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Suitability of Escape Route Design for Elderly Residents of Public Multi-storey Residential Building

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ABSTRACT

The rapid increase in the number of multi-storey residential buildings has raised concerns on the provision of escape route design. Statistics from the Fire and Rescue Department Malaysia showed a high number of casualties involved elderlies when there is a fire. This paper studies expert opinions on the suitability of escape route design for elderlies in public multi-storey residential buildings based on the Uniform Building By-Law (UBBL) 1984 specifications. The result showed enhancing the escape route design suited for the elderly is needed arising from the slow walking speed of the elderlies which can cause delays in the evacuation process. The majority of experts agreed that the escape route design is most important to provide safe evacuation process followed with occupant physiological and psychological characteristics.

Keywords: Elderly, escape route design, evacuation, safety

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INTRODUCTION

Population Growth and Safety of the Elderly

The rapid increase in the urban population has led to an expansion in the number of multi-storey residential buildings. The government has provided high-rise low-cost housing to meet the housing needs of the low-income group and to reduce the number of illegal residents and squatter settlements

(Karim, 2012; Muhamad Ariff & Davies, 2009). Malaysia has a specific uniform building by-law and planning guideline for public housing in Malaysia which has been developed by the Malaysian Construction Industry with the aim of ensuring the safety of the building occupant (Husin et al., 2012). Despite this, public safety issues continued to be reported (Husin et al., 2012).

Although building design is considered as the main factor in ensuring safety studies have shown that the response and behaviour of the people are often based on psychological and physiological factors (Hofinger, Zinke, & Künzer, 2014; Tan, Hu, & Lin, 2015; Tancogne-Dejean & Laclémence, 2016). During an emergency human impulsive behaviour and panic attacks are the main causes of casualties. Furthermore, the deterioration of environmental condition triggered new adaptive behaviours and physical responses (Ha & Lykotrafitis, 2012; Kady & Davis, 2009). There are many factors that influence the decision making and age is one of them (Zhan et al., 2013).

The number of those aged above 60 is expected to increase by 56% between 2015 and 2030 (UN Population Division, 2013). The increment of elderly population increases the concern for their safety, especially in the low-cost housing residences. During evacuation, this group of people could reduce or affect evacuation efficiency especially in staircases.

Expert Opinion in Safe Escape Route Design

The involvement of experts from different backgrounds is needed to ensure maximum safety in residential buildings. The basic principles of designing for fire safety in a building remain the same and is set by the Malaysian UBBL guidelines. Examples of the building regulations set for the public multi-storey residential building are maximum travel distance, provision of a fire hydrant and hose reel, alternative exit, and number of staircases.

Although due consideration has been given to aspects related to fire safety in buildings. Regular maintenance is needed to ensure all the fire safety facilities are well equipped and in good working condition and protected from vandalism.

The Fire Department is not only involved in an emergency situation but also during the design process stage to ensure adherence to fire safety regulations. Elevators too have been found suitable for evacuation purposes. Nevertheless, important fire safety factors such as the design and occupancy load of staircases, the maximum distance, and other matters related to staircases need to be prioritised in a multi-storey building.

METHODS

The approach of this study is to discuss expert opinions on the reliability of escape route designs for elderly residents in public multi-storey residential buildings. The

experts consisted of architects, engineers, fire brigade officers and building controllers. A pilot study was conducted to check the reliability of the survey questionnaire. Sixteen respondents were gathered and based on their responses, the Cronbach's Alpha (based on standardizing items) shows a 0.733 which fall under the acceptable internal consistency of range.

One hundred survey forms were distributed via email and only 27 experts responded. A quantitative method using a close-ended questionnaire survey consisting of three sections was used to ascertain the demographic background of the respondents, expert opinion regarding the safety measure, and a five-point Likert scale, ranging from "not important at all" to "very important". Each question is analysed according to the independent means score which ranged from high to low as shown in Table 1.

Table 1
Mean score range

Mean score range	Description
4.1 < Mean < 5.0	High
3.1 < Mean < 4.0	Medium
2.1 < Mean < 3.0	Average
1.1 < Mean < 2.0	Low

RESULTS AND DISCUSSION

Respondents' Profile

There were 27 expert respondents involved in this survey consisting of architects (48%), fire brigade officers (36%), engineers (8%), building controllers (4%) and academics (4%). In terms of fire safety design in buildings, 48% of the participants were found to have more than 10 years' experience; 32% had between one and two years of experience, 3-5 years' experience (16%) and 5-10 years' experience (4%). More than two thirds of the respondents were from the public sector (68%) with experience in designing public multi-storey residential buildings and 32% from the private sector with similar experience.

Safety for the Elderly

The second section of the survey involved a survey on experts view regarding safety measures in public multi-storey residential building. There are six variables in this section. The score of the survey is shown in Table 2 based on the highest to the lowest agreement of the survey.

Almost all (91.7%) experts agreed on the need to enhance building safety regulation enhancement. The majority (87.5%) of experts agreed that due to the slower walking speed of the elderlies compared with the younger groups, the efficiency of the evacuation process will be affected. Although during the emergency situation the usage of lift is prohibited 83.3% of the experts thought that the lift could be beneficial to transport people to safety. Slightly more than half or 56.5% of the experts considered current fire regulation to be adequate to ensure maximum safety while 43.5 % disagreed, raising issues whether existing fire regulation is adequate to ensure maximum safety for the aged.

