

A Case Study of Fire Safety Measures at Malaysian University Residential Colleges

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ABSTRACT: Fire emergencies are threat to the occupants of a residential college. Some of the Malaysian residential colleges were built in the 1970s. Back then, the compliancy to Uniform Building By-law 1984 was not entirely practiced. This study aims to evaluate fire safety measures in selected residential colleges of a Malaysian University, which were built before 1984. This includes occupants' level of awareness and knowledge of the occupants regarding fire safety measures. This study was conducted in selected residential colleges, built before 1984, which were named as A, B, C, and D Colleges. One new college building was selected to be the control variable, the E College. Survey questionnaires were given to 401 respondents to obtain information regarding the fire safety awareness and knowledge. Fire safety inspections were conducted to determine the level of fire safety protection systems in colleges and the documentation of emergency response plan were reviewed. From the study, the level of fire safety awareness among the occupants were higher compared to their fire safety knowledge. Fire safety inspection result indicated that overall buildings inspected complies with the local regulation while safety documentation reviews were satisfactorily adequate. Overall, the score for fire safety measures in all selected colleges were sufficient and in good condition. This study is significant for those in the field of safety and health practice pertaining to fire safety engineering and regulations, to plan for better and more efficient fire hazard and risk assessment.

Keywords - Fire emergency response plan, fire safety awareness, fire safety inspection, fire safety knowledge, residential college.

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1.0 INTRODUCTION

Residential colleges and student housing facilities are shelter for students attending a university, and is expected to provide attractive environment, conducive for learning and academic success, appropriate functionality that in compliance with codes or standards, and adequate safety features (Hassanain, 1998). Providing fire-safe facilities involves a comprehensive and well-balanced set of actions consisting of continual fire safety education and awareness programmes for the staff and students, firm adherence to fire safety legislative regulations, adequate fire protection features' maintenance, and prevention measures to limit potential fire sources and reducing total fuel load that may exist. If the fire safety systems for a facility are designed in accordance with prescriptive regulations, there are likely to be some built-in assumptions regarding fuel load, fire spread potential, fire detection, fire alarm triggering, and occupant evacuation (Meacham, 1999). Besides, it is necessary to ensure that, when a fire occurs, all the safety measures provided will be available for use and will perform satisfactorily (Ramachandran, 1999).

The aim of this study was to evaluate fire safety measures in the residential colleges in Universiti Putra Malaysia, built in the year before 1984. Fire safety measures in this context were referred to the active and passive fire protection system existed in the selected residential colleges whether they comply with the Uniform Building By-Law 1984. The second objective was to evaluate the level of awareness and knowledge of the occupants of the residential college, especially the students, regarding fire safety measures. The third objective was to review fire safety documentation regarding the emergency response plan of each selected residential college.

1.1 Fire Safety Scenario in Malaysia

Fire and Rescue Department of Malaysia (FRDM) had completed a statistical annual report on the occurrence of structural fire in 2016. The report was published in their website and can be viewed by the public. The overall reported fire investigation for residential categories that had been conducted was 3,178 cases as shown in Table 1.

Table 1 Fire cases for residential category

| No. | Type of Building | No. of Cases |
|-------------|-------------------------|--------------|
| 1. | Terrace House | 921 |
| 2. | Squatter | 147 |
| 3. | Traditional House | 128 |
| 4. | Residential | 1,263 |
| 5. | Shop House | 110 |
| 6. | Hotels | 41 |
| 7. | Flat | 331 |
| 8. | Apartment / Condominium | 221 |
| 9. | Premise / Budget Hotel | 2 |
| 10. | Hostels | 14 |
| Total Cases | | 3,178 |

Source: (Fire and Rescue Department of Malaysia, 2016)

Referring to Table 1, residential housing category was the highest number of cases (1,263) involved in a fire across the country. Housing refers to any housing built privately such as private homes, bungalows or detached. The fire statistics on residential categories then followed by terraced houses (921), flat (331) and apartment / condominium (221) cases. Hostels fire cases recorded 14 cases in 2016. Even though the number is low, but it should be emphasized as the number of occupants per hostel is quite high.

1.2 Fire Risk Assessment

Fire risk is defined as the product of the probability of fire occurrence and the consequence or extent of damage to be expected on the occurrence of fire (Hurley, 2016). Fire risk assessment in buildings comprises three steps which are fire hazard identification, fire risk analysis, and fire risk evaluation. Fire hazard identification is a systematic process to understand how, when, and why fire could happen. Fire risk analysis is a process of estimating probabilities of the adverse effects resulting from fire in a building and the magnitude of consequences (Xin and Huang, 2013). A number of scholars have studied in-depth on fire risk assessment and brought out many methods (Han, 2011). Based on studies, the fire risk assessment methods were divided into qualitative and quantitative methods. Different fire risk assessment methods are usually limitative in application, for example, narrative method as qualitative fire risk assessment method only able to give general description to identify dangerous events, not quantifying the fire risk. Because of easy operation, the qualitative fire risk assessment method, such as fire risk index, risk matrix method, can achieve a simple satisfactory outcome, which at present, are carried out by a majority of foreign insurance companies because of extensive application range and relative simpler procedure.

Life safety is one of the most important and minimum requirements buildings must meet. Whether a building can meet this requirement depends on the ability of occupants in the building to successfully evacuate from it in the case of emergencies like a fire prior to the onset of untenable conditions in the egress routes (Zhang et al., 2014). Fire protection system and emergency plan are the fundamental guarantee of campus fire safety. It is essential to improve personnel of faculties, colleges, departments, and individual responsibility at all levels of fire clear and refine the fire regulations so that each location has responsibility for fire supervision (Meng et al., 2016). Fire emergency plan should be made based on a comprehensive investigation of the actual situation of the building, to carry out scientific analysis and demonstration of the characteristics of the relevant building, for major fire hazards and possible fire or explosion of key positions and locations, to prepare a complete fire emergency plan to ensure that the construction of fire can quickly and effectively conduct emergency response.

