ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

DEVELOPMENT OF ASSESSMENT PROCEDURE FOR MEANS OF ESCAPE IN HOSPITAL'S BUILDING IN MALAYSIA.

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DOI: 10.5281/zenodo.834469

ABSTRACT

Hospital's fire is tragedy that needs to be avoided. However, when it occurs, it causes injuries, death, and may lead to losses for hospital's management and building. There is a need to ensure a safe means of escape is provided in a building for safe evacuation by the user. Previous researches were focusing on auditing checklist and analyzed by using qualitative method. However, this paper intended to enhance the research methodology from previous research by analyzing the audit checklist using weightings method. This is to ensure the results of auditing checklist become robust, acceptable and concurrently with result from previous research. The analysis starts by tabulating data gained from audit checklist into assessment grade. All detailed criteria for each design criteria were categorized according to the color codes that represents different general criteria. The grade score for detailed criteria were used to generate average grade score for general criteria mentioned before. Based on Fifth Schedule: Designation of Purpose Groups (UBBL 1984), weighting system that suitable to be selected corresponds to this study fall under group number II of purpose group which is Institutional. The results found that Hospital's A most complied with regulations outlined in acts.

KEYWORDS: audit, checklist, hospital's building, means of escape, procedure.

I. INTRODUCTION

The Fire and Rescue Department of Malaysia (FRDM) reported that there were average 29 hospital's fire breakouts in Malaysia between 2012 – 2016. The statistics on fire breakouts happen at healthcare's building in Malaysia as in Figure 1. Recently, Malaysia have been shocked by news of the fire incident at Hospital Sultanah Aminah in 2016. The fire has claimed six lives and three injured persons. This is happened because the high dependency of the patients on staff for evacuate during fire. [1] added that patients were highly dependable on staff due to they were weak, handicapped, and this issues is one of the greatest challenges facing by designer and most of the operators of healthcare premise. [2] addressed that the provision for fire resistance which safe Means of Escape (MoE) in fire are most important criteria during designing a building. Therefore, this research paper intended to enhance the research methodology from previous research by analyzing the audit checklist using weightings method.

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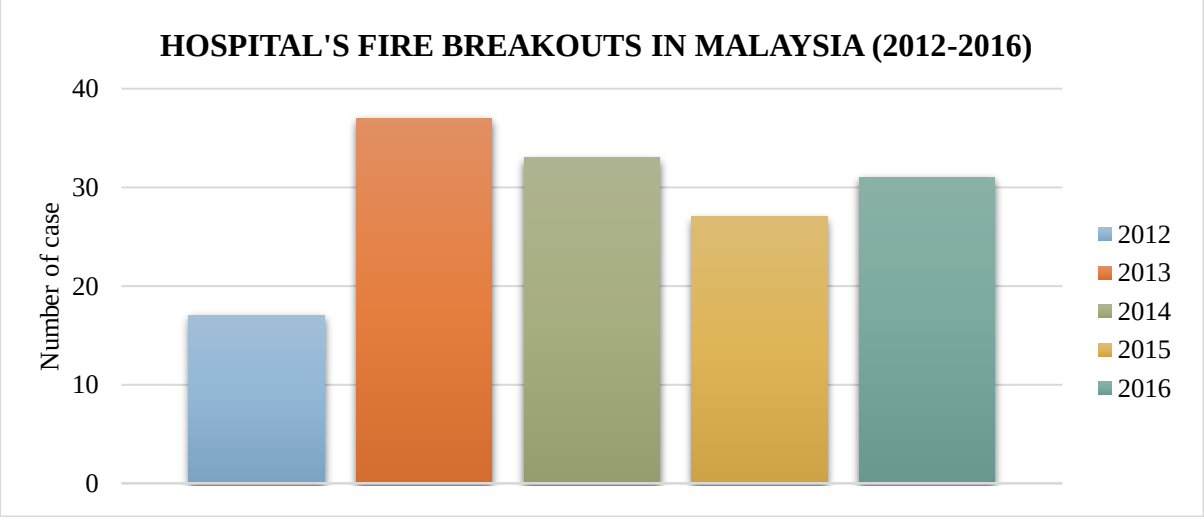

Figure 1: Statistics on fire breakouts at healthcare's building in Malaysia (2012-2016)

II. MEANS OF ESCAPE IN HOSPITAL'S BUILDING.

In a hospital's building, MoE is an important design criteria in designing the building. This is because, most of the user in hospital could not evacuate by theirself, specifically patients. [3] addressed that many patients usually incapable for self-evacuation, and they usually depend on mechanical system to survive. Thus, if there were any fire accident happen, they could not escape without help from other people. It is important for each building to include MoE design during design stage.

MoE could be define as a route that safe from fire which leads to a safety place during emergency. The routes itself is one of the important design criteria in designing a building. This is because, it is provided in order to enable the occupants of any part in the building leave by their own without in case of fire. [4] addressed that there are three factors in ensuring the effectiveness of MoE. The factors are (i)clear and unobstructed access, (ii) proper fire door, and (iii) the routes should clearly discharge to a safe area. In designing a safe MoE, there are eight design criteria as in Figure 2.

