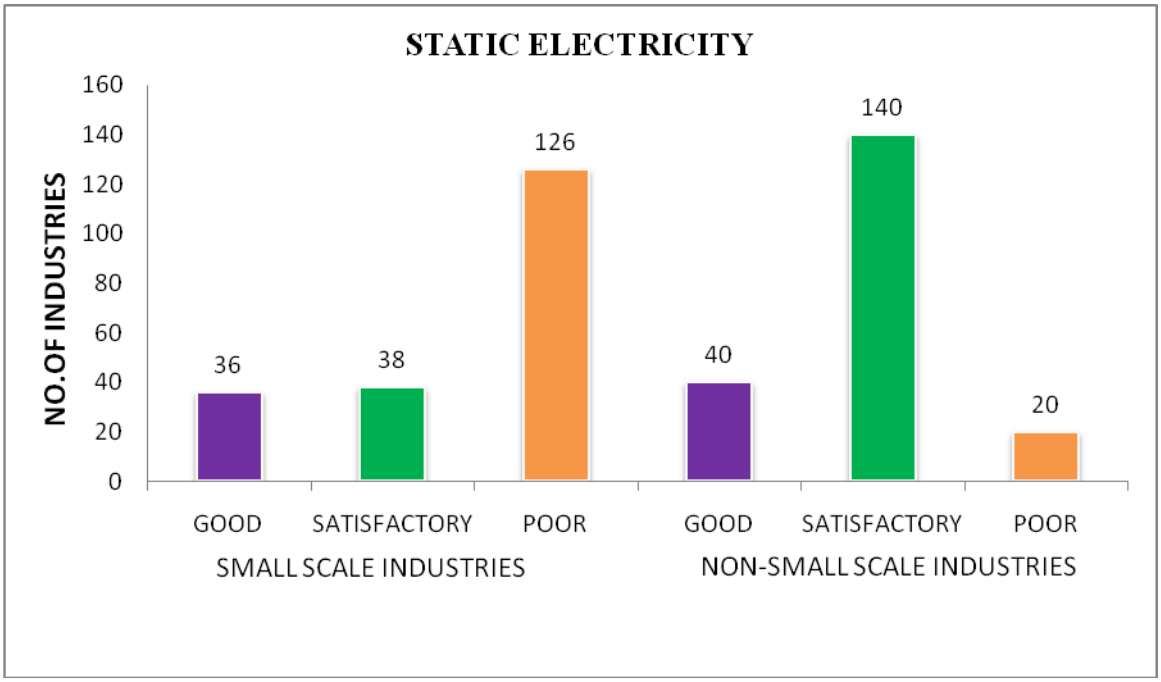

Figure 4. Control of Static Electricity among Small Scale and Non Small Scale Industries

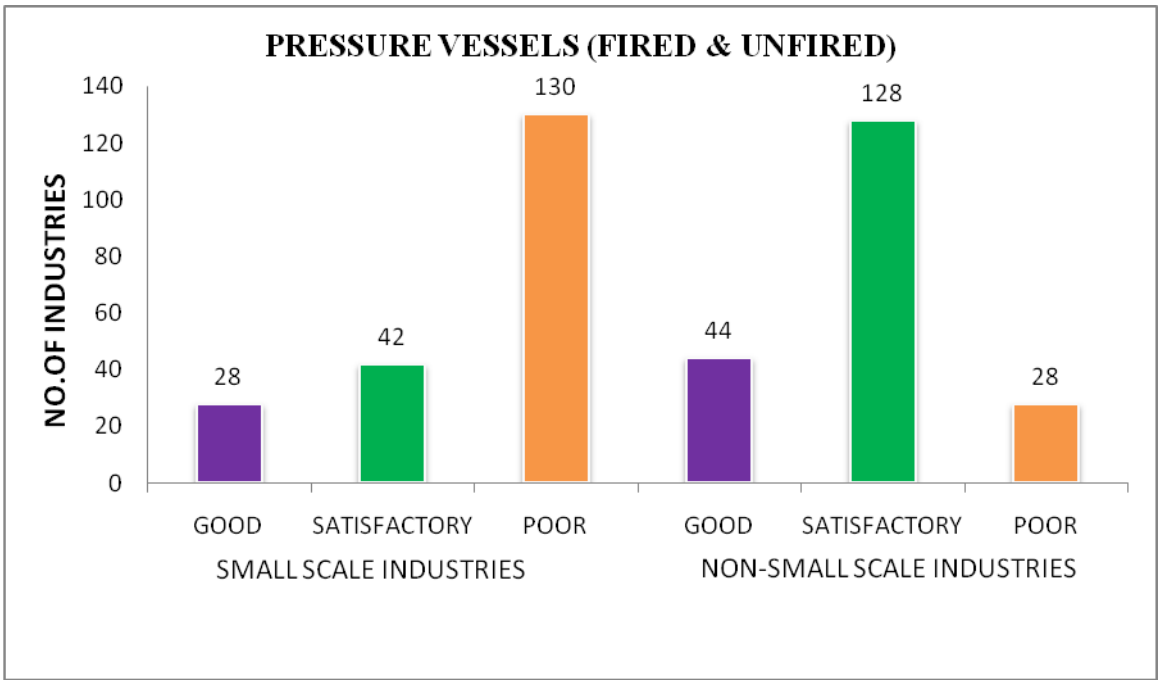

Figure 5. Safety of Pressure Vessels (Fired & Unfired) in Small Scale and Non Small Scale Industries