Publicity and education are the main way for students to obtain knowledge of fire protection. Nowadays the media network has become the pulse. It is the first source of information in society. Using the advantages of network platform to spread quickly, wide audience, combined with fire video, safety lectures, questionnaire and other means to carry out fire promotion from a number of angles, both to save the budget for the fire fighting hardware construction, and can greatly improve the efficiency of publicity. Each unit should be often supervision and check implement fire

safety responsibilities about the fire control safety regularly, such as firefighting equipment maintenance, emergency supplies, in particular to do spot check about student dormitories' safety, found the problem and follow up the rectification.

1.3 Previous Study

A study conducted by the Ministry of Education has found that there were outbreaks of fire in 22 primary and secondary schools and in institutions of higher learning for the year 1999 resulting in losses of RM 534,400 (Subramaniam, 2004). Some fires cause indirect consequential losses such as loss of production, unemployment and lowering of exports, although at the national level, these losses do not contribute significantly to the total fire loss (Ramachandran, 1999). In 2004, Subramaniam had conducted a study to identify the existing fire safety condition in residential colleges located in a local university (not stated for some reason). It also seeks to identify important human involvement elements that need concentration to achieve a higher standard in fire safety management for a local university. The author had conducted the study based on questionnaires to the occupants and safety inspection audit. In the research, the overall current fire safety condition is reported at 76.0% compliance and the critical non-compliant item has been identified as the exit sign requirement as stipulated by the Uniform Building By-Laws, 1984. The By-Laws were only issued in 1984 but these residential colleges were built earlier in 1983, so Subramaniam stated that there is a logical reasoning why these requirements were not met.

Hassanain previously has conducted a study in 1998 to investigate the design and operation factors that affect the provision of fire-safe student housing facilities. The proposed operational framework for fire safety evaluation in student housing facilities consists of five sequential processes, namely archival and document evaluation, development of an audit worksheet, commencement of the walk-through inspection, reporting of inspection findings, and development of a plan for remedial actions. The paper also discusses the causes of fire accidents in student housing facilities and classifies the factors that make it a high fire-risk type of facility. It identifies several common design deficiencies contributing to student housing fires and reviews measures to prevent fires in student housing facilities. Most fires in student housing facilities occur while universities are in session. These fires decline significantly during midterm and summer breaks when universities are not in full session. Among the leading causes of fires in student housing in the United States, the National Fire Incident Reporting System indicate that one-third of student housing fires are reported as incendiary or suspicious fires by arsonists who set fires as a prank or to cover-up a crime. Hot plates used for cooking are reported as the second leading cause in student housing (21%) followed by smoking as the third leading cause (14%), as smoldering cigarettes might be tossed carelessly into a trash can. The rest were caused by open flame fires from candles lit for atmosphere or for decorative purposes, overloaded electrical outlets, space heating equipment and electrical appliances (Hassanain, 1998).

Student housing is a distinctive type of densely populated building that house a large number of occupants. The functions usually accommodated in student rooms are studying, sleeping, dressing and relaxing. Student housing facilities constitute a high fire-risk type of buildings. This is mainly due to the combination of three risk factors. The first factor relates to the large number of students potentially exposed at one location, where some of these students may engage in risky behaviors (Comeau, 2003). Sometimes, occupants often lack a clear understanding of the logic underlying fire protection features. It is not surprising that they make mistakes when responding to emergencies. Unfortunately, these mistakes are rarely revealed because investigations of fires focus mainly on problems with physical systems (Groner, 2016).

The second risk factor relates to the high fire load attributed to the nature, amount and arrangement of fire fuel that exists in the student rooms. Fire load is defined as the amount of fuel within a room or a building, which will burn to release heat and feed the growth of fire (Stollard and Abrahams, 1999). Possible types of fire load that could be found in the student housing includes furniture, books, papers, and plastic displays, which are often suspended from ceilings and light fittings. The third contributing factor is the design configuration of the majority of student housing facilities. Most of these facilities are multi-storey buildings, occupants located in upper floors could experience escape problems due to the crowdedness and the chaos found at exit routs and while going down stairwells. Fire protection in buildings is required to achieve the overall objectives of providing protection to occupants for safe egress, safeguard firefighting personnel during their intervention activities and to prevent the spread of fire to other property (Poon, 2013).

This study provides a different way of evaluating fire safety measures in student housing facilities, which generally focused on passive and active fire measures conventionally, by adding the elements of occupants' awareness and knowledge regarding fire safety as well. Due to the fact that some large campaign just vanished after being carried out on a grand and spectacular scale for a day, making it rather difficult to make accurate interpretation about the participants' amount of awareness and knowledge obtained, remembered and converted into the improvement of fire safety quality by the participants (Helan et al., 2014). Hence, a simple way of evaluating the occupants' fire safety knowledge and awareness were suggested to be implemented in annual fire safety evaluation and campaign.

2.0 METHOD

Fire safety measures in residential college was categorised into three elements; 1) the level of fire safety awareness and knowledge among occupants, 2) visual inspection on fire safety protection systems, and 3) review of emergency response plan documents. The approach to obtain information regarding occupants’ fire safety knowledge and awareness was via survey method by distributing questionnaires. 401 survey questionnaires were distributed to the occupants of the selected residential colleges (College A, College B, College C, College D and College E). The selection of residential college was based on the built year, which is before 1984 (where applicability of UBBL 1984 is non-available). After that, a walkthrough visual inspection to assess the provision and the status of fire safety protection system of the building was conducted. Finally, reviewing the set of existing fire emergency response plan documentation of each residential college was done afterwards. The results were then validated using existing scoring of annual fire safety evaluation from the Occupational Safety and Health Management Office of the selected university. The fire safety measures element that were suggested in this study was shown in the Fig. 1.

