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Implementation of Fire Safety Management in multi-storey Buildings

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Abstract - Increased vulnerability to antagonistic attacks, along with an increase in the number of a multipurpose structures with many functions crammed into a limited space, provides new, previously unexplored problem areas that are often the building code does not consider or control these items. These additional problem areas must be investigated, as well as the potential for substantial societal implications in the event of a fire or other calamity. These issues, combined with the current lack of guidelines for evaluation techniques, as well as well-established evaluation procedures analytical methods, create a necessity for a method for measuring the fire safety level in multifunctional structures from a holistic perspective. Aim of this paper is to aid in Accident mitigation and repercussions in a multipurpose structure in the event of an accident or antagonistic attack.

Keywords - Multifunctional Buildings; fire safety; electrical failure; Fire suppression

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INTRODUCTION

The principal discrepancies of the public houses from contemporary fire code manuals were reviewed in Multifunctional Buildings- Problem Areas. The essential concepts of FSM will be addressed in this chapter, as well as the existing practices and processes inside the BNN. Despite the fact that the relevance of FSM is gradually being recognized, there is still a scarcity of study on the subject, particularly on the organization and implementation of FSM.

Definition of fire safety management (FSM)

FSM was formerly defined as "the application of policy, standards, tools, information, and procedures to the process of assessing, evaluating, and regulating fire safety by a management" (Howarth and Kara-Zaitri, 1999).

FSM is defined as "the tasks carried out by a defined individual with appropriate powers and resources to ensure that the fire safety systems, passive, active, and procedural, within the building are working properly at all times" according to the British Standards Institution's (BSI) Publicly Available Specification 79: 2007. (*British standard BS OHSAS 18001:2007*). This definition of FSM might be considered a practical and applied definition. Typically, such a role is included within the property manager's or property management agent's daily building management responsibilities.

FIRE SAFETY CONCEPTS TREE

There is no such thing as total security in the actual world. Building fire safety is not an exception. Building fire safety is influenced by a variety of elements, including human, mechanical, and environmental considerations.

Fire safety is defined by the National Structure Code of Canada (National Research Council (US). 2005) as "a purpose to limit the chance that a person in or adjacent to a building would be exposed to an unacceptable fire danger as a result of the building's design and construction."

In traditional way, structure is regarded sufficiently fire safe if it is built according to the current fire code, representing the society tolerance for fire consequences at the time. This strategy, on the other hand, lacks a systematic approach. While there is no one-size-fits-all approach for building fire safety, it is preferable to have a balanced design that incorporates a number of measures, including:

1. Prevent fire ignition
2. Control process of combustion
3. To Control fire by construction
4. Fire detection and providing warning
5. Automatic Fire Suppression
6. Manual Fire Suppression

7. Managing, either people or property exposed to fire

Figure 1 shows the "Fire Safety Concepts Tree" (FSCT) designed by the National Fire Protection Association (NFPA). The FSCT is a diagrammatic representation that depicts main parts of fire safety measures to help us make judgments about a variety of options. The elements that run down the pictogram's tree branches reflect the methods for meeting the requirements that are directly above them. It should be noted that logic gates are used in the FSCT to indicate which strategies should be implemented concurrently ("AND" gate) and which tactics can be implemented separately (the "OR" gate).

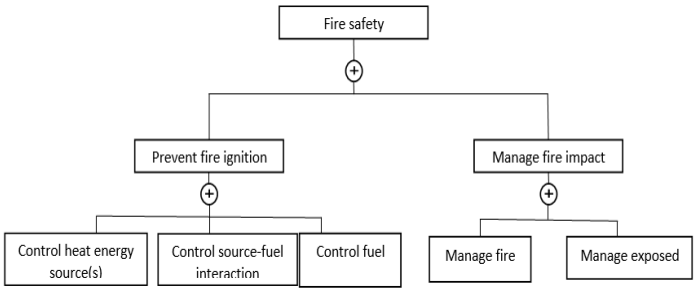

Figure 1: Fire Safety Concepts Tree - Principal Branches (NFPA, 2007)

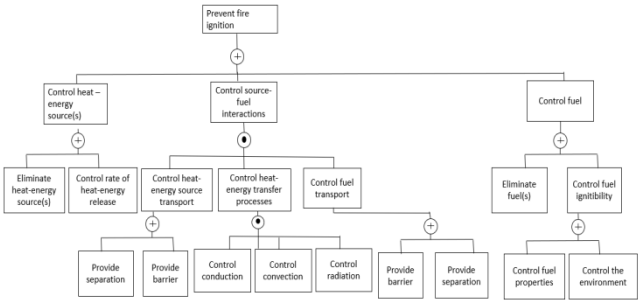

Figure 2: Representation of Fire Safety Concepts Tree (NFPA, 2007)

These three concepts are based on the "Fire Triangle," which is a model commonly used by fire engineers to present "Fuel," "Heat," and "Oxygen" as the three elements required to initiate combustion. The combustion process or the fire cannot start if one of these three elements is removed.