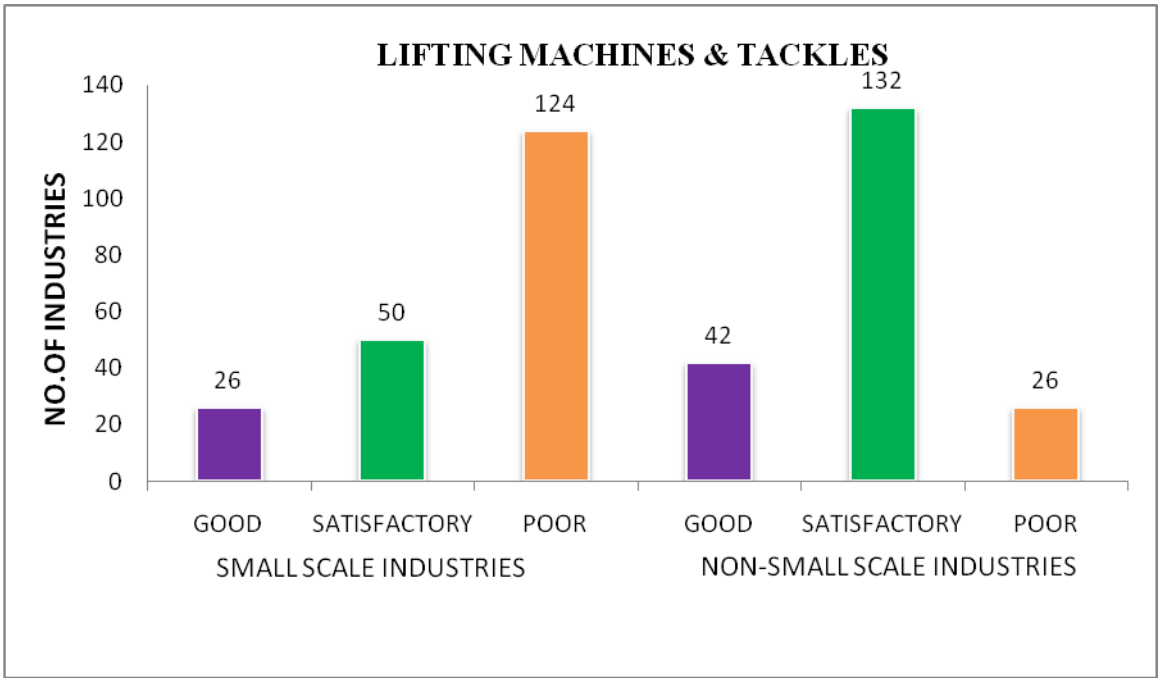

Figure 6. Lifting Machines and Tackles in Small Scale and Non Small Scale Industries

Figure 6 illustrates how safely Lifting Machines and Tackles are handled in small Scale Industries and non small scale industries. It was inferred that Lifting Machines and Tackles were handled with good safety in 26 industries, satisfactory safety in 50 industries and not safely handled in 124 industries among small scale industries. Among Non-Small Scale Industries, 42 industries followed good safety measures, 132 industries followed satisfactory measures and 26 industries did not possess required safety measures in handling lifting machines and tackles.

According to figure 7, among small Scale Industries, usage of Mobile Equipment and Vehicular Traffic showed good safety in 28 industries, satisfactorily safe in 64 industries and not safe in 108 industries. It was also inferred that when safety of Mobile Equipment and Vehicular Traffic is considered among non small scale industries, 42 industries possess good response, 140 possess satisfactory response and 18 industries poor response.

