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# **EFFECTIVE FIRE SAFETY PLANNING FOR INDUSTRIAL BUILDINGS: A LITERATURE REVIEW**

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# EFFECTIVE FIRE SAFETY PLANNING FOR INDUSTRIAL BUILDINGS: A LITERATURE REVIEW

## ABSTRACT

*The lives and health of human beings, the growth and prosperity of organisation, and the increasing need for fire safety are immediate concerns which provide the original momentum for the business continuity of the organisation. Fire safety consideration should form an important part of any new product or technology development to promote sustainable development, and acceptable solutions to acute fire safety concerns must not pose a threat to the long term development. Simply, the fire safety and sustainable development has common interest in making sure that fire safety is achieved in the most sustainable way. However, the direct property damage to the buildings due to ineffective fire safety planning is increasing with the development of industrialisation and urbanisation. This paper therefore aimed to develop a conceptual model for effective fire safety planning for industrial buildings. A comprehensive literature review was used as the research methodology for this paper. Key words search for fire accidents causes for fire accidents, fire safety planning and industrial buildings were used to search the literature. The literature findings highlighted that many buildings such as factories do not arrange regular drill; therefore the workers discover themselves in an alien situation whenever an emergency situation arises, causing panic, stampede etc. which further escalate the degree of casualty. Further, accidents are caused mainly due to technical failures and human failures where human failures include lack of awareness of the safety precautions required, inadequate expert knowledge and qualifications in accident prevention. Failure to effective planning for fire safety in buildings can hinder the recovery process, whereas recognition of its importance leads to more efficient use of resources in the wake of emergencies*

**Keywords:** Fire Safety; Fire Safety Planning; Industrial Buildings.

## 1. INTRODUCTION

The greater understanding of the issues and dialogue between the varieties of disciplines can help make the buildings safer and more sustainable. Safety is the complement or antithesis of risk and if safety will increase then the risk is reduce (Ramachandran, 1999). Fire accidents cause fatal and serious injuries to occupants of the building and direct material damage to the building and other assets of the building (Subramaniam, 2004). The likelihood of the occurrence of an accidental fire and its consequential loss will depend on the standard of precaution measures and whether appropriate emergency actions have been taken (Tsul and Chow, 2004). Innovative building methods lead to concerned about choosing the safest and most effective fire safety planning strategy when attending a fire.

Effective fire safety planning prevents the occurrence of fire by the control of fire hazards in the building, ensures operation of fire protection systems by establishing maintenance procedures, and provides a systematic method of safe and arranged evacuation of the building in the event of fire. However, currently buildings have become more complex, thus a more effective approach to industrial fire safety is needed to deal with the complexities and changers that exist in modern industrial facilities (Zalosh, 2003). According to the Lin (2005), Taiwan shows that industrial occupancy has the highest annual rate of probability of fire occurrence than other building categories. Moreover, Fire Service Department of Sri Lanka (2011) highlighted that fire hazardous in industrial buildings are higher than other building categories. Thus, this study was focus on effective approach for fire safety planning in industrial buildings.

## **2. RESEARCH METHOD**

A comprehensive literature was used as research methodology for this research paper. Information relevant to the key words such as fire safety, fire safety planning, industrial buildings were obtained through various sources such as journal articles, online journals, e-books, web sites, electronic library data base and other publications.

## **3. FIRE SAFETY**

Fire Safety imposes on nearly every aspects of human endeavor. The term, fire safety refers to fire prevention, limiting the spread of fire and smoke, extinguishing a fire and the chance of a quick and safe exit (Kobes *et al.*, 2010). As described by Hassanain (2006), fire safety is the reduction of the potential for harm to life as a result of fire in buildings (CWC, 2000 cited Hassanain, 2006). Hence, fire hazards with numerous casualties generally raise questions about the safety requirements in buildings with the type of occupancy levels that there were in the property wherein the fatal fire occurred (Kobes *et al.*, 2010). Moreover, Porter (1990) stated that in order to achieve the highest fire safety level in a building, it is necessary to have a greater reliance on what are known as active fire safety systems such as automatic sprinkler systems, smoke detection systems and smoke control systems.

The consequences of poor fire safety practices and a lack of emergency planning are especially serious in properties where processes or quantities of stored materials could pose a serious threat to the community and environment in the event of fire hazardous (Fire Safety Planning for Industrial Occupancies, 2000). Marchant (2000) pointed out the objectives of fire safety as Life safety; The protection of the contents of a building; The protection of the building fabric and The minimization of threat to the environment. All these objectives highlight one main objective that is to prevent ignition.

