

**STUDY OF INFLUENCE OF SAFETY ENGINEERING  
AND MANAGEMENT PRACTICES IN SELECTED  
INDUSTRIES IN KERALA**

*A Thesis*

*Submitted by*

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*for the award of the degree*

*of*

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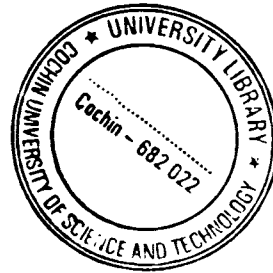
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## CERTIFICATE

Certified that this thesis entitled “**STUDY OF INFLUENCE OF SAFETY ENGINEERING AND MANAGEMENT PRACTICES IN SELECTED INDUSTRIES IN KERALA**”, submitted to the Cochin University of Science and Technology, Kochi for the award of Ph.D. Degree under the Faculty of Engineering, is the record of bonafide research carried out by **Mr. Vinodkumar M.N.** under my supervision and guidance at School of Engineering, CUSAT. This work did not form part of any dissertation submitted for the award of any degree, diploma, associateship, fellowship or other similar title or recognition from this or any other institution.

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## ABSTRACT

**Keywords:** Safety Management, Safety Climate, Safety Performance

In the twentieth century, as technology grew by leaps and bounds, associated hazards also grew with it. This resulted in collective efforts and thinking in the direction of controlling work related hazards and accidents. Thus, safety management developed and became an important part of industrial management. While considerable research has been reported on the topic of safety management in industries from various parts of the world, there is scarcity of literature from India. It is logical to think that a clear understanding of the critical safety management practices and their relationships with accident rates and management system certifications would help in the development and implementation of safety management systems.

In the first phase of research, a set of six critical safety management practices has been identified based on a thorough review of the prescriptive, practitioner, conceptual and empirical literature. An instrument for measuring the level of practice of these safety management practices (from the employees' perception) has been developed by conducting a survey using questionnaire in chemical/process industry. The instrument has been empirically validated using Confirmatory Factor Analysis (CFA) approach. As the second step, predictive validity of safety management practices and the relationship between safety management practices and self-reported accident rates and management system certifications have been investigated using ANOVA. Results of the ANOVA tests show that there is significant difference in the identified safety management practices among the organizations. In the next step, the relationship between safety management practices and the determinants of safety performance have been investigated using Multiple Regression Analysis. Similar analysis has been carried out to investigate the predictive capacity of determinants of safety performance on components of safety performance. The impacts of personal attributes of employees, management system certifications and accidents on determinants and components of safety performance have also been investigated using ANOVA. Results of the regression tests show that safety training predicts both safety knowledge and safety motivation, which in turn predict both safety compliance and safety participation. The inter-relationships between safety management practices, determinants of safety performance and components of safety performance have been investigated with the help of structural equation modelling. Further investigations into engineering and construction industries reveal that safety climate factors are not stable across industries. However, some factors are found to be common in industries irrespective of the type of industry.

This study identifies the critical safety management practices in major accident hazard chemical/process industry from the perspective of employees and the findings empirically support the necessity for obtaining safety specific management system certifications.

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## LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
COM	Safety Compliance
GFI	Goodness of Fit Index
HSE	Health and Safety Executive
IAEA	International Atomic Energy Authority
ISO	International Standards Organization
ISRS	International Safety Rating System
KNO	Safety Knowledge
MC	Management Commitment
MOT	Safety Motivation
NIOSH	National Institute for Occupational Safety and Health
NNFI	Bentler-Bonnet Non-Normed Fit Index
OECD	Organization for Economic Cooperation and Development
OHSAS	Occupational Health and Safety Assessment Series
OSHA	Occupational Safety and Health Act
PAR	Safety Participation
RMSR	Root Mean Squared Residual
SC	Safety Communication and Feedback
SP	Safety Promotion Policies
SR	Safety Rules and Procedures
ST	Safety Training
TLI	Tucker- Lewis Index
TQM	Total Quality Management
VIF	Variance Inflation Factor
WI	Worker Involvement in Safety

## CHAPTER 1

### INTRODUCTION

*Section 1.1 describes the development of safety management in industries. Section 1.2 discusses safety management in Indian industries. A brief description on methods of measuring safety management is presented in Section 1.3. Section 1.4 contains the research issues followed by research objectives in Section 1.5. Research methodology adopted for this study is presented in Section 1.6. Section 1.7 describes the organization of the thesis.*

#### 1.1 DEVELOPMENT OF SAFETY MANAGEMENT

The Industrial Revolution that took place in the eighteenth century changed forever the methods of producing goods. The most important change was the substitution of machines for people. This resulted in organization of work into large units called “factories”, followed by direct supervision of the manufacturing process and efficient division of work among the labor. As the industrial revolution continued its rapid growth, unsafe production methods exacted a heavy toll on the workforce in terms of job-related injuries and deaths (Felton, 1986).