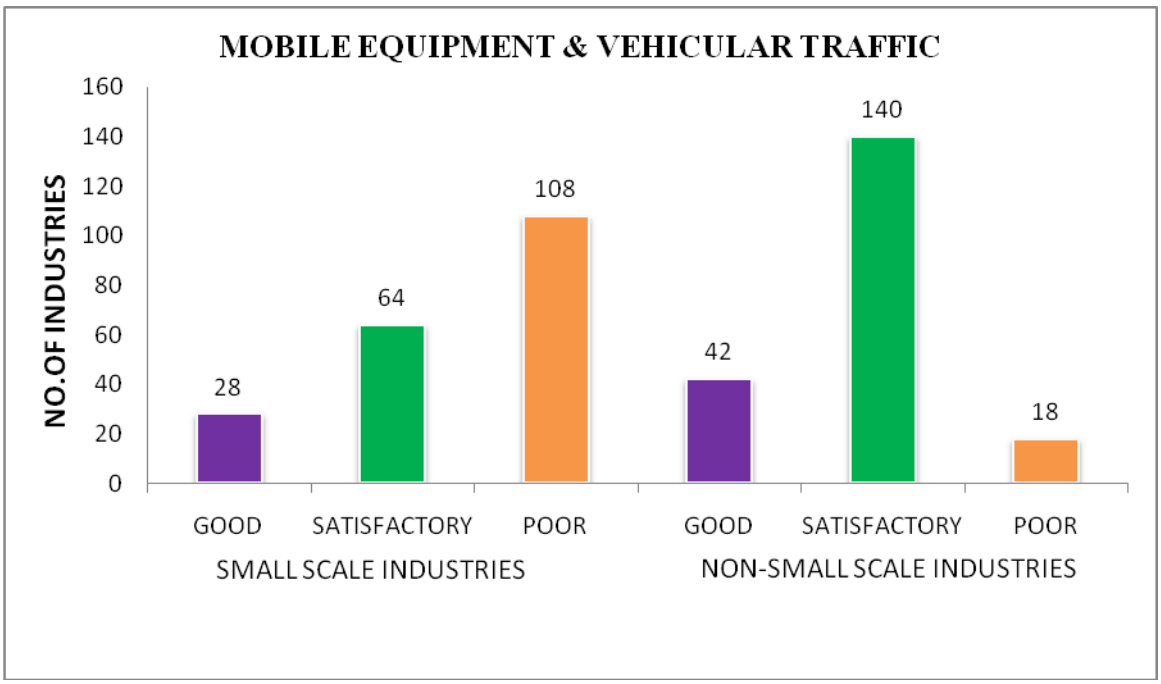

Figure 7. Mobile Equipment and Vehicular Traffic in Small Scale and Non Small Scale Industries