Several major disasters, such as fire at the Manchester Airport (UK, 1985) and the fire incident in the channel tunnel (UK-France, 1995) etc. have highlighted the need of improving safety performance in any facility (Santos-R and Beard, 2001). Fire safety is also a matter of Sri Lanka due to rapid increment of fire hazardous with the industrialization and urbanization. According to the Fire Bridget of Sri Lanka (2012), 10% growth of fire hazardous from 2007 to 2011 can be seen. In fact, achieving fire safety in the built environment requires contributions from a number of organizations and during the operational stage building should be maintained and operated in accordance with the effective fire safety planning (Wang, Marsden and Kelly, 2011).

## **4. FIRE SAFETY PLANNING**

Fire safety planning prevents the occurrence of fire by the control of fire hazards in the building, ensures operation of fire protection systems by establishing maintenance procedures, and provides a systematic method of safe and orderly evacuation of the building in the event of fire (Fire Safety Plan- British Colombia, 1998). Effective planning strategy is crucial to ensure a safe built environment for occupants'. Fire Safety Plan, British Colombia (1998) further stated that fire safety planning basically has three objectives, namely; Fire Hazard control; Fire Protection System Maintenance; Emergency Evacuation. Thereby, a proper fire safety plan is need to be developed in order to achieve these objectives. According described by Tsui and Chow (2004), a fire safety plan should comprise with at least following four plans.

- Maintenance plan
- Staff training plan
- Fire action plan
- Fire prevention plan

Santos-R and Beard (2001) asserted that fire safety can be planned according to four safety levels (as shown in Figure 1) of achievement and planning is continues process of decision taking, whereby resource allocations are made.

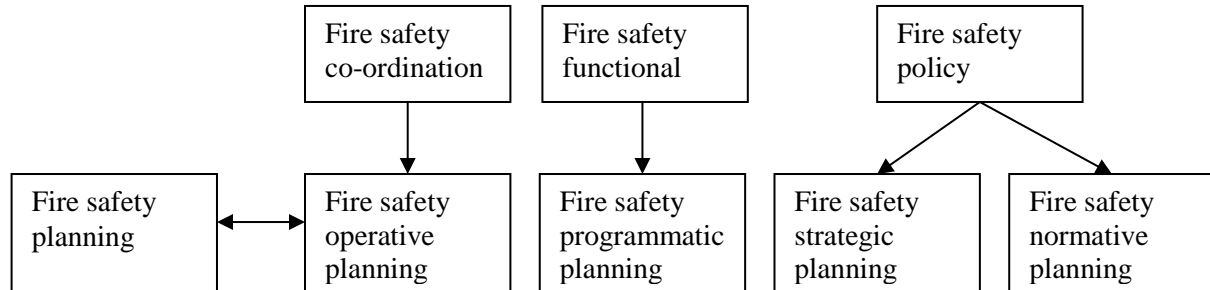


Figure 1: A Fire safety management system performance measurement system (Adopted from Santos-R and Beard, 2001)

As per the Tsui and Chow (2004), a complete fire safety plan should be formulated to cover following five major components to give five sub-plans

1. Documentation, information record and review plan
2. Maintenance of fire safety measures and fire prevention
3. Staff training
4. Emergency action procedures
5. Assessment on building alternation/addition.

Hassanaim (2006) highlighted that fire safety planning must do with knowledge of the occupancy profiles of their facilities. Moreover, fire safety planning should be updated with requirements to accomplish the highest degree of safety level. Moreover, Marchant (2000) acknowledged that fire safety planning should be carried out separately from fire safety designs in many cases after the design is complete. Effective fire safety planning specially for industrial building is very much crucial as facilities such as industrial buildings have greater possibility for unplanned incidents such as fire disaster (Ripple, 2003; Alexander, 2005).

## 5. FIRE SAFETY PLANNING IN INDUSTRIAL BUILDINGS

Fire safety is a function of the design and use of the building, but also and importantly, how the facilities are manage day to day and how well plan active fire safety systems are the good indices to assess the level of fire safety (Shields, Boyce and Silcock, 1999). It is commonly believed that improper design, high population load and mismanagement of floors and circulation systems in industrial buildings are major contribution to fire hazardous (Firoz, 2011). According to the Lin (2005), industrial buildings define as buildings where the main activity is for processing, manufacture or repair although there may also be a part of the building used for storage, offices of some other purposes.