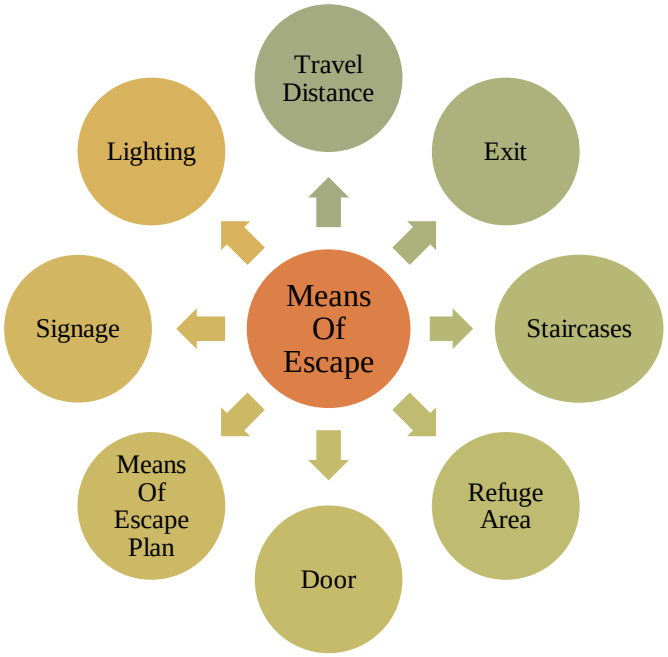

Figure 2: Design Criteria in Means of Escape

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Issues of Means of Escape

Table 1: Summary of lack of MoE during fire accident

Problems related to means of escape during fire.	British Petroleum Company (2005)	Roberts and Chan (2000)	Hassanain (2009)	M'Arquez Sierra *et al.* (2012)	Abdullah (2001)	Chen *et al.* (2012)	TOTAL
User unfamiliar with surrounding	X	X	X				3
User not understand the local situation		X	X				2
Lack of maintenance	X						1
Presence of security bars at window	X						1
User unaware of emergency procedure	X					X	2
User did not receive any training about fire safety	X						1
User did not familiar with design of means of escape.						X	1
Fire exit door were locked	X				X	X	3
Fire exit door obstructed						X	1
Fire exit door did not close automatically					X		1
No emergency lighting and signage	X					X	2
Inappropriate of signage						X	1
Means of escape route blocked with decorated material		X				X	2
Means of escape routes had decorations consisting of flammable material.						X	1
Means of escape plan did not provided.		X					1
User have difficulties in understand the plan.			X	X			2

Source: [4]

[4], [5] acknowledge three main issues regarding MoE, which are unfamiliarity of user with the building's surroundings, obstructed of fire exit doors, and lastly, difficulties in understanding the escape plan. However, based on Table 1, it could be found that there are ten issues regarding MoE which focusing on the design attributes itself. All these ten issues were summarized in

Table **2**.

Table 2: Summary of issues related to design attributes on MoE.

Ref	Design Attributes	Issues
1	Passive protection system	Fire exit door were locked
		Fire exit door obstructed
		Fire exit door did not close automatically
2	Active protection system	No emergency lighting and signage
		Inappropriate of signage
		Presence of security bars at window
3	Fire safety management	Means of escape routes had decorations consisting of flammable material.
		Means of escape plan did not provided.
		Means of escape route blocked with decorated material
		Lack of maintenance

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III. METHODOLOGY

Previous research on MoE Hospital's building assessment by [1] was focusing on qualitative method. While for this research, it is a continuation from previous research which combination of the qualitative and quantitative methodology. The methodology used in this study was summarized in the Figure 3 which starts with literature review, data collection stage and lastly, data analysis stage. Before an audit checklist take place for data collection stage, the checklist instrument was developed by reviewing relevant acts related to MoE. The acts included the Uniform Building By-Law 1984, National Fire Protection Act 101 and Malaysian Standard. This research adopted checklist from [1] since its related to hospital's building.