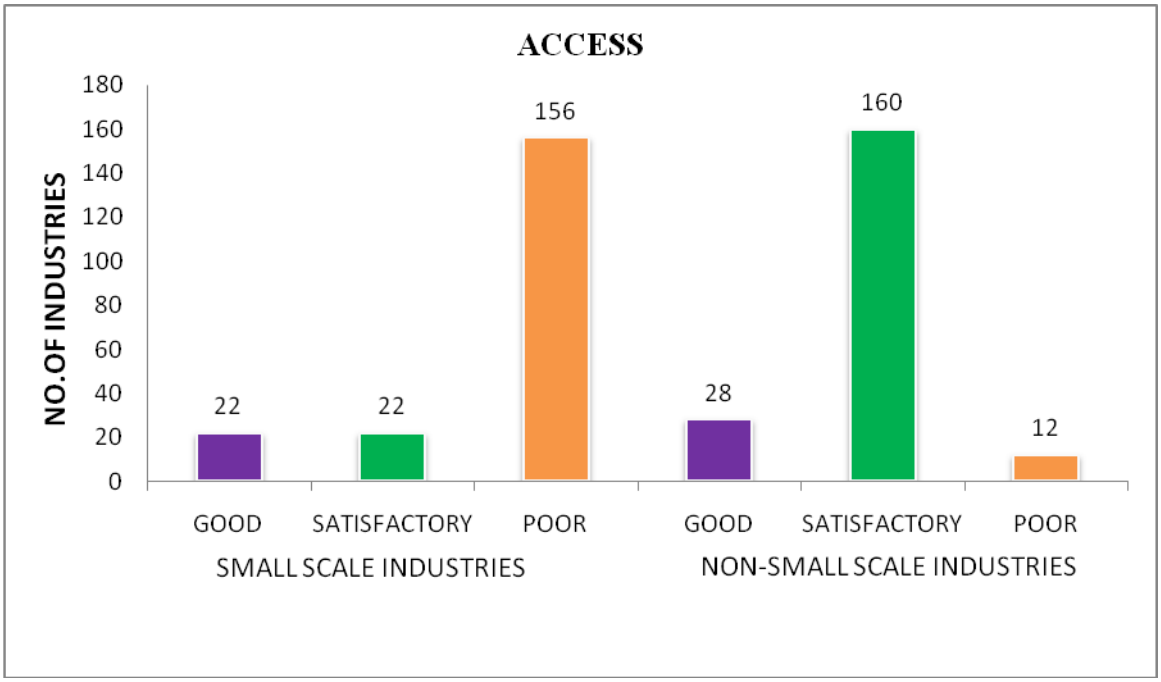

Figure 8. Access in Small Scale and Non Small Scale Industries

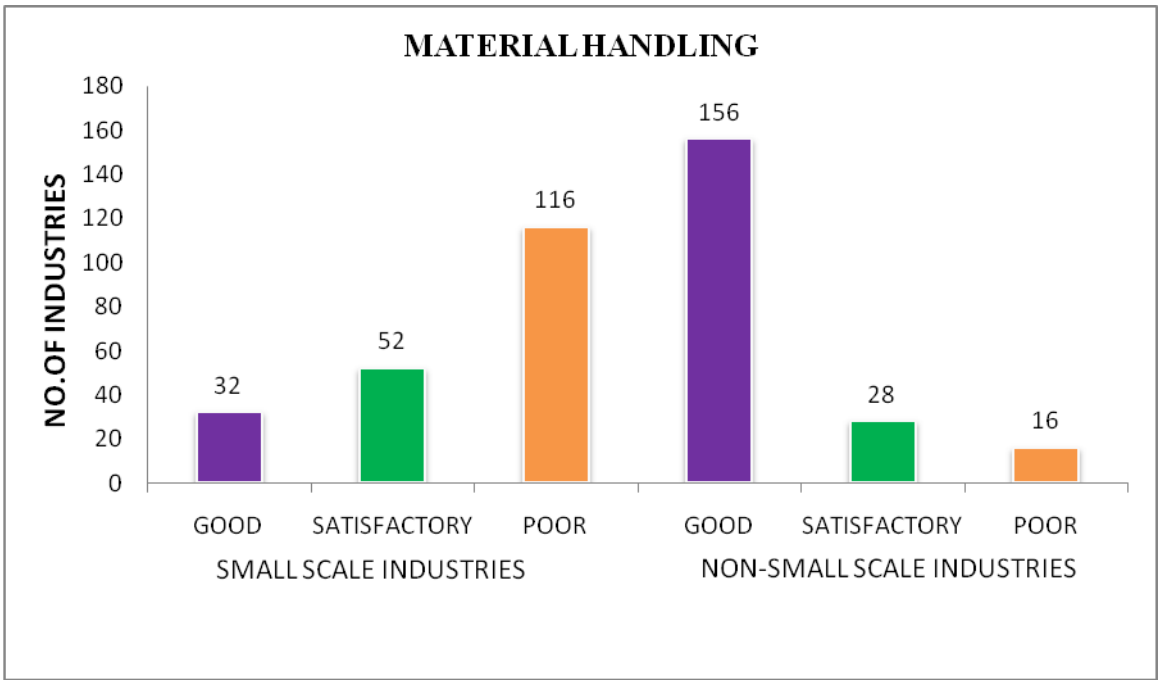

Figure 9. Material Handling in Small Scale and Non Small Scale Industries

According to figure 8 among selected small scale industries 22 industries had sufficient good access to all workplaces, 22 industries had satisfactory access and 156 industries had no proper access to workplaces which made the workplace unsafe for the workers. Among selected Non-Small scale industries 28 industries were seen with good access, 160 industries with satisfactory access and 12 industries with poor access to the workplace.

Figure 9 illustrates that among selected small scale industries, 32 are good, 52 are satisfactory and 116 are poor in handling materials safely. Among Non-Small scale industries, 156 are good, 28 are satisfactory and 16 possess poor response in material handling. Figure 10 shows that among selected small Scale Industries, 24 industries are good, 58 industries are satisfactory and 118 industries are poor in maintaining safety in tank storage vessel area. Among Non-Small Scale Industries, 46 industries are good, 30 industries are satisfactory and 124

are poor in tank storage vessel area safety. Figure 11 displays safety among selected small scale and Non-Small scale industries. Among small scale industries, 46 industries are good, 58 industries are satisfactory and 96 industries are poor in communication system safety. In the case of selected Non-Small scale industries, 138 industries are good, 48 industries are satisfactory and 14 industries are poor in Communication System safety adapted in Plant. The findings from figure 12 depict that among small Scale Industries, 24 industries are good, 42 industries are satisfactory and 134 industries are poor in road safety aspects like employing licensed vehicles, loading and unloading procedures, parking tankers or trucks in specified parking area, employing trained drivers in handling emergencies. Among non small scale industries, 40 industries are good, 138 industries are satisfactory and 22 industries are poor in the above mentioned road safety aspects.

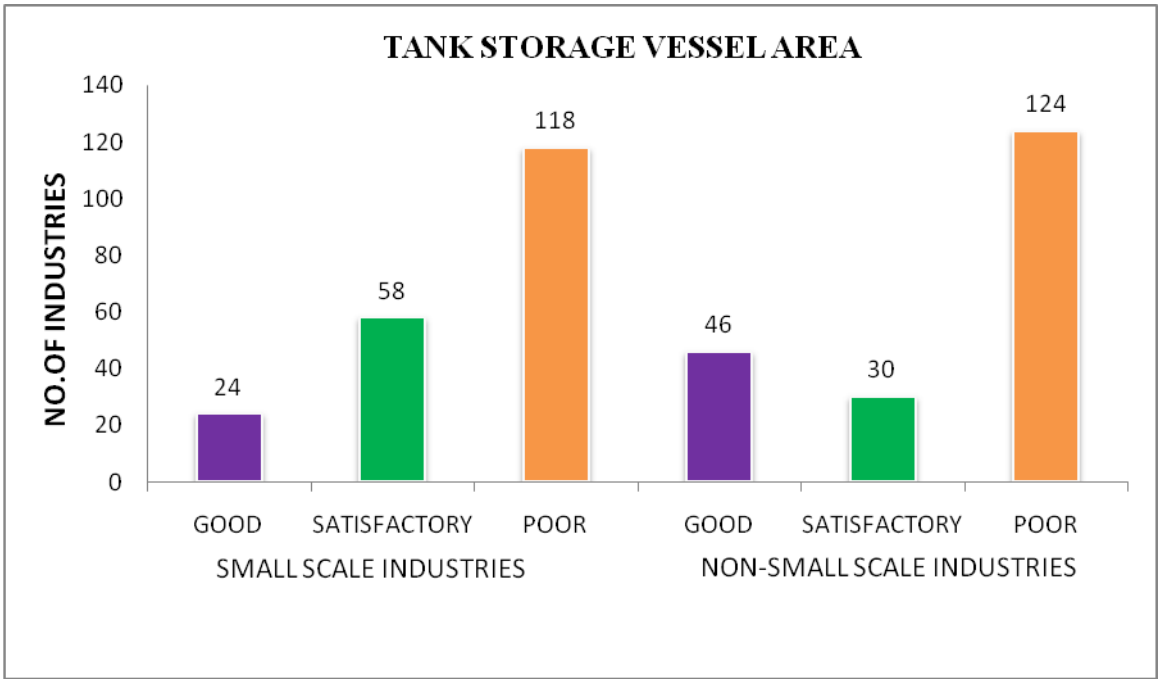

Figure 10. Safety of Tank Storage Vessel Area in Small Scale and Non Small Scale Industries

