

Conference Paper

Evaluation on Fire Safety Management Implementation for Commercial Buildings: A Case Study of Shop Houses/Commercial Houses

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Abstract

Fire is a frequently occurring disaster that may be caused by nature, human, and/or both. Fire leads to fatalities and also material loss. In addition, it may damage the environment, facilities and infrastructures, public facilities, and may also create disturbance in the society's life and livelihood. This study aims to evaluate the implementation of fire safety measures in shop houses/commercial houses in X city, assess the fire resistance nature of shop houses/commercial houses against fire, provide recommendations for fire safety facility improvement in shop houses/commercial houses, and to reveal the fire safety reliability score for the shop houses/commercial houses based on the compliance to the 12 safety parameters and additional requirements in NFPA 101A: *Alternative Approaches to Life Safety* and NFPA 101: *Life Safety Code* standards. The sample of this study consists of shop houses/commercial houses in the corridor of Jl. KH Soleh Iskandar that were selected using cluster sampling method based on the predetermined criteria. Data were then analyzed using a descriptive qualitative approach with the support of CFSES tool. The results suggested that the shop houses/commercial houses should comply with the safety aspects in the future by providing various alternative safety paths to prevent fatalities during fire as well as complying to other safety elements.

Keywords: Fire safety, shop houses/commercial houses, NFPA 101 A, CFSES

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1. Introduction

Fire is a frequently occurring disaster that may be caused by nature, human, and/or both. Fire leads to fatalities and also material loss. In addition, it may damage the environment, facilities and infrastructures, public facilities, and may also create disturbance in the society's life and livelihood.

An appropriate fire control during a fire in a shop house/commercial house is important and should be done since the initial step of designing the shop house/commercial house to the fire extinguishing system and evacuation of the inhabitants in the case of fire. With the need to increase the awareness of the developer and inhabitants of shop houses/commercial houses on the importance of fire safety for those buildings, one of the methods that can be applied during the design process as well as for evaluation purpose is an evaluation on the implementation of fire safety measures in shop houses/commercial houses.

2. Theoretical Review

Fire is an unwanted event and, sometimes, out of control. The theory that describes the process of fire is referred to as the fire triangle theory. This theory describes three factors that react to one another to create fire. Without one of the elements, fire will not happen. The three elements of fire are fuel, which consists of combustible solid, liquid, or gas materials that are mixed with the oxygen in the air, such as wood, paper, or benzene compound. Heat source, which is an energy that is adequate for igniting the mixture between fuel and oxygen in the air and trigger fire, such as hot surface, electric devices, or static electricity. Oxygen, both in the air or as an oxidized compound. However, with the advances in science, a fourth element of fire is found, which is referred to the chemical reaction chain. This chemical reaction chain sustains fire [1]. The four fire elements are often referred to as the fire tetrahedron. Fire load is a value that relates to the amount of goods or materials in a combustible building/room. Fire load is the level of heat contained by the material. A fire load of a building is classified into two: fixed fire load and movable fire load. Fixed fire load is caused by the amount of structural materials that can be burnt such as walls and floors. Meanwhile, the movable fire load is caused by the content of the building such as furniture and decoration. Hence, the fire load for a building will be varied according to its function, which influences the content of the building.

Fire growth rate is a rate based on the estimation on how fire will grow, both through the spread on surfaces or each part of the available fuel. This fire growth rate will influence the stability of the building and effectiveness of an emergency response program to make sure that the people in the building can leave the building safely. Several factors may influence this fire growth rate, including the construction and location of the building as well as the ventilation to, along, and out of the building.

In NFPA 101 *Life safety code*, it is stated that there are 12 parameters of safety that can be used to assess safety in a building: construction, danger segregation, vertical opening, sprinkler, fire alarm system, smoke detection, interior finish, smoke control, exit access, evacuation path, corridor or compartment, and emergency response training. With the limitation of a human body to endure fire, a method to estimate the condition when there is a fire in the vicinity is needed. One method that can be applied to do evaluation on the fire safety level of a shop house/commercial house is by doing simulation [2]. There are several models that are used for calculations in fire in fire simulation, such as for predicting the temperature of the room when it is on fire, smoke growth rate, gas produced by combustion [3]. Such models include zone model and CFD (Computational Fluid Dynamic)/field model [4, 5]. The Fire Risk Method (FRIM) is a method for evaluating fire danger that is frequently used in Nordic countries [6]. The Fire Risk Method (FRIM) can be applied easily without requiring in-depth knowledge on fire safety. However, building structure should be known, such as building plan, building materials, and ventilation system design. The Fire Risk Method (FRIM) can be used for multi-story buildings such as apartment [7]. A high index value shows a high fire safety value and, on the contrary, a low fire safety score shows a low fire safety value. In FRIM, there are 17 parameters that become the indicators of fire safety of a building, including the walls, rooms, fire extinguishing system, fire extinguishing services, compartment arrangement, structural separation, doors, windows, outside part of the building, attic, surrounding buildings, smoke control system, signal system, escape route, structure load, maintenance/information, ventilation system.