It's critical "prevent fire ignition" is prioritised as the first line of defence. However, if a true fire occurs, the only way to meet the safety goal is to change the strategy to "Manage fire impact," which can be accomplished by either of "Manage fire" and "Manage exposed." One can "manage fire" by controlling or suppressing it. The "Manage exposed" strategy, on the other hand, may be used to safeguard people, property, and material from the damaging effects of fire by "Limiting the exposed" otherwise "Safeguarding the exposed" within tenable standards.

The National Fire Protection Association (NFPA) has compiled a list of resources to help people learn fire prevention in a systematic way which is mention in table 1.

Table 1: Fire Prevention Factors (NFPA, 2003, pp. 2-40)

1.) Main Sources of Heat	a. Fixed equipment b. Torches and other tools c. Materials for smoking and lighting devices d. Portable equipment e. Explosive materials f. Other fire exposure g. Natural causes
2.) Ignitable Materials Types and Forms	a. Building materials b. Contents and furnishings c. Interior and exterior finishes d. Trash, lint, and dust e. Stored materials and supplies
3.) Factors brining Heat and Ignitable Material Together	a. Arson b. Misuse of heat source c. Mechanical or electrical failure d. Misuse of ignitable material e. Error in operating equipment f. Design, construction, or installation deficiency g. Exposure h. Natural causes
4.) Practices affecting he Prevention Success	a. Housekeeping b. Education of occupants c. Security d. Control of heat energy sources e. Control of fuel type, quantity, and distribution

"Fire Safety Management Handbook" based on the FSCT is also published by the American Society of Safety Engineers. A programme on fire safety management (Della-Giustina, 1999, pp. 24) should comprise the subsequent parts, according to the handbook:

- **Inspections -** Inspections are carried out on a regular basis to discover possible fire

hazards and ensure that fire prevention systems are operational.

- **Education and training -** Recognizing fire threats, using firefighting equipment, and adhering to fire codes should all be included in training.
- **Fire suppression -** Extinguishers and alarms, for example, need to be available.
- **Service in Emergency -** Fire and emergency response plans should be created by the fire safety manager, which should involve the usage of local fire and police agencies.
- **Fire prevention -** It is the use of inspections and education to avoid fire losses before they happen.
- **Reports and record keeping -** Senior management might benefit from a report and record to improve fire safety performance. Inspection and maintenance schedules, as well as fire histories and investigations, should all be kept in records.
- **Communication -** To guarantee programme compliance, communication should be maintained across all organisational units.

ROLE OF FSM

FSM is often regarded as having a critical role to play in fire prevention. Furthermore, "a frequent component in many multi-fatality fires is the inability of the building's inhabitants, whether management, personnel, or others, to take the proper action when a fire is found or when an alarm is sounded," according to the literature (Stationery Office, Her Majesty, 1995). "Even with the most extensive fire safety precautions that contemporary technology can give, proper fire safety management is required to guarantee that building occupants reach a safe location in the event of a fire and to avoid tragedy" (Akande *et al.*, 2016). When a structure is effectively maintained, the chances of a fire breaking out are considerably decreased, and the chances of residents successfully evacuating are increased.

The value of FSM is being addressed in Bhopal, where clusters of high-rise structures are being developed (Chow, 2001). However, the Building Management Ordinance (BMO) (Bhopal. 2003) is the sole piece of legislation that applies to FSM at the moment.

ELEMENTS OF FSM

FSM practice, according to (Naresh K. Malhotra, 1988) necessitates the creation of a Fire Safety Plan that includes a Maintenance Plan, Staff Training Plan, and a Fire Action Plan. Furthermore. Stationery Office, Her Majesty, 1995 proposes a Fire Prevention Plan, which effectively addresses the FSCT's "Fire Prevention" section. The Fire Safety Plan is subdivided into four categories as explained below:

Maintenance Plan

A Maintenance Plan outlines how the building's passive and active fire services installations (FSI) are regularly maintained and tested to guarantee their performance. It is obvious that adequate FSI maintenance aids in ensuring that fire safety systems function as intended in the event of a fire. For example, a Registered Fire Services Installation Contractor (RFSIC) is required to examine the hose reel system and fire alarm system at least once a year (FSD, 2005). The fire door is not stuck open, therefore, the escape routes are routinely monitored.