Figure 13 reveals that among selected small scale industries 36 industries are good, 62 industries are satisfactory and 102 industries are poor in Pipeline safety Elements such as corrosion prevention measures, using booster pumps, suitable pipe material for chemicals, provision of leak detectors, automatic shut off valves, etc. Among selected Non-Small scale industries, 58 industries are good, 110 industries are satisfactory and 32 industries are poor in Pipeline Safety Elements. The results shown in figure 14 indicated that Noise control among small Scale Industries was found to be good in 14 industries, satisfactory in 144 industries and poor in 42 industries. Among Non-Small Scale Industries, 144 industries are good, 20 are satisfactory and 36 industries are poor in controlling noise pollution.

Figure 15 depicts that among small scale industries, 16 industries are good, 56 are satisfactory and 128 industries are poor in provision of ventilation facilities whereas among Non-Small Scale Industries, 44 industries are good, 144 are satisfactory and 12 industries are poor in ventilation facilities. The result presented in figure 16 shows the among selected small scale industries 30 industries are good, 102 industries are satisfactory and 68 industries are poor in Hazard Identification Control. Among selected Non-Small scale industries, 38 industries are good, 22 industries are satisfactory and 140 industries are poor in Hazard Identification Control.

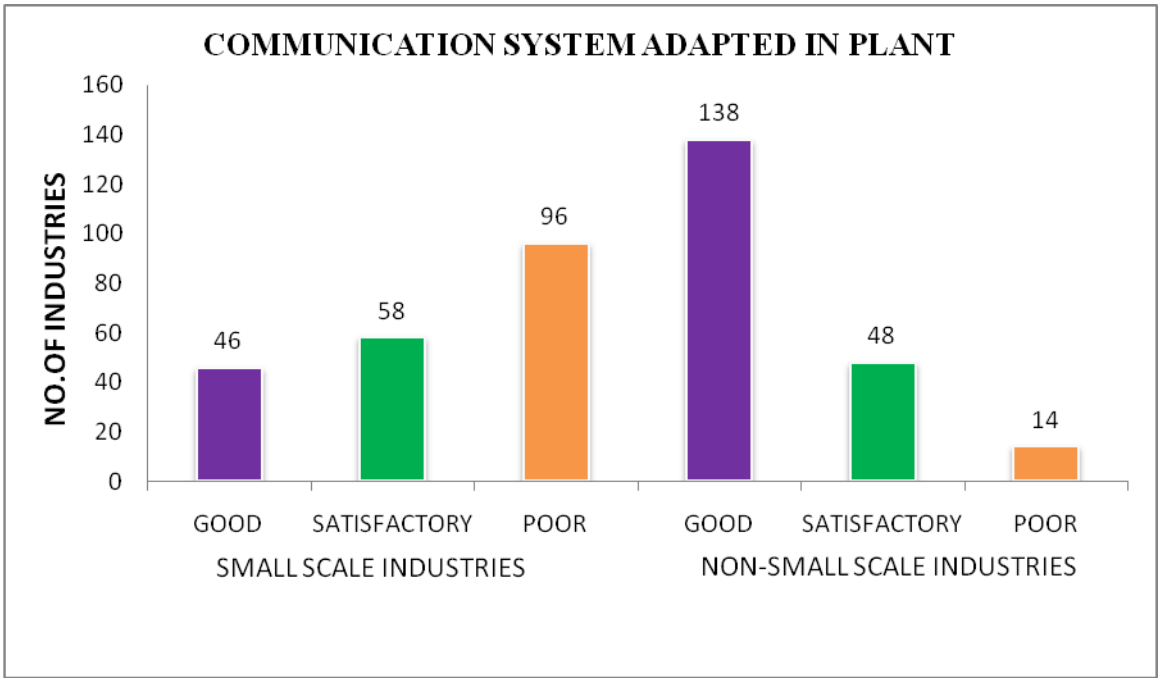

Figure 11. Communication System adapted in Small Scale and Non Small Scale Industries