Table 2
Safety measure of building occupied by elderlies

Variables	Yes	No
	%	
With the increment in elderly occupants, the building safety regulation needs to be enhanced	91.7	8.3
Low walking speed delayed and affected the evacuation efficiency	87.5	12.5
Lift usage is advisable for the elderlies as they are more prone to the risk of falling during emergency situation	83.3	16.7
Travel distance plays a very important role in determining the total evacuation process.	78.3	21.7
Elderlies need longer time to evacuate	75	25
The current fire regulation is enough to ensure maximum safety for the elderly	56.5	43.5

Fire Safety Measurement

The third section of the questionnaire was conducted using a Likert scale where comparisons of means were used to determine which variables are more important. Ranking is based on the high and medium score where high priority is when the means score 4 and above, scores below 4 will be considered as a medium priority.

Results of questions in Section 3 is shown in Table 3. Everyone responsible for providing safety measure in the building falls under the high priority. The top three people responsible are the firefighters (4.7778) followed by building maintenance officers (2.6296) and building designers

Table 3
Priority for responsibility, and factors affecting evacuation and causes of fire

Priority	Responsibility		Factor		Cause of fire	
	Variable	Means Ranking	Variable	Means Ranking	Variable	Means Ranking
high	Firefighter	4.7778	Maintenance	4.2963	Short circuit	4.2593
	Building maintenance officer	4.6296	No. of Occupancy	4.1111	Home appliance failure	4.2593
	Building designer	4.4815	Passive & active	4.0370	Explosion	4.0000
	Building owner	4.4444	Design layout	4.0000		
	Regulatory body	4.1852				
medium			State of mind	3.8889	Open flame	4.2593
			Building layout familiarity	3.8519	Glowing fire	4.2593
			Experience	3.5926	Hot surface material	4.0000
			Ages	3.5185		

(4.4815). Firefighters scored the highest followed by building maintenance officers and building designers. As for the factors that affect the evacuation efficiency, regular maintenance, the level of density, fire safety criteria available and also the complexity of the building layout feature as a high priority while panicking, and familiarity with the building layout counted as medium priority. The third question is the cause of fire, where the experts and the statistics from the fire rescue department Malaysia agreed that the short circuit is the main cause of fire breakout in residential area.

Table 4 shows the result of occupants response to an emergency and majority of experts found awareness to be a high priority. On the subject of end-user safety factor it was found that the presence of too many safety locks had a mean value of 4.2593 suggesting that it could delay or block evacuation. Second highest is the lack of emergency training.

Table 4
Occupants' response towards reducing injury and end-user safety factor

Priority	Occupant response		End-user safety factor	
	Variable	Means Ranking	Variable	Means Ranking
high	Aware of the exit passage	4.4074	Too many safety locks	4.2593
	Attended a fire drill training	4.2963	Lack of emergency training	4.0000
	Aware of the location of safe assembly	4.2222		
	Aware of the location of firefighting equipment	4.1852		
	Attempt to put down the fire	3.9259	Concern of valuable item	3.9259
	Evacuate early	3.8519	Too many obstacles in corridors	3.7-27
Medium	Have knowledge in using firefighting equipment	3.5556	Not aware of the safety means and equipment	3.6296
	Have an experience involving fire	3.5185		

Table 5 shows the building element and escape route design that should be incorporated in the public multi-storey residential building to ensure maximum safety during the evacuation process. It is clearly shown that high priorities are the variables that are stated in the UBBL 1984 as part of the regulation for the multi-storey residential. The provision for sufficient exit doors to cater to the elderly in residential building was the highest priority, as the experts deemed that it would contribute positively to the overall evacuation process.

Future research could test design features to check whether they contribute towards improving the evacuation process. The width and depth of the staircases fall under the medium category as it does not contribute much to the evacuation efficiency. Alternative staircases have often

Table 5
Building element and escape route design

Item	Variable	Means	Overall ranking from respondent	
			Ranking	Priority
1	Sufficient number of exit doors	4.4444	1	
2	Staircase width maintained	4.3704	2	
3	Corridor follows max travel distance	4.1481	3	
4	Provide alternative staircase	4.1111	4	
5	Provide alternative exit			high
6	Uniform tread and riser			
7	Exit width sufficient with building capacity	4.0370	5	
8	Provide both handrails	3.9259	6	medium
9	Bigger passage to cater to the elderly	3.8889	7	
10	Occupant load control	3.7778	8	
11	Width of staircase is less than the depth of staircase	3.5556	9	
12	Protected corridors	2.4444	10	

been provided however proper maintenance is needed to ensure evacuation efficiency. That is why the staircases' width are to be maintained throughout the building and alternative staircases fall under the highest priorities.

CONCLUSION

The increase in the urban and elderly population gives rise to challenges in the time taken to evacuate the public from multi-storey residential buildings. A survey conducted to solicit expert opinions on the matter found the need to enhance evacuation efficiency. There was some disagreement on the issue whether current regulations are sufficient to deal with the matter. Further study is needed to test on the suitability of building regulation towards the occupant density and elderly occupant as there is still a lack of study on the minority of the population.

The results showed the end user or human factor is important in providing safety during emergency human factors such as the presence of excessive numbers of safety locks and absence of emergency training could delay the evacuation process.

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