

**ASSESSMENT OF FIRE RISK LEVELS OF INDUSTRIAL  
BUILDINGS IN BIYAGAMA EXPORT PROCESSING ZONE AREA:  
A CASE STUDY**

Nalaka Prasanna Jayarathna Liyanapeli

(149384L)

Thesis submitted in partial fulfilment of the requirements for the degree Master of  
Science in Safety and Health Management

Department of Building Economics

University of Moratuwa

Sri Lanka

June 2017

**ASSESSMENT OF FIRE RISK LEVELS OF INDUSTRIAL  
BUILDINGS IN BIYAGAMA EXPORT PROCESSING ZONE AREA:  
A CASE STUDY**

Nalaka Prasanna Jayarathna Liyanapeli

(149384L)

Thesis submitted in partial fulfilment of the requirements for the degree Master of  
Science in Safety and Health Management

Department of Building Economics

University of Moratuwa

Sri Lanka

June 2017

### **Candidate's Declaration**

I declare that this is my own work and this thesis does not incorporate without acknowledgement of any material previously submitted for a Degree or Diploma in any other University or the institute of higher learning according to the best of my knowledge. I believe it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

In addition to that I hereby grant to the University of Moratuwa, the non-exclusive right to reproduce and distribute my thesis, in whole or in part, in print, electronic, or other medium. I retain the right to use this content in whole or in part in future works.

.....

Signature:

.....

Date:

### **Supervisor's Declaration**

The above candidate has carried out research for the Master's thesis under my supervision.

Name of the Supervisor: Professor Lalith de Silva

.....

Signature of the Supervisor

.....

Date

## **Acknowledgement**

I would like to thank all the health and safety managers /executives of the selected factories in Biyagma export processing zone for giving me an opportunity to visit their factories to do an in-depth study of the fire safety systems within their premises. I am also grateful for their participation in the survey and helping me in getting validated the data .In addition to that for support made by them in order to get better quality result.

I would like to convey my sincere gratitude to dean, faculty of architect Professor Lalith De Silva, supervisor of my research who extended his kind co-operation, guidance and directing me in completing this thesis successfully.

Nevertheless, I am also grateful to Dr.Nayanthara De Silva, the course coordinator of MSc Health and Safety management courses, for extending her support in numerous ways to start and complete this research.

Last but not the least; I would like to thank my family for supporting me during writing this thesis and throughout my life.

## Abstract

To meet the needs of growing population and changing consumption patterns, productions and services have to be changed and increased drastically. Due to this reason, industries change rapidly, and with these changes, massive alterations happen in industrial buildings to accommodate new production and service requirements. This research aims to explore any significant changes of fire risks levels in industrial buildings due to those changes happening with the time, as compared to initial approval stage of the building plan. A case study was performed with randomly selected five manufacturing plants in Biyagma Export Processing Zone and surroundings, based on the Questioner/Check list developed after studying local and foreign fire safety rules and regulations applicable to manufacturing plants. Structured interviews were conducted to obtain data, validated with responsible persons for fire and safety in selected factories.

According to the results, it was evident that, due to alterations, significant changes of fire risks levels in industrial buildings occur with time, as compared to the initial building plan approval stage. In addition, it revealed that existing Sri Lankan fire safety rules and regulations are not sufficient to ensure fire safety at working places, and Sri Lankan industries are not complying more than 41% with existing best fire safety requirements/standards, which are practiced by the British and the Europeans. Further, Sri Lankan laws and regulations cover 5% and 40% of fire safety requirements respectively, out of the prescribed rules and regulations by British and European.

The necessity of having strict monitoring mechanism was recognised to ensure the factories comply with fire safety requirements when approving building plans for new constructions and for any significant changes, and periodically, with the age of the building.

This research will help the community by introducing a new user-friendly fire risk assessment tool to assess the level of fire risks and help industries to take necessary actions to fulfil the gaps, thereby ensuring life safety of employees and business continuity.

*Key words: Fire risk assessment, Five barriers, Fire resistance, Fire protection measures, Fire scenarios.*

## Table of Contents

Candidate's Declaration .....	ii
Supervisor's Declaration .....	ii
Abstract .....	iv
List of Figures .....	vi
List of Tables.....	vii
List of Abbreviations.....	vii
List of Appendices .....	vii
1. INTRODUCTION.....	1
1.1 Introduction .....	1
1.2 Problem.....	4
1.3 Research Question .....	5
1.4 Research Objectives .....	5
1.5 Structure of the Thesis .....	7
1.6. Limitations of the Study .....	9
2. LITERATURE SYNTHESIS.....	11
2.1 Introduction .....	11
2.2 Fire Safety of the Industrial Building .....	11
2.3 Factory Building Approval Procedure.....	14
2.4 Common Changes in Industries.....	17
2.5 Effects of Changes on Main Barriers .....	17
2.5.1 Fire initiations .....	17
2.5.2 Fire growth and spread.....	19
2.5.3 Smoke spread .....	23
2.5.4 Occupant Evacuation .....	25
2.5.5 Fire Department Response .....	27
3. RESEARCH METHOD .....	30
3.1 Introduction .....	30
3.2 Fire Scenarios .....	32
3.3 Fire Events .....	32
3.4 Conceptual Framework and Research Method.....	35

4 RESULTS AND ANALYSIS .....	41
4.1 Results .....	41
5. SUMMARY AND CONCLUSION .....	53
REFERENCES .....	58

## List of Figures

Figure 2.1: A complete set of possible fire scenarios	12
Figure 3.1: Typical heat release rate curves	30
Figure 3.2: Five major barriers between fire and fatality	31
Figure 3.3: A simple event tree	32
Figure 3.4: A theoretical model of Fire events	34
Figure 4.1: Average percentage complying with BS and EN fire safety standards	41
Figure 4.2: Percentages complying with BS and EN fire safety standards	42
Figure 4.3: Percentage of complying with local fire safety standards	42
Figure 4.4: Average percentage of complying with local fire safety standards	43
Figure 4.5: Percentage of complying with five major barriers	44
Figure 4.6: Percentages of complying with fire initiation barrier	45
Figure 4.7: Average percentage of complying with fire initiation barrier	45
Figure 4.8: Percentages of complying with fire growth and spread barrier	46
Figure 4.9: Average percentage of complying with fire growth barrier	46
Figure 4.10: Percentages of complying with fire smoke control barrier	47
Figure 4.11: Average percentage of complying with smoke control barrier	47
Figure 4.12: Percentages of complying with evacuation barrier	48
Figure 4.13: Average percentage of complying with fire evacuation barrier	48
Figure 4.14: Percentages of complying with facilities for fire brigade invention	49
Figure 4.15: Ave. percentages of complying with facilities for fire brigade	50
Figure 4.16: Percentages of fire safety requirements coverage by Sri Lankan law	50
Figure 4.17: Percentages of fire safety requirements coverage by BOI Guidelines	51

Figure 4.18: Percentages of fire safety requirements coverage by Local Standards 51

## **List of Tables**

Table 3.1 Levels of Compliance	36
Table 3.2 Panel of expert crosschecked	39
Table 4.1 Summary of Complying status of Local and Foreign standards	41

## **List of Abbreviations**

ICTAD: Institution for Construction, Training, and Development

IFE: Institution of Fire Engineers (UK)

BS: British Standards

NFPA: National Fire Protection Association (USA)

## **List of Appendices**

Fire risk assessment checklist	65
--------------------------------	----