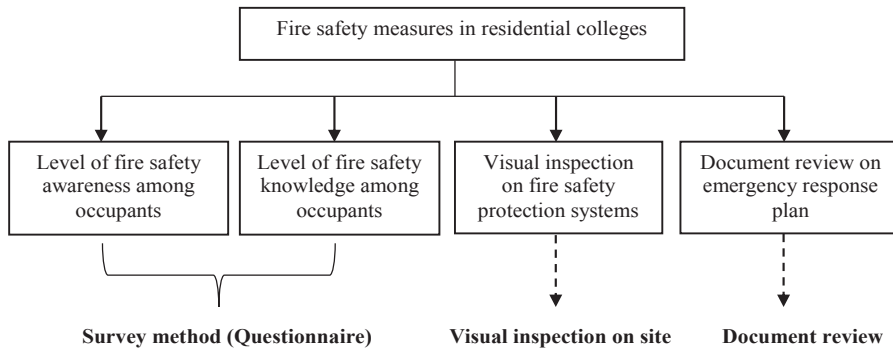


Figure 1 Fire safety measures element suggested in this study

2.1 Residential Colleges Background

The selection of residential colleges in this study was based on the year of construction, ranging from 1970 to 1980. One newly built college was chosen as a control variable to compare the fire safety measures between old building and new buildings. Table 2 shows the selected residential colleges with their background information.

Table 2 Selected residential colleges’ background information

| Residential College | No. of Occupants | Year of Construction | No. of Blocks* | No. of Storey |
|---------------------|------------------|----------------------|----------------|---------------|
| College (A) | 637 | 1971 | 5 | 4 |
| College (B) | 650 | 1973 | 4 | 4 |
| College (C) | 666 | 1973 | 4 | 4 |
| College (D) | 676 | 1979 | 4 | 4 |
| College (E) | 1,500 | 1998 | 5 | 5 |

* Number of blocks does not include cafeteria and administrative office (dormitories only).
 (Source: From visitation and interview conducted on 2016)

2.2 Survey Design

Survey questionnaires were distributed randomly to 401 students to access the information on fire safety awareness and knowledge among occupants. The questionnaires designed has six sections as shown in Table 3.

Table 3 Sections in the survey questionnaire

| Section | Contents | No. of Questions |
|---------------------------|---------------------------------|------------------|
| Section A | Demographic Information | 8 |
| Section B | Awareness Regarding Fire Safety | 20 |
| Section C | Knowledge Regarding Fire Safety | 20 |
| Section D | Fire Hazard in the College | 25 |
| Section E | Consequences of the Fire Hazard | 25 |
| Section F | Involvement of Students in ERT | 10 |
| Total Number of Questions | | 108 |

From Table 3, the set of questionnaire was designed through focused group discussion among experts of Occupational Safety and Health Management Office of the selected university to survey the level of awareness and knowledge of the respondents regarding fire safety measures, fire hazard in colleges and the consequences of the hazard due to the existing fire hazard. The survey questionnaire also includes a section to find out whether the respondents agreed or not for the involvement of student emergency response team in a residential college.

2.3 Fire Safety Inspection

The current fire safety measures in each residential college was evaluated from visual observation and safety inspection. In order to cover crucial elements of fire protection system, a local guideline was used, which was the Form A as stated in the Fire Service Act 341 of the Fire Rescue Department checklist. The inspection on fire safety measures were focused on; 1) life safety facility, 2) fire prevention facility, 3) fire protection facility and 4) fire-fighting facility of each selected residential colleges.

2.4 Document Review

The final methodology for the study was reviewing existing fire emergency response plan documents for each of the selected residential colleges. The criteria for the fire emergency response plan to be reviewed were namely; 1) emergency planning committee, 2) emergency action plan, 3) emergency response procedure, 4) emergency response team, 5) training and exercise, 6) student involvements in the ERT and 7) documentation and records. The document review was conducted to determine whether the existing fire emergency response plan for the colleges complied with the campus guideline set by the Occupational Safety and Health Management Office of UPM. Fire emergency response plan documentation are included in the elements of fire safety measures and should be accounted for in the scoring system.

3.0 RESULT AND DISCUSSION

Table 4 summarizes the survey questionnaire results of the respondents' demographic information that includes the respondents' gender, age, marital status, accommodation campus, current level of study, period of staying in the residential college, faculty and household income per month.