Staff Training Plan

Refresher training should be arranged on a regular basis to ensure that employees are up to speed in the event of a fire. Typical training should include how to raise an alarm, guide occupants to a safe location and use first-aid fire-fighting equipment - among other things.

Fire Action Plan

When a fire is suspected, the Fire Action Plan will detail the steps that each member of the assigned staff should do. The goal is to ensure that the employees are able to perform their jobs properly without feeling frightened. The Fire Action Plan will incorporate what was covered in the training (such as alerting the FSD, evacuating residents, and so forth).

Fire Prevention Plan

As previously said, fire prevention should take precedence in maintaining fire safety of any building. "Most building fires are ignited by heat sources and ignitable materials carried into the building, not built into it," according to experience (NFPA, 2003, pp. 2-39). As a result, a first step in fire prevention is to restrict the source of ignition and flammable items. Procedures in the aversion of heat sources and combustibles should be developed by excellent housekeeping, such as correct disposal of cigarette ends, storage limitations for flammable substances, and frequent garbage clearance, among other things.

On the other side, education to instil fire safety precautions in tenants should be addressed. Short courses, the posting of posters, and the distribution of instructional booklets are all examples of this. A Fire Safety Manual is suggested for developing a systematic Fire Safety Plan (e.g. Porter, M. 1990). The manual's specifics may vary depending on the building's complexity. In addition to the processes in each sub-plan, the design assumptions and

characteristics of the fire safety strategies should be included in the handbook for reference by fire safety experts. This is especially crucial for a building that was constructed with a performance-based strategy in mind. Typically, FSM is used as one of the fire protection techniques in complicated and huge structures with several advanced fire engineering systems.

FSM IN BNN BUILDING- POLICY AND PRACTICE

FSM Procedures

There are 3 levels and a total of 9 principal factors that should be considered in required level assessing, according to British Standard BS 9999:2008:

- Changes in risk profile planning
- Authority and resources
- Staffing level
- Fire safety trainings
- Control of work
- procedures of Communication
- Fire safety systems – testing and maintenance
- Rescue service and Liaison with fire
- planning for Contingency

The BNN administers a fleet of 1,420 rental buildings, and for residential buildings, Level 1 FSM (the highest level) is often suggested. Apart from the fact that there is no official "Permit to Work" mechanism for "hot work," the preceding nine concerns are handled. The numerous FSM practises and procedures are outlined in Appendix A under the four sub-headings of the Fire Safety Plan, namely, a comprehensive coverage of the Fire Prevention Plan, Staff Training Plan, Maintenance Plan, and Fire Action Plan.

Maintenance of Building Services System

As previously stated by NFPA (2003), "mechanical or electrical failure" is one of the fire prevention factors. As a result, proper maintenance of building services plants and equipment may help reduce the danger of fires while also enhancing system reliability and reducing downtime.

BNN has always employed a preventative maintenance strategy when dealing with the community building services systems (Akande *et al.*, 2016). In compliance with legislative requirements and plant condition, all plants and equipment in the public area and plant rooms are checked, tested, and repaired on a regular basis.

BNN, on the other hand, is responsible for maintaining internal services and landlord's provisions within flats, provided that the installations have not been tampered with or altered by the tenants, and any faults are due to regular wear and usage (BNN, 2009a).

While repairs to in-flat installations are handled on a daily basis in response to tenant requests, similar installations are also changed and enhanced as needed during unoccupied flats restoration after tenants have moved out. Furthermore, for estates older than 20 years, a yearly inspection of the quality of the internal wiring will be performed. Electrical issues caused by renters' inadequate remodelling work will no longer be a fire threat thanks to the RDF initiative. The number of final circuits and socket outlets has also been increased, eliminating the requirement for adaptors.

The workflow is depicted in Figures 3 and 4, respectively, in order to visualise the normal upkeep and closure of FSI.