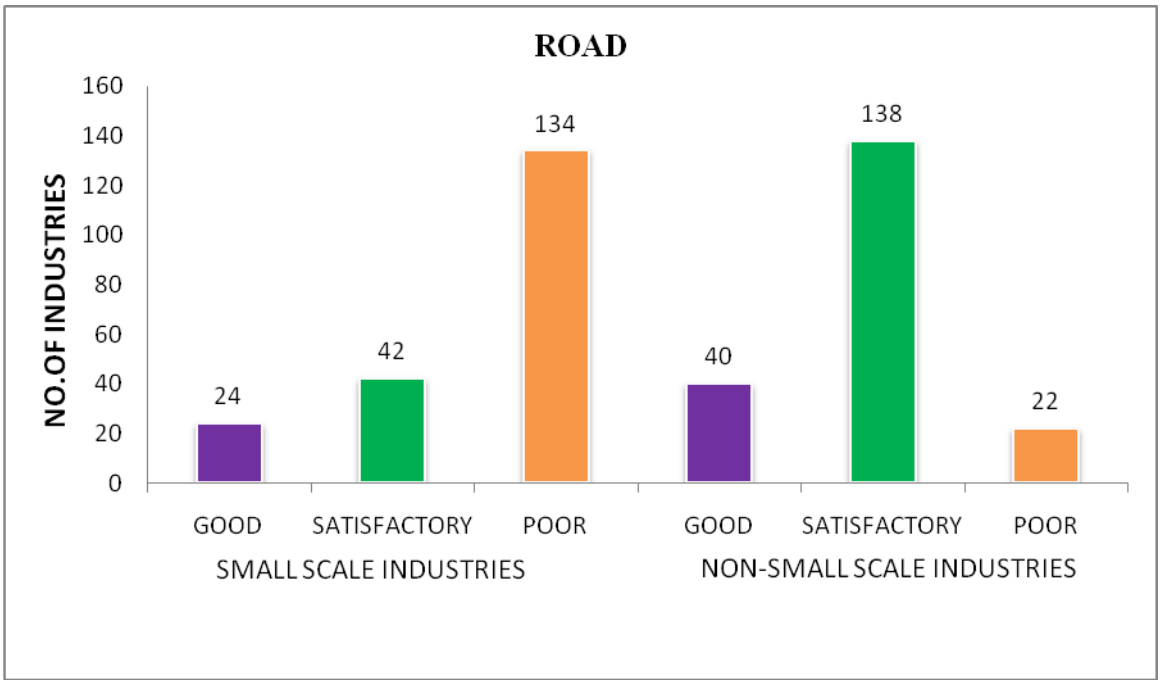

Figure 12. Safe transportation of Goods on Road in Small Scale and Non Small Scale Industries