Table 4 Demographic information of the respondents

| Demographic Information | | Frequency | Percentage (%) |
|-------------------------------------|---|------------|----------------|
| Gender | | | |
| - | Male | 135 | 33.7 |
| - | Female | 266 | 66.3 |
| Age | | | |
| - | 20 years old and below | 59 | 14.7 |
| - | 21 to 25 years old | 324 | 80.8 |
| - | 26 to 30 years old | 17 | 4.2 |
| - | 30 years old and above | 1 | 0.3 |
| Marital status | | | |
| - | Married | 23 | 5.7 |
| - | Single | 378 | 94.3 |
| Accommodation | | | |
| - | College (A) | 80 | 20.0 |
| - | College (B) | 76 | 19.0 |
| - | College (C) | 80 | 20.0 |
| - | College (D) | 60 | 15.0 |
| - | College (E) | 105 | 26.0 |
| Current level of study | | | |
| - | Diploma | 12 | 3.0 |
| - | Degree | 369 | 92.0 |
| - | Master | 18 | 4.5 |
| - | PHD | 2 | 0.5 |
| Period of staying in college | | | |
| - | One year | 86 | 21.4 |
| - | Two years | 112 | 27.9 |
| - | Three years | 85 | 21.3 |
| - | More than three years | 118 | 29.4 |
| Faculty | | | |
| - | Agriculture | 16 | 4.0 |
| - | Forestry | 6 | 1.5 |
| - | Economics and Management | 51 | 12.7 |
| - | Engineering | 1 | 0.2 |
| - | Education Studies | 57 | 14.3 |
| - | Science | 83 | 20.7 |
| - | Food Science and Technology | 8 | 2.0 |
| - | Human Ecology | 59 | 14.7 |
| - | Modern Language and Communication | 57 | 14.3 |
| - | Medicine and Health Science | 1 | 0.2 |
| - | Computer Science and Information Technology | 46 | 11.5 |
| - | Biotechnology and Bio Molecular Science | 7 | 1.8 |
| - | Mathematics | 1 | 0.2 |
| - | Environmental Studies | 6 | 1.5 |
| - | INTROP | 1 | 0.2 |
| - | Putra Business School | 1 | 0.2 |
| Household income per month | | | |
| - | RM 1000 and below | 174 | 43.4 |
| - | RM 1001 to RM 2000 | 90 | 22.4 |
| - | RM 2001 to RM 3000 | 49 | 12.2 |
| - | RM 3001 to RM 4000 | 37 | 9.3 |
| - | RM 4000 and above | 51 | 12.7 |
| Total Respondents | | 401 | 100 |

3.1 Level of Fire Safety Awareness

From the findings, it was observed that there were four questions (highlighted in yellow) that have majority answers from 1 (strongly disagree) to 3 (slightly agree). The four questions were related to the Uniform Building By-Laws 1984 (B2), the Fire Service Act 341 (B3), cooking in dormitories (B6) and the experience of fire occurrence in life before (B8). This shows that majority of the respondents were unaware of the existence of the Uniform Building By-Law and the Fire Service Act, still cooks in the dormitories and also never involved in a real scenario of fire event before in their life. All the results from Section B of the questionnaires are shown in Table 5.

Table 5 Section B respondents answer

| No. | Questions | Percentage (%) | | | | |
|-----|---|------------------|-------------|------------------|------|------------------|
| | | S _T D | D | S _L A | A | S _T A |
| 1. | Fire is inevitable but there surely something we can do to avoid it | 1.5 | 0.5 | 15.2 | 50.4 | 32.4 |
| 2. | I'm aware about the Uniform Building By-Laws 1984 | 21.2 | 33.9 | 32.9 | 9.7 | 2.3 |
| 3. | I have heard about the Fire Service Act 1988 | 17.2 | 26.4 | 36.2 | 16.0 | 4.2 |
| 4. | I'm aware about the danger and consequences of a fire incident | 0.7 | 2.0 | 14.8 | 52.1 | 30.4 |
| 5. | I have always cared about fire safety precautions | 0.3 | 4.0 | 22.2 | 52.1 | 21.4 |
| 6. | I will not let my friends cook in the dormitories for safety reason | 6.5 | 15.0 | 40.1 | 28.7 | 9.7 |
| 7. | I will not let my friends throw away lit cigarette butts in the dormitories | 2.0 | 6.7 | 21.9 | 37.9 | 31.5 |
| 8. | I have experienced fire occurrence in my life before | 27.2 | 23.2 | 24.7 | 16.7 | 8.2 |
| 9. | Fire extinguisher is the best tool for early stage in any fire event | 1.0 | 4.5 | 22.4 | 43.9 | 28.2 |
| 10. | I'm aware what can ignite fire in my college | 1.5 | 5.0 | 29.7 | 47.1 | 16.7 |
| 11. | I'm aware the emergency contact number for fire emergency | 2.2 | 8.2 | 27.4 | 41.6 | 20.4 |
| 12. | I memorize the fire action plan for my college | 7.0 | 11.5 | 34.4 | 34.7 | 12.5 |
| 13. | I'm aware about the location of the nearest assembly area | 2.2 | 4.5 | 25.9 | 47.9 | 19.5 |
| 14. | I'm aware of the location of the nearest fire extinguisher or hose reel in my college | 1.5 | 3.7 | 26.2 | 45.4 | 23.2 |
| 15. | I am familiar with the layout plan of the college buildings | 2.5 | 8.2 | 24.7 | 45.9 | 18.7 |
| 16. | I know exactly what to do if fire happens at the college | 0.7 | 10.0 | 29.7 | 44.1 | 15.5 |
| 17. | I am willing to help my neighboring mates to escape if fire happens | 0.7 | 4.2 | 25.7 | 45.9 | 23.4 |
| 18. | I will check all rooms and toilets for any occupants left if fire occurs | 2.2 | 11.5 | 36.2 | 37.9 | 12.2 |
| 19. | I will switch off all electrical appliances before leaving my room | 1.7 | 6.8 | 26.2 | 36.4 | 28.9 |
| 20. | I will leave all my personal belongings and evacuate if fire happens | 2.7 | 9.5 | 30.2 | 35.4 | 22.2 |

(S_TD: strongly disagree, D: disagree, S_LA: slightly agree, A: agree, S_TA: strongly agree)

Fig. 2 shows the level of fire safety awareness among the occupants for each respective residential colleges. The highest level of fire safety awareness recorded from the questionnaires goes to the College (E) with 74.50%, while the least was College (C) which record 69.64% level of awareness among its occupants. 69.88%, 71.22% and 69.80% level of awareness recorded in the College (A), College (B) and College (D) respectively. The average level of fire safety awareness among the students are 71.01%.