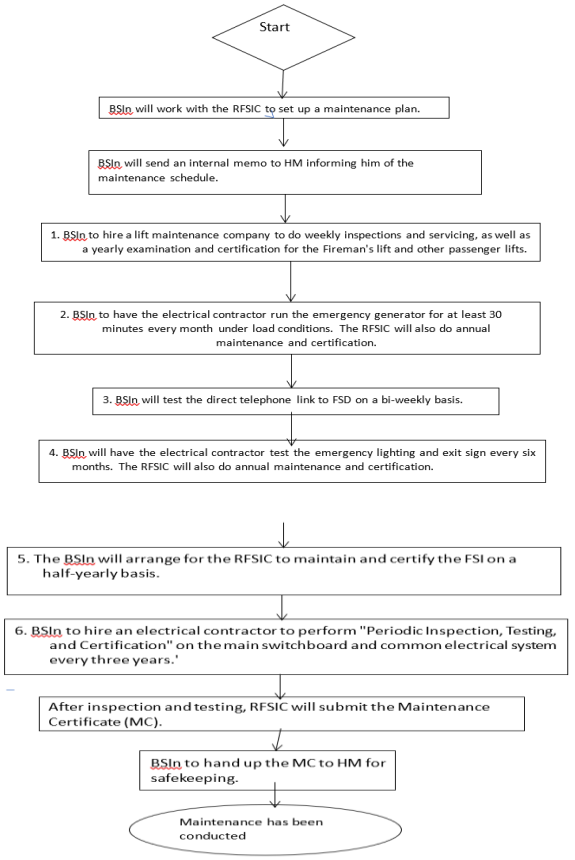

Figure 3: Workflow of routine maintenance to FSI, Legend: BSIn: Building Services Inspector HM: Housing Manager

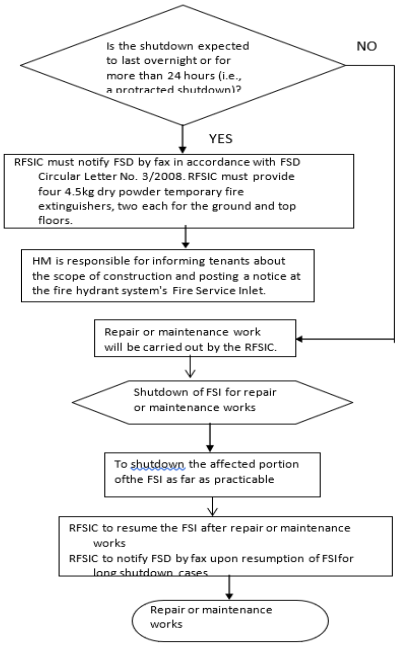

Figure 4: Flow chart for shutdown of FSI

Improvement to FSI and building construction

BNN's policy is to improve and upgrade the FSI and the building fabric as much as possible. Due to site-specific concerns, there are always practical limits on alterations and additions to older buildings. The disadvantages to renters, on the other hand, may be terrible at times, or the work may take a long time to complete.

The dependability and maintainability of FSI should be taken into account before any upgrade work is carried out. They claim that the building's fire safety management is ineffective and undeveloped, and that the sprinkler system may not function properly in the event of a fire. He evaluated the overall system's reliability to be very poor utilising the FTA technique and data on system component reliability from other guide books. He suggested that more frequent proof tests on the system be conducted in order to ensure its reliability. These findings suggest that, rather than merely asking for more FSI, management and maintenance are still crucial in terms of fire safety for old existing structures.

Education to tenants

BNN has spent a lot of money on publicizing fire safety and educating renters about it. A "Fire Safety Education Path" has been established in several estates to educate residents on fire safety awareness and understanding.

A total of over 1,500 interviews were conducted each time. The consultant used a stratified random sampling method to identify buildings of various ages for the survey. The selected flat's household members above the age of 18 would be questioned over the phone. Each time, nearly 1,500 interviews were done, with a response rate of over 70%. The survey findings in Table 2 clearly illustrate that in just two years, fire safety knowledge and awareness has risen considerably.

