



A fire risk simulation system for multi-purpose building based fire statistics

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ABSTRACT

Statistical data over the past 24 years detailing the number of fires and building floor areas published by the Taiwan government was employed to determine the fire probability, frequency, and cycle for each building category. By applying a matrix calculation, the fire probability, frequency, cycle, and risk ratio for each functional area within a multi-purpose building were obtained. With assistance from the Taiwan government, the fire case investigation and statistical data for building fires were established. By adopting the risk ratio concept, the weight values for 20 fire safety assessment criteria and 4 fire safety strategies for a multi-purpose building were acquired to indicate the possible causes of fires and the quantitative extent of fire influence.

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1. Introduction

Rapid economic growth has caused multi-purpose buildings to become commonly seen in many Taiwan metropolitan areas in recent years. In this research, a multi-purpose building follows the definition of National Fire Agency, MOI, Taiwan, as a building serving two or more functions, with each containing a certain amount of floor area and the facility management and usage having a relationship between all used areas [11]. Because of the combined functions a multi-purpose building serves, and each functional area has different fire risk characteristics, many loopholes exist in the building fire safety management. A fire that occurred on May 12, 2001 at Hsichi's Eastern Science Park Building in Taipei, which the building contained 220 different purpose units, can serve as an example. Because of an ignored broken fire pump of the automatic sprinkler system, smoke from a third-floor fire traveled through the pipes to the sixteenth floor and ignited a second fire. The fast spread of fire and the superior height of the building impeded the fire-fighting, this fire endured 43 h and caused a more than \$US 150,000,000 loss [7]. There are many buildings similar to Hsichi's Eastern Science Park Building in Taiwan, which emphasizes the importance of related fire safety research.

It is necessary to develop a complete and accepted fire safety assessment method for multi-purpose buildings. With the participation of all social circles and financial support from the Architecture and Building Research Institute, Ministry of the Interior (MOI), the strengths of other assessment systems were adopted. Statistical fire data published by the government were applied to a matrix calculation. This research set up a domestic fire safety assessment system for multi-purpose buildings. The evaluated data can be presented to relevant personnel to understand the fire safety grades and improvement directions for building fire safety rapidly, to reduce the casualties and damage caused by fire.

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2. Fire safety assessment criteria and fire safety strategies

The building fire safety assessment criteria are closely related to the causes of fires, playing an essential role in the development of a fire safety assessment system [10]. Because the coverage of building safety assessment criteria must be broad and complete [1], this study selected adequate fire safety assessment criteria based on: (1) Assessment Methods for Fire-Safety Functions in Special Buildings in Japan, (2) the Fire Safety Valuation (Point) Scheme of Edinburgh, Scotland, and (3) the opinions of domestic specialists and scholars.

2.1. Fire safety assessment criteria

Because the extensive scope and geographical and cultural similarity to Taiwan, the 34 fire safety assessment criteria of the “Assessment Methods for Fire-Safety Functions in Special Buildings in Japan” is the most common basis for fire safety assessment research in Taiwan [3,12]. The selection of 34 fire safety assessment criteria comes from the reference to Japanese architectural laws and fire causes and a statistical analysis conducted by 20 scholars and building fire experts. Its coverage includes the building interior and exterior, fire safety software and hardware equipment. Therefore, according to the 34 fire safety assessment criteria from Japan, this study incorporated the current regulations in Taiwan regarding building fire safety and combined or eliminated criteria that had similar names. Table 1 reveals the modification of assessment criteria between two assessment systems.

According to Marchant's research [10] on the “Fire Safety Evaluation (Point) Scheme of Edinburgh, Scotland”, it was concluded that fire rescue capability was closely connected with the fire damage. Hence, the two fire safety assessment criteria, “essential equipment for fire-fighting” from Japan and “fire brigade” from Scotland, are combined into the assessment system defined here as one of the fire safety assessment criteria: “fire rescuing ability”.

During the discussion of fire causes in Taiwan [4], this study incorporated “safe operation and hazard protection” into the fire safety assessment criteria after a suggestion made by domestic scholars and experts from related fields. The safe management of the production procedure and the employ and control of hazardous high-volatility material

Table 1

Modification of assessment criteria between two assessment systems.

This research	Japan
1. Organization, management and planning	1. Organization, system, and limits of authority 2. Training and fire-fighting plan 3. Equipments, management, and inspection
2. Usage and control of fire, gas and electricity	4. Fire-source management 5. General equipment management 11. Location be on fire 20. Fire-source equipment management
3. Individual's fire reactive capability	6. Fire-prevention consciousness 7. Efficiency and reaction capability
4. Individual's physical and mental state	8. Action and consciousness 9. Physical condition 10. People capacity
5. Quantity and quality control of flammable materials	19. Quantity and quality of flammable materials
6. Safe operation and hazard protection	–
7. Internal decoration materials	21. Decoration materials
8. Main structure and space arrangement	22. Main structure 23. Space feature
9. External wall opening	24. External wall's opening 25. Horizontal fire area and partition
10. Horizontal fire areas	26. Vertical fire area
11. Vertical fire areas	18. Opening and closing of fire safety door
12. Fire safety doors and windows	27. Fire safety doors
13. Fire refuge facility	15. Application of refuge facility 28. Refuge facility
14. Refuge and escaping equipment	16. Application of refuge equipment 29. Refuge equipment
15. Fire smoke equipment	17. Operation and application of fire smoke equipment 30. Fire smoke equipment
16. Alarm and broadcasting equipment	12. Application of fire alarm equipment 13. Application of emergency broadcasting equipment
17. Manual fire extinguishing equipment	31. Fire alarm equipment 14. Application of fire extinguishing equipment
18. Automatic fire extinguishing equipment	32. Fire extinguishing equipment
19. Environmental features of buildings	34. Automatic sprinkler equipment
20. Fire rescuing ability	– 33. Essential equipments for fire-fighting

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