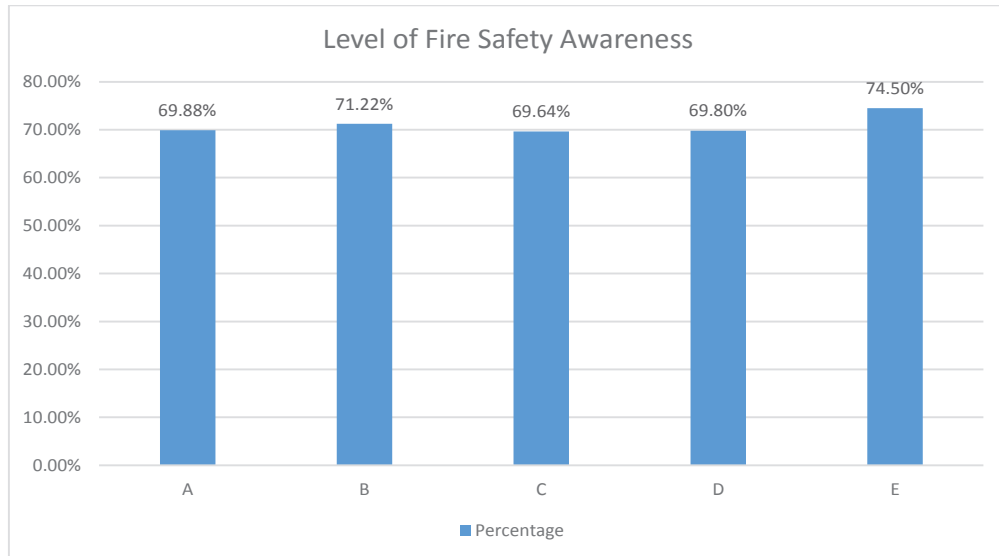


Figure 2 Level of fire safety awareness by residential colleges

A study by Altabbakh in 2015 was conducted that the students were asked if they received any formal safety training and awareness program during their academic years. Results indicated that less than 30% of their respondents had any type of formal training or awareness program in their stays (Altabbakh et al., 2015). This revelation enables them to prioritize safety awareness programs to students. With such method of simple questionnaires, this study attempted to identify the occupants level of awareness by using several questions as demonstrated in Table 5. From the questionnaire as well, the lack of awareness issue can be selected and prioritized so that the management might be able to select or allocate funding for which type of fire safety awareness program to be injected for the students prior to the stay in the colleges. For example, if the percentage of students that not aware the locations of assembly point of their respective colleges are high, then the administrative action that could be done is by putting proper signage and fire action plans more at strategic places where the student can access the information with ease. Another example is that if the students were cooking during their stay, ensuring safe housekeeping or prohibit them from cooking might be a necessary action. These questionnaires enable us to evaluate the level of fire safety awareness of the occupants and project a new remedial action to be taken efficiently.

3.2 Level of Fire Safety Knowledge

The results of Section C respondents' answer were as shown in Table 6. From the findings, majority of the respondents were not exactly sure what is fire tetrahedron (C12), the types of fire or classes of fire (C14), stages of fire development (C16), the maximum travel distance during evacuation (C18) and the appointed Fire Marshall in their colleges (C20).

Table 6 Section C respondents answer

| No. | Questions | Percentage (%) | | | | |
|-----|---|------------------|-------------|------------------|------|------------------|
| | | S _T D | D | S _L A | A | S _T A |
| 1. | I have involved in fire drills many times before | 3.0 | 10.2 | 20.0 | 42.1 | 24.7 |
| 2. | I know how to use a portable fire extinguisher without any doubt | 3.7 | 10.2 | 37.4 | 36.7 | 12.0 |
| 3. | I know what is a fire rated door and the fire resistance period | 4.7 | 16.0 | 32.6 | 36.7 | 10.0 |
| 4. | I know the emergency escape route for this college building | 2.0 | 8.0 | 23.4 | 49.6 | 17.0 |
| 5. | I know exactly where the assembly area for this college is located | 2.0 | 6.0 | 25.0 | 42.6 | 24.4 |
| 6. | I know what is an emergency lighting and emergency escape sign | 1.0 | 7.0 | 22.7 | 49.9 | 19.4 |
| 7. | I know exactly how to react if I spot a fire | 0.2 | 6.0 | 30.2 | 44.6 | 19.0 |
| 8. | I know what is the main idea of a fire emergency action plan | 0.5 | 7.7 | 24.8 | 45.6 | 21.4 |
| 9. | I know what a fire hydrant is and how it functions | 1.5 | 12.5 | 33.4 | 34.9 | 17.7 |
| 10. | I am familiar with hose reel and sprinkler system | 2.2 | 15.2 | 31.9 | 35.2 | 15.5 |
| 11. | I know what a smoke and heat detector is and how they work | 2.0 | 9.5 | 31.4 | 40.4 | 16.7 |
| 12. | I really understand the fire tetrahedron concept | 8.7 | 20.7 | 35.7 | 27.4 | 7.5 |
| 13. | I know what to do if I'm trapped in a room filled with smoke | 5.0 | 15.0 | 33.2 | 36.4 | 10.4 |
| 14. | I know all classes of fire / type of fire | 10.5 | 23.9 | 36.4 | 21.7 | 7.5 |
| 15. | I know how does a fire alarm system operates | 3.2 | 13.7 | 33.2 | 37.7 | 12.2 |
| 16. | I know all the stages of fire development | 6.7 | 21.7 | 37.9 | 26.2 | 7.5 |
| 17. | I know what is the purpose of a fire emergency response team | 2.8 | 10.7 | 37.9 | 36.9 | 11.7 |
| 18. | I know what is the maximum travel distance during an evacuation | 5.0 | 19.7 | 35.9 | 29.7 | 9.7 |
| 19. | I do know what is a dead end corridor and its limitation | 6.0 | 18.4 | 35.4 | 29.7 | 10.5 |
| 20. | I know who is the incident officer/fire marshal appointed in this college | 11.7 | 20.0 | 31.4 | 27.4 | 9.5 |

(S_TD: strongly disagree, D: disagree, S_LA: slightly agree, A: agree, S_TA: strongly agree)

Fig. 3 shows the level of fire safety knowledge among the occupants for each respective residential colleges. The highest level of fire safety knowledge recorded from the questionnaires goes to College (A) with 70.85%, while the least is College (C) which record 66.31% level of knowledge among its occupants. 67.76%, 66.83% and 70.35% level of knowledge recorded in College (B), College (D) and College (E) respectively. The overall level of fire safety knowledge among the students are 68.42%.