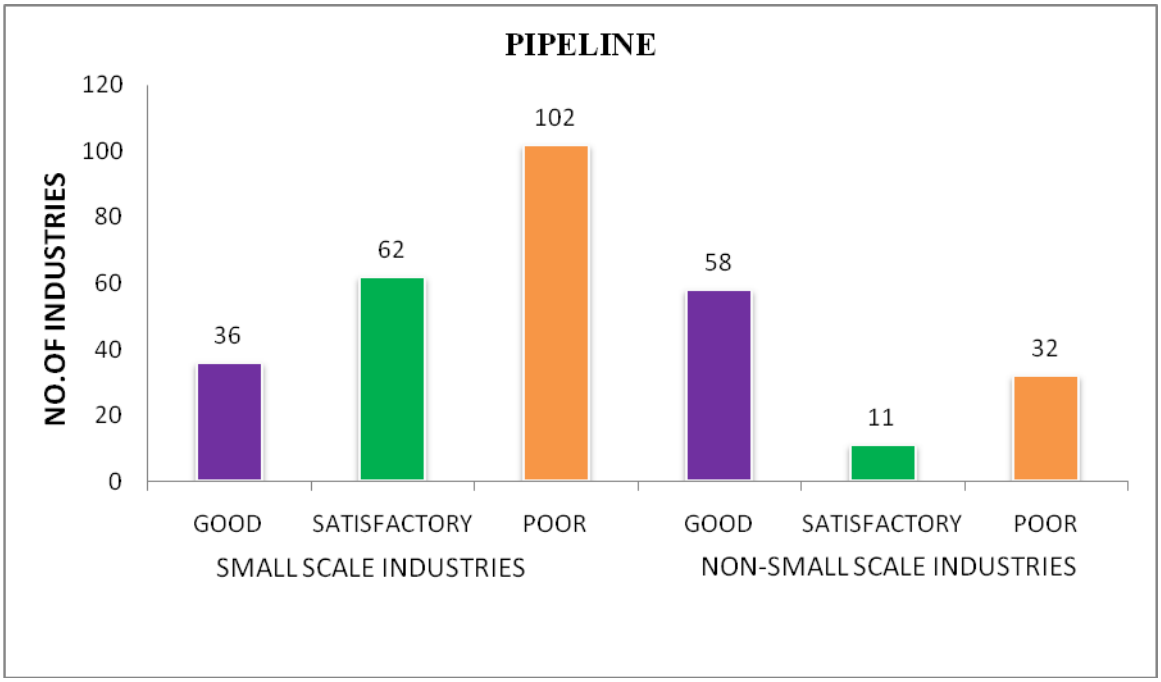

Figure 13. Pipeline Safety in Small Scale and Non Small Scale Industries

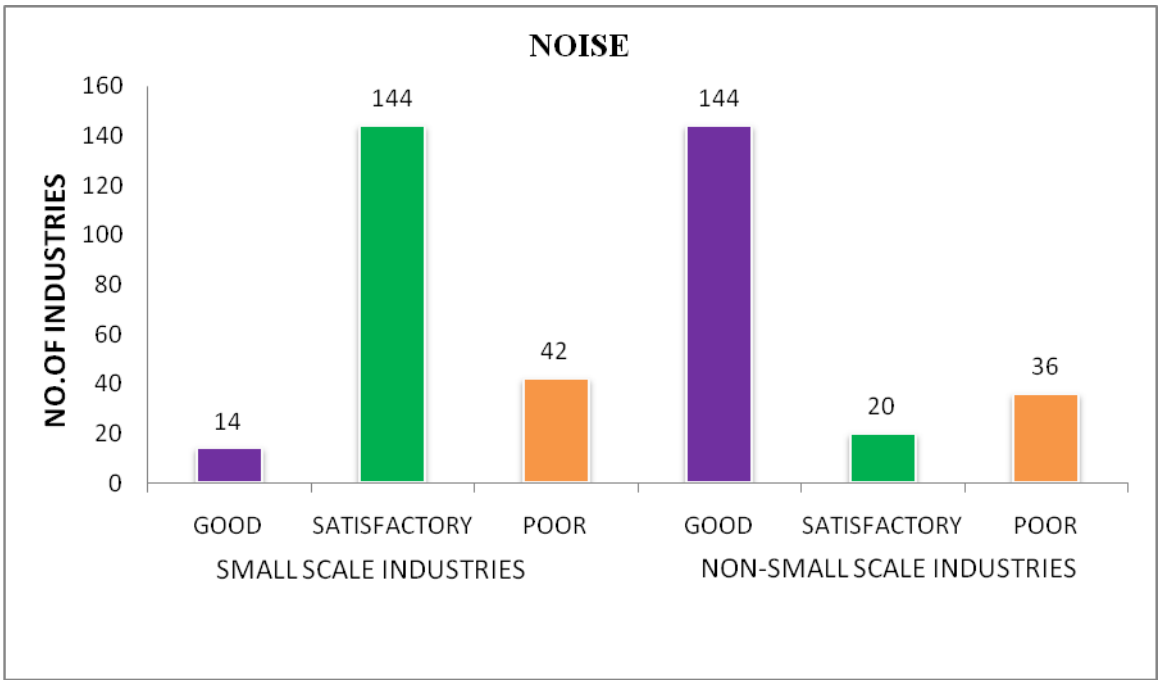

Figure 14. Noise Control in Small Scale and Non Small Scale Industries

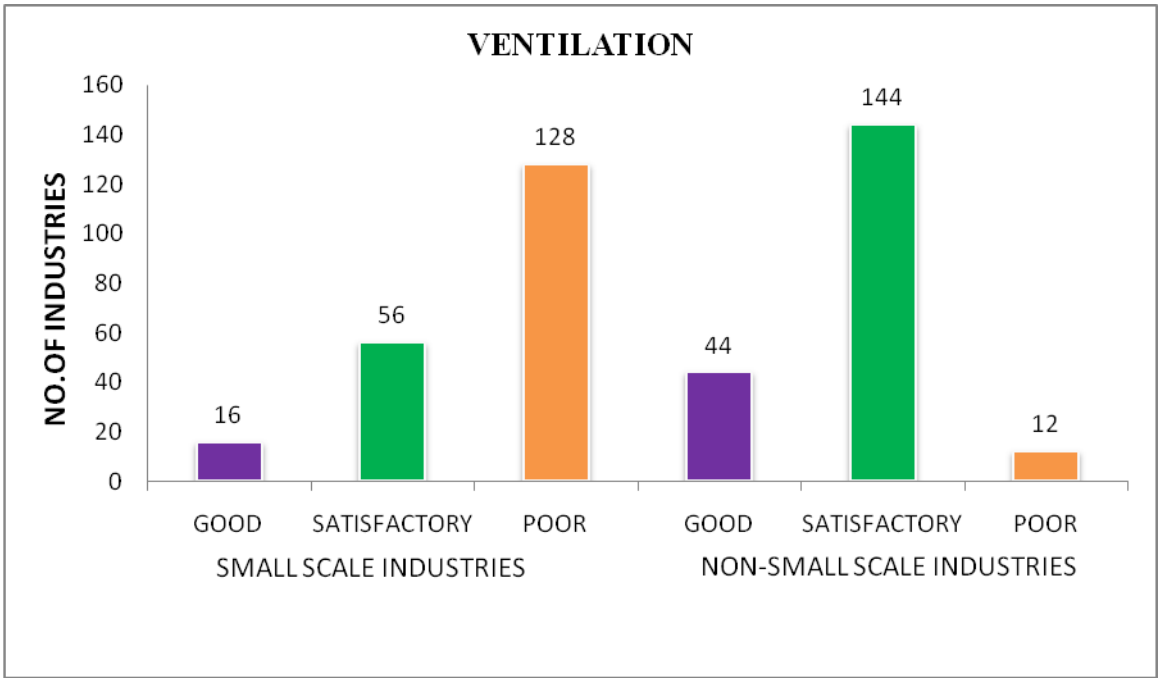

Figure 15. Ventilation facilities in Small Scale and Non Small Scale Industries

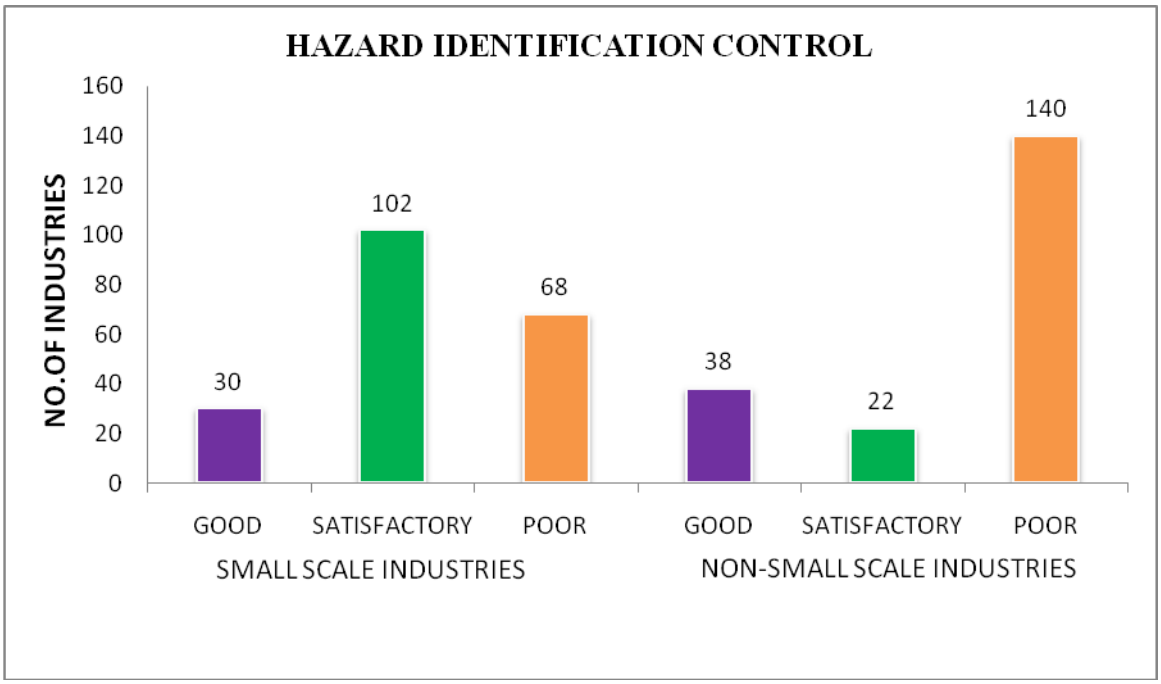

Figure 16. Hazard Identification Control in Small Scale and Non Small Scale Industries

DISCUSSION

- The purpose of this study is to analyse the safety technical elements among small scale and non small scale engineering industries.
- The fifteen safety technical elements taken in to consideration were compared between small scale and Non small scale industries and the results are summarized below.
- The effective usage of Personal Protective Equipment among Non small scale industries were found to be good when compared to small scale industries.
- The safety Technical element, Fire Protection facilities of Non small scale industries were found to be good when compared to small scale industries.

- Static Electricity, one of the safety Technical element of Non small scale industries were found to be good when compared to small scale industries.
- The condition of Pressure Vessels of Non small scale industries were found to be good when compared to small scale industries.
- The handling of Lifting Machines and Tackles among Non small scale industries were found to be good when compared to small scale industries
- The safety Technical element, Mobile Equipment and Vehicular Traffic was found to be good in Non small scale industries when compared to small scale industries.
- Access to all workplaces, a safety Technical element of Non small scale industries was found to be good when compared to small scale industries.
- Material Handling of Non small scale industries were found to be good when compared to small scale industries.
- Safety of Tank Storage Vessel Area of Non small scale industries were found to be good when compared to small scale industries.
- Communication System Adapted in Plants of Non small scale industries were found to be good when compared to small scale industries.