In the twentieth century, as technology grew by leaps and bounds, associated hazards also grew with it. This resulted in collective efforts and thinking in the direction of controlling work related hazards and accidents. A group of delegates including safety professionals, management leaders, public officials and insurance specialists who met in a national safety meeting in New York in the year 1913, had a desire to attack the problem of occupational health and safety which most people considered either unimportant or insoluble. This resulted in the birth of a voluntary organization, named “National Safety Council”, which helped to create the safety movement, as we know it today. Later, similar voluntary organizations such as International Labor Organization, British Safety Council etc. came up with support from industries in various parts of the world.

Early legal action in industrial safety took the form of laws to regulate and investigate industry working conditions, death and injury rates. The next phase was largely concerned with workers' compensation payments. In subsequent years, governments gradually expanded their roles in regulating industry on safety matters.

In 1970, 'Occupational Safety and Health Act, (OSHA)' was passed in United States of America as a comprehensive national safety law. Safety took a new direction and meaning as a result of OSHA. Similar steps were followed by other countries, such as United Kingdom (Health and Safety at Work Act, 1974), Australia (Victoria Occupational Health and Safety Act, 1985) etc.

As a result of the above Acts, Safety and health of workers became a major concern and priority of management. In addition to the losses due to downtime, costs for workers' compensation insurance, medical and administrative expenses resulting from disability, death and impaired productivity, they were liable to face serious monetary penalties and criminal sanctions from the government side, for non-compliance of law. Therefore, safety management became an important part of industrial management.

### **1.1.1 Safety management in industries**

The systematic and planned top management driven activity that aims at controlling the health and safety hazards of its employees is called safety management (Booth and Lee, 1995). The primary aim of safety management is to intervene in the causation process that leads to accidents. This includes above all, the active recognition of both visible and latent hazards. However, safety management is more than just a hazard identification system. It is an overall system for ensuring that safety activities are properly planned, effectively implemented, and that follow up system is arranged. Typically, safety management includes activities such as risk analysis, arrangement of safety training, accident and near-miss investigation, safety promotion and assessment of human reliability. In an effective safety management system, these activities are assigned to all the different hierarchical levels of the organization (Booth and Lee, 1995; Grimaldi and Simmonds, 1975).



### **1.1.2 Traditional safety management**

The form of safety management followed by most of the industries, called as 'traditional safety management', has the following characteristics (Smith, 1996; Weinstein, 1996; Hansen, 1993).

- Top/down communication.
- Minimal employee participation.
- Dependence on discipline to influence safety behaviour.
- Centered on technical requirements aiming at short-term results.
- Safety techniques are used after accident and injury.
- Safety programme is not integrated with the rest of the functions of an organization.
- Safety director is responsible for safety programme, but does not have the authority to make changes.

In spite of these efforts to promote health and safety of employees, some major industrial disasters took place between 1970 and 1990 in various parts of the world. Scientific investigations into these accidents by researchers pointed out some major deficiencies in the existing safety management system. Powell and Canter (1985) observed that "more than half of the industrial accidents are attributable to deficiencies in the human and management component than to unforeseeable weaknesses in the technical component". These findings prompted further studies to improve safety management. After studying more than 200 companies, Dumas (1987) discovered that programmes of quality and programmes of safety have similar components. He concluded, "Safety is a dimension of quality, after everything, the elimination of defects includes the elimination of practices of unsafe work". According to Minter (1991), "if one looks at safety as a consequence of making things well, then the programme will undoubtedly bear quality".

### **1.1.3 Safety integrated with quality**

Recognizing the need of ensuring quality in safety management, many companies started to deviate from traditional safety management to embrace a new system approach to

safety management in the 1990s. This method, according to Petersen (1994), with philosophies of quality in conjunction with safety, has the following salient features:

- Safety becomes a system, more than a programme.
- Progress is not measured by injury ratios.
- Statistical techniques drive the efforts of continuous improvement.
- Investigation of accidents and following up corrective actions.
- Technical principles and tools for statistical control of process are used.
- Emphasis is placed on improving the system.
- Benefits are provided for people who discover illegal situations.
- Participation of workers in problem solving and decision-making.
- Ergonomic well-being is projected inside the place of work.
- The traps within the system that cause human errors are eliminated.

Companies in developed countries have been practicing quality integrated safety management since two decades. Different safety management practices are followed voluntarily in those industries to improve health and safety of employees at workplace.

## **1.2 SAFETY MANAGEMENT IN INDIAN INDUSTRIES**

In India, The Factories Act, 1948 (Central Act 63 of 1948) came into force on 1.4.1949 to ensure the healthier and safer work atmosphere for the workers, and for improving the general welfare of workers. The Act sets out the broad outline of the measures for achieving the object of protecting the workers from industrial and occupational hazards and for their welfare. Power is given to state governments to frame rules regarding the details of the measures for various types of factories so that the local conditions prevailing in the State are appropriately reflected in the enforcement.

Government of Kerala has framed various rules such as 'Kerala Factories Rules, 1957', 'Kerala Factories (Welfare Officers) Rules, 1957', 'Control of Major Industrial Accident Hazard (Kerala) Rules, 1993', etc to provide guidelines for the enforcing agencies.

National Safety Council was set up by Ministry of Labor, Govt. of India in 1966, as a non-profit making, non-political voluntary organization to generate, develop and sustain a





















































































































































































































































































































































































































