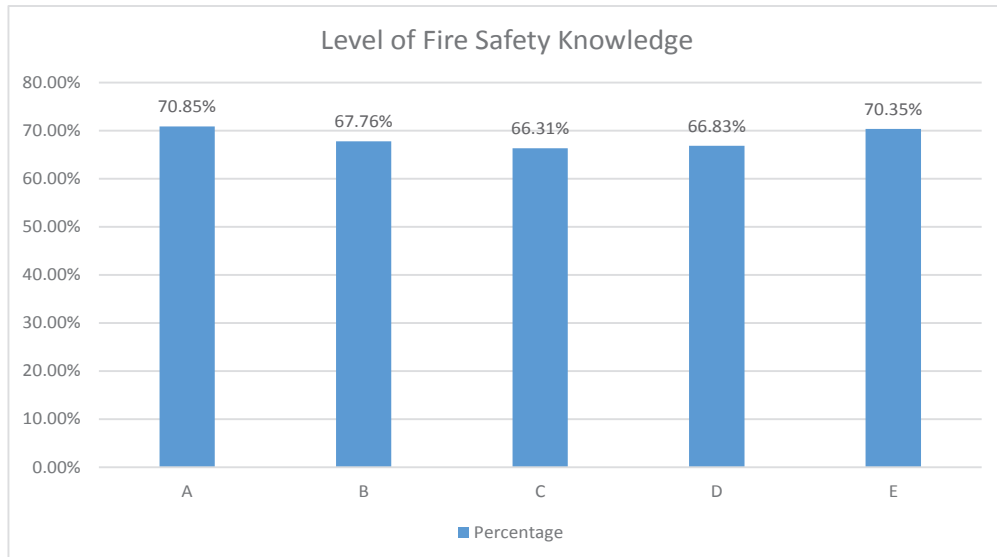


Figure 3 Level of fire safety knowledge by residential colleges

In a study by Altabbakh et al. (2015), respondents were asked about knowledge and fire safety procedures. The question was designed to assess students' knowledge of facility evacuation procedures, usage of portable fire extinguisher and others. Only 47% of respondents know how to use the firefighting equipment or evacuation task execution. As a result, the students do not know how to properly respond to a fire, or do not know the proper evacuation route and assembly point. In this study, it was demonstrated that 63.1% of students did not know who to notify during fire emergencies. Mostly the students do not know how to use fire extinguisher and other firefighting facilities of their colleges. Since having this questionnaire distribution enable us to identify what type of fire safety campaign to be injected for the students, the evaluation of fire safety knowledge can now be implemented by the residential colleges personnel easily.

After conducting the evaluation of fire safety knowledge among students, it was crucial to ensure the firefighting facilities to function properly. There is no use of knowledge to respond to a fire situation if the facilities are not working when the time of need. Hence, the college administration personnel should conduct regular inspection and maintenance to those fire safety protection systems throughout the year. Besides, if the students know how to respond to fire and how important the fire protection system are, they would not try to attempt or mess around with the equipment in the first place. From the findings as well, the residential colleges management can now establish internal emergency response team specialized for fire incident. This information can be used to select the manpower needed for designated emergency response team among student's involvement.

3.3 Fire Safety Inspection Result

From the findings, there were several elements that require attention (score with 75% and less). For older college buildings, the issues highlighted were the floor exit door, which were not fire rated doors. Most of the older colleges have open-spaced staircases design, which are not fully fire protected. Most of the colleges have major issue on their fire alarm system, which were still under maintenance. Fire safety protection system inspection results for each residential college were shown in Table 7.

Table 7 Fire safety protection system audit results

| No. | Description | Percentage of Compliance (%) by College | | | | |
|----------|-------------------------------------|---|--------------|--------------|--------------|--------------|
| | | A | B | C | D | E |
| 1 | Life Safety Facility | | | | | |
| 1.1 | Exit signage | 94.29 | 99.38 | 81.67 | 100.00 | 90.00 |
| 1.2 | Emergency Lighting | 90.00 | 98.04 | 92.61 | 100.00 | - |
| 1.3 | Fire action plan | 100.00 | 18.75 | 68.75 | 100.00 | 25.00 |
| 1.4 | Fire emergency notice | 100.00 | 0.00 | 87.50 | 100.00 | 25.00 |
| 1.5 | Stairs | 91.67 | 75.00 | 75.00 | 75.00 | 75.00 |
| 1.6 | Corridors | 100.00 | 84.62 | 84.62 | 84.62 | 85.00 |
| 1.7 | Floor exit door | 75.00 | 62.50 | 62.50 | 62.50 | - |
| 2 | Fire Prevention Facility | | | | | |
| 2.1 | Heat detector system | 66.67 | 100.00 | 0.00 | 66.67 | 100.00 |
| 2.2 | Smoke detector system | 66.67 | - | - | - | - |
| 2.3 | Public address system | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 2.4 | Direct line to local fire station | - | 100.00 | - | - | - |
| 3 | Fire Protection Facility | | | | | |
| 3.1 | Fire rated door | - | - | - | - | 100.00 |
| 3.2 | Electrical wiring | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| 4 | Fire Fighting Facility | | | | | |
| 4.1 | Portable fire extinguisher | 100.00 | 99.53 | 91.88 | 100.00 | 0.00 |
| 4.2 | Fire hydrant | 100.00 | 90.00 | 100.00 | 100.00 | 100.00 |
| 4.3 | Hose reel system | 84.88 | 100.00 | 98.44 | 100.00 | 100.00 |
| 4.4 | Pump house | 31.25 | 100.00 | 87.50 | 81.25 | - |
| 4.5 | Fire alarm control panel | 55.00 | 100.00 | 40.00 | 40.00 | 75.00 |
| 4.6 | Fire engine access | 72.73 | 81.82 | 81.82 | 81.82 | 72.73 |
| 4.7 | Alarm bell | 100.00 | 100.00 | 98.65 | 69.22 | 100.00 |
| 4.8 | Break glass panel | 100.00 | 100.00 | 99.79 | 68.13 | 100.00 |
| | Overall Score Percentage (%) | 85.69 | 84.72 | 80.60 | 84.96 | 77.98 |