- The safety Technical element, Road, its utilization was found to be good in Non small scale industries when compared to small scale industries.
- The maintenance and usage of Pipeline, one of the safety Technical elements was found to be good in Non small scale industries when compared to small scale industries.
- Noise, its control measures in Non small scale industries were found to be good when compared to small scale industries.
- Provision of Ventilation for ensuring safe workplace of Non small scale industries were found to be good when compared to small scale industries.
- Hazard Identification and Control was found to be good among Non small scale industries when compared to small scale industries.
- The results of the present investigation revealed that the Non small scale industries have sufficient safety Technical elements.
- From the analysis, it was inferred that the small scale industries do not have satisfactory safety Technical elements.
- The Non small scale industries were equipped with adequate safety Technical elements.
- Further it was inferred that the small scale industries were equipped with poor safety Technical elements.

CONCLUSION

The safety technical system and security management system are the two cornerstones of industries for their effective functioning. These systems are essential because of the increased risk in industries coupled with public awareness and cost towards compensation against damages. It becomes imperative on Indian industries irrespective of the size to adopt safety and security system elements as a measure towards social commitment, legal compliance and meeting supplier and end user requirements. Hence the safety technical elements should be adopted in all kinds of industries in a complete manner by providing all the required inputs such as finance, man power, infra structure, soft and hard skill, expertise and experience. Industrial safety is important in all types of industries which safeguards life at the same time economy of the nation.

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