The methodology used in CFSES is by comparing the score gained based on the assessment results to the standard score that should be met by a building. The assessment on the safety of a building is performed by comparing the standard score for building general characteristics that include number of stories, building height, and building floor size, to the score achieved for each parameter [8].

3. Methods

This study is a descriptive qualitative study that produces a description based on primary and secondary data collected on the field. Data collected were then analyzed using the CFSES software. Important variables for certain standards related to parameter were then selected and weighed. The weights were then used to give scores to the assessed parameters. The data collection process was performed through direct observation and document review. The results of the observation and document review were used as the basis for evaluating the fire safety system implementation in the shop house/commercial house. The CFSES tool itself is a semi-quantitative fire safety evaluation method [9]. The CFSES was selected because it is already proven as reliable for building fire safety evaluation and this method has also been used by NFPA.

4. Results

The CFSES required that a minimum score that should be achieved by a shop house/commercial house that has 3 stories with a height of 8.6 meters or 28.2 ft and a floor size of 432 m² or 4650.009 ft to be stated as reliable during fire is 0 for egress, 0 for safety, and 0 for general safety of the building. After the scoring was performed to all data according to the 12 assessment parameters of CFSES, the software then provided the total score that described the comparison between the real score of the building and the standard score for the building fire safety that should be attained according to the mandatory requirements. The score for fire safety of a building is divided into three: fire control, egress, and general fire safety. The score for fire control of PT X shop house/commercial house building was -8.25 against 0 as the minimum requirement. The score for egress was -4.75 against 0 as the minimum requirement and the score for general fire safety was -8.5 against 0 as the minimum requirement standard. The scores for fire control, egress, and general fire safety of this building have not met the minimum mandatory requirement of NFPA 101: A Guide on Alternative Approaches to Life Safety 2013.

5. Discussion

The characteristics of materials that can become fuel in a fire, which increase potential fire in the shop house/commercial house, include the goods or equipment placed on the ground floor that is used as a workshop and storage for most material such as

motor oil product, accu house, and gasoline that are categorized as combustible materials. In addition, there are also other materials in the shop house/commercial house such as wooden tables and chairs; document papers and archive papers; and gypsum boards that are used as the compartment dividers that can also become fuels during fire.

Another important aspect that has to be attended in the case of fire in shop houses/commercial houses is the evacuation of inhabitants [10]. Following is the site plan of the shop house/commercial house studied as sample in this study. In all shop house/commercial house units, there is only one path for evacuation which access is directly through the door that is located in the ground floor. In this case, when there is a fire, time for evacuation of all inhabitants becomes important so that they can go out from the place safely. The time for evacuation is calculated since the start of the ignition or the time when fire is detected to the time when the inhabitants respond to the fire and then mobilize themselves to safety.

6. Conclusions

The implementation of fire safety measures in one of the shop house/commercial house areas in X city has not, generally, met the minimum mandatory requirements of NFPA 101: A Guide on Alternative Approaches to Life Safety. The shop house/commercial house's resistance to fire is 1.7 hours with the predicted safest time for the inhabitants to save themselves from fire of 1 minute. The factor that is predicted to hinder the evacuation of inhabitants and worsen the damage of the building due to fire is the dense smoke accumulation that cannot be expelled due to the lack of smoke extract fan system. The corrective action efforts that can be performed in this shop house/commercial house area in X city based on CFSES is to do improvement by modifications of building specific (especially in electricity and ventilation system), addition of protection system, more attention to the safe and easy exit route access for inhabitants to evacuate from the building, and emergency respond training program to train the inhabitants of the shop house to deal with fire.

7. Recommendations

It is recommended that improvements of electricity and ventilation system are performed in the form of closing the space between panels and metals to form a room and to tidy up the electricity cable system. In addition, a smoke extract fan system becomes

very important and plays a key role during fire to draw the smoke out and to arrange oxygen stability, hence giving enough time to the inhabitants to do evacuation. The use of balcony in each floor with alternative doors enable the inhabitants to gain temporary protection. Addition of portable emergency escape such as portable chute in balcony area or window area is needed for an emergency ladder in the external part of the building. Corridor should be free from things that can be burnt easily. The exit access should be free from anything that may block the route. Exit signage should be posted. In terms of the fire protection system, it is suggested to activate a sprinkler or fire suppression system in dangerous areas. Drilling may contain method to deal with fire. It is important to make sure that the inhabitants understand the simple technics for extinguishing fire and the appropriate way of evacuation to make sure that the time is appropriate.

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