Table 7 summarized the inspection results in all the selected residential colleges. College B, C and E has issue on fire action plan, which is not full distributed throughout the floors and corridors. Fire emergency notices, which listing the emergency contact numbers were not available in College B and E. In the aspect of fire prevention, College A, C and D have issues on their heat and smoke detector system, which then relates to the fire notification system. If smoke and heat detectors are malfunctioning, the detection will not be successful and fire alarm would not be triggered automatically. College E, the newest selected college has issue on the maintenance of portable fire extinguishers. Some of them have reached expiry date on 11th of May 2016 (the inspection conducted on 23rd of May 2016). As for alarm system, most of the college's fire alarm control panel are still under maintenance, due to budgetary issue. In College D, some of their alarm bell and break glass panel are not fit for duty and requires immediate repairs. Overall, the compliance score is 82.79%.

3.4 Document Review on the Emergency Response Plan

The final methodology was reviewing the fire emergency response plan documentation for each residential college selected. The content of the document was checked and compared with the university's OSH Disaster Management Plan. From the review, most of the colleges have students' involvements but no appointment letter. Only College E still does not have students' involvements in their internal emergency response team of the college. Table 8 summarized the document review on the fire emergency response plan of each college selected.

Table 8 Fire emergency response plan document review results

| No. | Content | Availability | | | | |
|----------|-------------------------------------|--------------|--------------|--------------|--------------|--------------|
| | | A | B | C | D | E |
| 1 | EMERGENCY PLANNING COMMITTEE | | | | | |
| 1.1 | Membership | √ | √ | √ | √ | √ |
| 1.2 | Role and Responsibility | √ | √ | √ | √ | √ |
| 1.3 | Organization Chart | √ | √ | √ | √ | √ |
| 2 | EMERGENCY ACTION PLAN | | | | | |
| 2.1 | Emergency Classification | √ | √ | √ | √ | √ |
| 2.2 | Emergency Level Notification | √ | √ | √ | √ | |
| 2.3 | Communication Plan | | | | √ | |
| 2.4 | Evacuation Diagram | | √ | √ | √ | √ |
| 2.5 | Distribution of Plan | | √ | √ | √ | √ |
| 3 | EMERGENCY RESPONSE PROCEDURE | | | | | |
| 3.1 | Standard Operating Procedure | √ | √ | √ | √ | √ |
| 3.2 | Emergency Color Code or Tags | | √ | | | |
| 3.3 | List of Inventory and Equipment | | | √ | √ | |
| 4 | EMERGENCY RESPONSE TEAM | | | | | |
| 4.1 | Incident Command System | √ | √ | √ | √ | √ |
| 4.2 | Emergency Contact List | √ | √ | √ | √ | √ |
| 4.3 | Role and Duties | √ | √ | √ | √ | √ |
| 4.4 | Identification of Members | √ | √ | | √ | |
| 5 | TRAINING AND EXERCISE | | | | | |
| 5.1 | Seminar Exercise | | | √ | | |
| 5.2 | Table Top Exercise | | | | | |
| 5.3 | Fire Drills | √ | √ | √ | √ | √ |
| 6 | STUDENT INVOLVEMENT IN ERT | | | | | |
| 6.1 | Student Membership | | | | | |
| 6.2 | Organization Chart | √ | | √ | √ | |
| 6.3 | Role and Duties | √ | √ | √ | √ | |
| 6.4 | Contact List | √ | √ | | | √ |
| 7 | DOCUMENTATION | | | | | |
| 7.1 | Safety Audit and Inspection Record | √ | √ | √ | √ | √ |
| 7.2 | Regular Safety Meeting or Briefing | √ | √ | √ | √ | √ |
| 7.3 | Records of Fire Drills or Exercise | √ | √ | √ | √ | √ |
| 7.4 | Records of Fire Safety Maintenance | √ | √ | √ | √ | √ |
| 7.5 | List of Occupants and Inventory | | | | | |
| | Total Score | 18/27 | 20/27 | 20/27 | 21/27 | 16/27 |
| | Total Percentage Score (%) | 66.67 | 74.07 | 74/07 | 77.78 | 59.26 |

As shown in Table 8, most of the colleges lack proper communication plan for fire emergency, which supposedly to list all the frequency and channel used for walkie-talkies and type of devices used. They also should have a complete list of inventory and occupants list readily for use in case of emergency. Members of the emergency response team also must have proper identification, such as vest and name tags, so that they can be identified easily. Overall, the older colleges have much better emergency response plan documentation compared to the new college. The newer college students' emergency response team has not yet been developed and require improvements. Moreover, the College E has larger occupants number, making the coordination much more complex compared to the older colleges. Hence, the students ERT should be developed in order to have more coordinated effort during emergency at internal level.

3.5 Overall Result on Fire Safety Measures

From all element of fire safety measures evaluated from the methodology, the overall results were shown in Table 9.