Table 2: Survey Results on Fire Safety Awareness of Tenants in Public Rental Housing

	Survey result 2005	Survey result 2007	Improvement [(b)-(a)]/(a)
	(a)	(b)	
A. Fire Safety Knowledge			
1. Perceived main causes of fire			
1.1 Leaving stove on when nobody is at home	45.00%	87.30%	92.90%
2. Fire safety awareness of tenants			
2.1 Respondents observed that the smoke doors were being opened in the week before the survey	10.60%	11.20%	11.10%
2.2 Respondents observed that there was obstruction in the corridor or staircase in the week before the survey	11.00%	8.00%	32%
2.3 Respondents are aware of where the emergency escape is located.	96.21%	96.60%	0.42%
3. What to do in case of fire?			
3.1 To ON the fire alarms	64.80%	71.10%	7.51%
3.2 To take wet towel for escape.	38.01%	41.02%	8.01%
3.3 To utilize staircase for emergency escape	98.98%	97.90%	-0.39%
B. Effectiveness of Education Activities.			
1. BNN hosts educational events and messages, which respondents are aware of.	68.90%	72.10%	4.01%
2. Respondents would be willing to participate in fire drill	62.98%	68.60%	8.30%
3. Respondents are willing to participate in educational activities	49.98%	64.20%	26.30%
4. sabotage observed by respondents	2.90%	2.11%	30.01%

Liaison between BNN and FSD

The BNN and the FSD have an unique inter-departmental liaison because of the high population density in PUBLIC HOUSES. A "Significant Disaster Manual" (BNN, 2009b) has been created to lay out the full warning system as well as a contingency plan in the event of catastrophic calamities like fire and explosion

If an event is reported, the FSCC will take care of it and maintain track of its progress. In the event of a fire with a Level 3 or higher alert, the HAD's relevant District Officer will organise the setup and operation of an inter-departmental helpdesk on the site, which will include other government departments. Temporary shelter will be provided to those who have been displaced as a result of the tragic fire.

CONCLUSION

FSM's foundational concepts are explained in this chapter against the framework of the NFPA Fire Safety Concepts Tree. By exploring the internal process guidelines and manuals, the FSM practises and procedures at BNN have been reviewed. The practise is determined to be structured and organised in general. The numerous Fire Prevention Factors are routinely addressed, regardless of the fact that there is no formal control system in place for "hot work" from contractors. Furthermore, tenants' fire safety education has been prioritised. Tenants' fire safety understanding has improved in recent years, according to Consultancy Reports that Have Been Published Recently on "Survey on Fire Safety Awareness of Tenants in Public Rental Housing." The educational process is thought to be successful.

RFSIC maintains the FSI on a half-yearly basis, which is more frequently than the statutory obligation of once a year (Bhopal. 2003). The active firefighting systems' reliability and availability are greatly assured. FSI's closure is strictly controlled by departmental protocols, and additional fire extinguishers are provided throughout the shutdown period. Communication with the FSD is done through special arrangements between the FSD and the BNN, which are especially important during disasters like huge fires with a number 3 alarm or higher. Staff receives adequate training from both inside and outside the business, and each employee's responsibilities are clearly outlined.

BNN is the landowner of 1,420 rental building blocks, some of which are 45 years old. The current prescriptive fire safety code requirements may not apply to "older structures" built many years ago. Despite this, given the large number of residents engaged, there is no risk to the life safety goal. While BNN makes every effort to adjust and improve fire safety provisions, there could be technical limits such as identifying sufficient accommodation space for placing backup generators, space constraints for creating a smoke lobby, and so on. Furthermore, the inconvenience caused to tenants throughout the lengthy duration of construction may be politically undesirable at times. As the "Fire Prevention" part of the FSCT is heavily addressed, it is widely accepted that effective FSM plays a vital role in increasing a building's fire safety level. Because of effective management, it is expected that the fire safety performance of BNN's "older buildings" will not be inferior to others that have already been built.

Despite this, no official and comprehensive FSM system exists to describe the overall FSM design and execution strategy for property portfolios with top management commitment, particularly the Director of Housing.

ABBREVIATIONS

AASW	All Active Systems Working (scenario)
ASET	Available Safe Egress Time
CC	Cone Calorimeter
CCF	Common-Cause Failure
CDF	Cumulative Distribution Function
DE	Domino Effect
FP	Fire Protection
FPA	Fire Propagation Apparatus
HRR	Heat Release Rate
IS	Ignition Scenario
OASI	One Active System Impaired (scenario)
PBD	Performance-Based Design
QRA	Quantitative Risk Assessment
RQ	Research Question
RSET	Required Safe Egress Time
SA	Sensitive Area
SL	Safety Level
WCC	Worst Credible Consequence (scenario)
DFC	Design Fire Curves
NFPA	National Fire Protection Association
FHA	Fire hazard analysis
FSM	Fire Safety Management
FSI	Fire services installations
FSD	Fire Safety Design

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