Facilities such as factory buildings have greater possibility for unplanned incidents such as fire disaster than do commercial facilities (Ripple, 2003; Alexander, 2005). According to the statistical data of fire calls (Fire Service Department, Sri Lanka, 2009), 10 fire emergency calls received from factories out of 49 fire emergency calls received from industrial buildings. No of fire accidents reported to the Fire Service department are increased by 14% by the end of 2010 and records further revealed that it was 20 fire emergency calls out of 49 fire emergency calls (Fire Service Department, Sri Lanka, 2010).

Facilities such as factory buildings have greater possibility for unplanned incidents such as fire disaster than do commercial facilities (Ripple, 2003; Alexander, 2005). According to the statistical data of fire calls (Fire Service Department, Sri Lanka, 2009), 10 fire emergency calls received from factories out of 49 fire emergency calls received from industrial buildings. No of fire accidents reported to the Fire Service department are increased by 14% by the end of 2010 and records further revealed that it was 20 fire emergency calls out of 49 fire emergency calls. Recently, World Trade Organisation (WTO) has ranked Bangladesh as the 4<sup>th</sup> largest exporter of readymade garments in the world. This sector contributes for 75% of foreign currency earning for Bangladesh. This industry has played a significant role in elevating economic and living standard of millions of families all over the country. Along with bringing blessing for the nation, textile and readymade garment industry also hold the record of experiencing some worst industrial fire accidents in the country (Ahamed and Hussain, 2010; Firoz, 2011). Further, as explained by Ibem (2011), in Nigeria 29.17% of disasters are occurred in built facilities due to the fire hazardous that is mainly due to the poor fire safety planning.

The cause analysis for most of the fire accidents in industrial buildings shows that many accidents have occurred due to technical and human failures where human failures include lack of awareness of the safety precautions required, inadequate expert knowledge and qualifications in accident prevention, poor guidance (Gunasekara, *et al.*, 2008; Ahmed and Hossain, 2009). Further, a study by Bryan (2002) highlighted that the size of a fire is related to the behaviour of the personnel in the building either before or during the incident. These entire causes highlight the absence of effective fire safety planning in industrial buildings. Failure to address this issue for fire safety in a building can hinder the recovery process whereas recognition of its importance leads to more efficient use of resources in the wake of emergencies (Rick *et al.*, 2007). Thus, effective approach for fire safety planning in industrial buildings is becoming the crucial fact to concern.

## 6. DISCUSSION

The result of literature on this subject matter have revealed some vital issues that require to addressing though effective approach. In fact, results show that the most prevalent fire hazardous is related to the Industrial sector. In order to be more considerable for industrial occupancies, there is a need to look into this matter more seriously as it directly relates to human lives. Fire safety planning basically involves four levels where all these four levels are needed to be addressed as described in below for effective fire safety planning.

- Fire safety operative planning - There is no fire safety performance improvement or change, accepts the existing status of fire risk.
- Fire safety programmatic - Sets new short-term objectives for fire safety performance improvement and tries to achieve. Objectives can be achieved without extra money.
- Fire safety strategic planning - Sets new medium term objectives for fire safety performance improvement.
- Fire safety normative planning - Sets long-term fire safety objectives to achieve these objectives organizations will need to commit major investment.

However, many challenges are involved in effective fire safety planning. Major challenge of fire safety planning is about identifying the changes that may happen in the future. As per Meacham (1999), the types of material stored in a warehouse may change over time, and production equipment may change in industry hence, identifying those changes in planning stage is a real challenge. Moreover, local codes on the active fire safety systems change at different times and would have different requirement (Chow and Lui, 2002). Hence, anticipation of future legislative requirement in planning stage is a greater challenge. Gibson (1997) pointed out that it is always necessary to ensure that design criterion of building agreed with the building which is actually occupied, mostly actual situation and design situation may change. Instead of that addressing those challenges in planning stage is crucial fact to concern.

## 7. CONCLUSION

Fire safety is a highly national and international issue where industrial buildings need to focus this as one of the major risks which has negative impact on business continuity. The research findings highlighted some of the interesting and crucial challenges that are encountered when carrying out fire safety planning. It is further revealed that probability of fire occurrences in factory buildings is higher than other building categories. Many factories do not arrange regular drill; therefore the workers discover themselves in an alien situation whenever an emergency situation arises, causing panic, stampede etc. which further escalate the degree of casualty. For the purpose of achieving higher degree of safety of occupants, property and environment, effective fire safety planning is required. Effective approach for fire safety planning in industrial buildings is becoming the crucial fact to concern.

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