Table 9 Overall scoring from the methodology conducted

| Element | A | B | C | D | E | Average |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------|
| Fire safety awareness | 69.88% | 71.22% | 69.64% | 69.80% | 74.50% | 71.01% |
| Fire safety knowledge | 70.85% | 67.76% | 66.31% | 66.83% | 70.35% | 68.42% |
| Fire safety inspection | 85.69% | 84.72% | 80.60% | 84.96% | 77.98% | 82.79% |
| Emergency response plan (ERP) | 66.67% | 74.07% | 74.07% | 77.78% | 59.26% | 70.37% |
| Total score | 73.27% | 74.44% | 72.66% | 74.84% | 70.52% | 73.15% |
| Grade | B (Good) | B (Good) | B (Good) | B (Good) | B (Good) | |

Table 9 show that all of the colleges have obtained good results (70.0 to 79.9%). Overall score from fire safety inspection was 82.79%, level of fire safety awareness among occupants was 71.01%, level of fire safety knowledge among occupants was 68.42%, document review recorded 70.37%, while the overall average score of all selected colleges was 73.15%. The result was then compared with the existing scoring of annual fire safety evaluation from the Occupational Safety and Health Management Office of the selected Malaysian university for the year 2015. The annual report of fire safety evaluation was shown in the Table 10.

Table 10 Existing fire safety evaluation annual report scoring for 2015

| Residential College | A | B | C | D | E | Average |
|---------------------|----------|---------------|---------------|---------------|----------|---------|
| Total Score | 77.00 % | 89.00 % | 80.00 % | 95.00% | 78.00 % | 83.80 % |
| Grade | B (Good) | A (Excellent) | A (Excellent) | A (Excellent) | B (Good) | |

(Source: Occupational Safety and Health Management Office report of the selected university, 2015)

The result from Table 9 and Table 10 shows the difference in result of scoring methodology. Table 9 shows the result from the methodology of this study fire safety evaluation while the Table 10 shows previous annual report scoring for year 2015. The result validates that the element of fire safety awareness and knowledge among occupants should be included in the methodology of scoring for fire safety evaluation in residential colleges. Base on the overall result, it was observed that the score of four older buildings (built before 1984) recorded were higher compared to the newer building (College E). From initial hypothesis, it was expected that the score of older building colleges will be lesser than the control variable which is College E (built after 1984). However, the result shows that the older college score less than the older residential college building. This shows that year of construction (either before or after the existence of UBBL 1984) does not significantly affect the performance of fire safety measures in any particular facilities. The important aspect in consideration should come from the occupants such as staff or students themselves.

It is believed that the occupants should be involved somehow in the evaluation so that the annual audit will be more efficient and detailed. Usually in general, a fire safety evaluation in student housing facilities were conducted twice a year or in yearly basis at least. The criteria of evaluation often referred to the most critical elements, as stated in Fire Service Act 341. However, occupants' awareness and knowledge on fire safety measures were merely not taken into considerations. This study tests the availability of information regarding occupant's awareness and knowledge taken into account for evaluation of overall fire safety measures in a facility. This is to create a new understanding of resiliency or coping capacity of a housing facility occupants to adapt with emergencies. Hence, a new way to evaluate fire safety measures was introduced for a better scoring, which the role of occupants taken into account.

With both elements taken into consideration, the scoring will be more dynamic each year since the residential college will have different intake each year, making a challenge for the management and authorities to provide basic knowledge and awareness campaign for its occupants annually. As can be seen in the result, without having the occupant's safety awareness and knowledge into the scoring system, fire inspections scores will be high (above 80.0% in average), which is very pleasing to see. But to have pleasing scores is not the real goal in life saving perspective. It is crucial to have everything taken into account, for which this study opens up the new way of evaluation including internal resilience of the occupants. With knowing the level of awareness and knowledge, the management can plan for better measure and preparedness campaign such as fire safety week. Due to the facts that occupants are the one who lives in the college, it is important for them to have at least basic awareness and knowledge regarding fire safety, as this study tried to proof.

4.0 CONCLUSION

Overall, the fire safety measure of all selected colleges in average obtained 73.15% score. The detailed scoring of fire safety measures in this study was divided into four elements, which were the level of fire safety awareness (71.01%), the level of fire safety knowledge (68.42%), visual inspection of fire safety protection system (82.79%) and the document review on emergency response plan (70.37%). The methodology of combined elements of respondent's level of awareness and knowledge regarding fire safety measures with the conventional method of visual inspection and document review were able to reflect the fire safety scores of the residential colleges. Without having the information of the occupant's level of fire safety awareness and knowledge, the normal scoring (inspection and document review only) will always be higher. From the 2015 annual report of the Occupational Safety and Health Management Office of the selected university, the average scoring of fire safety measures in the selected residential colleges was 83.80%, with each college scores 77.00% for A College, 89.00% for B College, 80.00% for C College, 95.00% for D College and 78.00% for E College. The difference of scoring method shows that the methodology of including respondents level of awareness and knowledge of fire safety was lower compared to only using visual inspection and document review solely. The new method was able to reveal the vulnerability of its own occupants as well as the existing fire safety protection system and emergency response plan in the selected residential colleges. These findings were not meant to uncover weakness of the residential colleges, but instead it reveals the opportunity for improvements for the management of the residential colleges to ensure the safety of its occupants as well as enhancing the level of fire safety measures respectively. Improvements in this context is where all personnel and students work together in performing good practice in fire safety measures and behaviour practise. With better awareness and knowledge, the coordination of emergency action plan and procedure can be well executed. From the perspective of OSH, the new checklist and visualization of layout plan can be useful in the future inspection where the scoring system can be easier to understand. From this study, it is hoped that the method of fire safety inspection can be more comprehensive and can be regulated much frequently, and can be easily done by colleges' personnel. With all fire hazards and risk issues addressed, action for improvements can be conducted with more optimum efforts by the management boards.

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