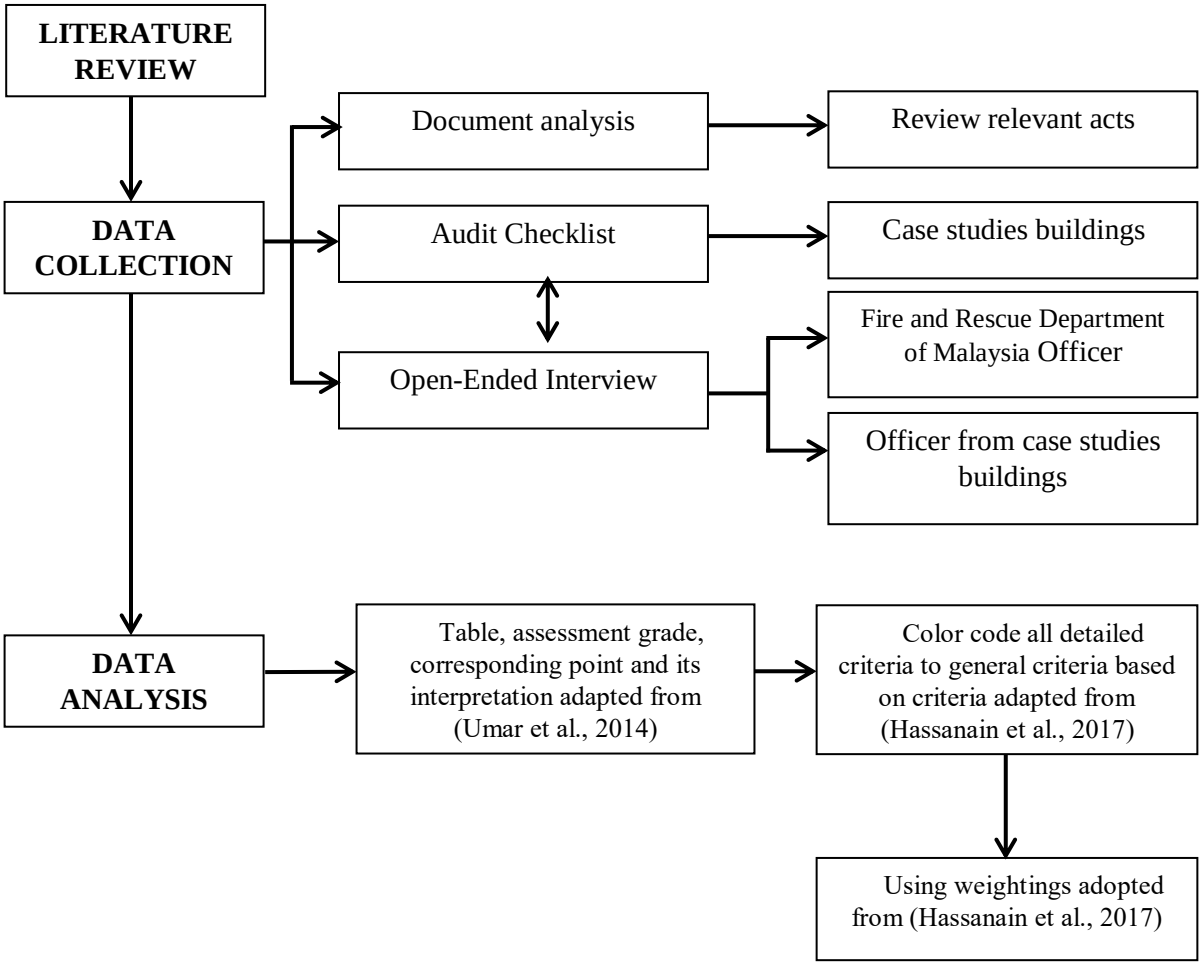

Figure 3: Research methodology

The developed checklist was used to carry out audit checklist of the hospital's building. This was done in three different hospital's building in Malaysia. The selection of the building was based on the list of hospital's building that adapted green element in the buildings. Due to the privacy and confidentiality of the case study building, all buildings name anonymously. There were three hospital's building selected which are Hospital A, Hospital D, and Hospital E. Table 3 identify the extent of research accessed in the hospital's building and duration taken of the auditing.

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Table 3: Frequency, duration and respondents interference for observation.

Ref	Type of Building's Area To Access.	Frequency / Duration	Respondent Interference (If Any)
1	Ward	Once/ peak hour and off-peak hour / half an hour.	Staff Nurse – to ask in detail about the procedure for fire escape.
2	Exit from the ward	Once/ peak hour and off-peak hour / half an hour.	N/A
3	Stairs	Once/ peak hour and off-peak hour / half an hour.	N/A
4	Refuge Area (if available)	Once/ peak hour and off-peak hour / half an hour.	N/A
5	Travel distance from the ward to assembly area	Once/ peak hour and off-peak hour / half an hour.	N/A

The audit checklist was carried out assisted by officer in-charge (engineer/fire safety security) and FRDM officer. The open-ended interview being done simultaneously during the auditing. Data gained from interview essential source in identifying the MoE routes in each hospital's building. In addition, in also an added information to identify issues that could not be audited by the researcher.

Table 4: Assessment grade, corresponding point and its interpretation.

Assessment Grade	Corresponding point	Interpretation
1	0.00	Non-existence of fire safety attribute
2	0.25	Non-fulfillment of the assessment criteria in the checklist
3	0.50	Low fulfillment of the assessment criteria in the checklist
4	0.75	High fulfillment of the assessment criteria in the checklist
5	1.00	Full fulfillment of the assessment criteria in the checklist

Source: [6]

Next, this research continued with the data analysis stage. The analysis starts by tabulate data gained from audit checklist into assessment grade as in

Table 4. This research adapted method by [1] with added an enhancement on assessment grade as per

Assessment Grade	Corresponding point	Interpretation
1	0.00	Non-existence of fire safety attribute
2	0.25	Non-fulfillment of the assessment criteria in the checklist
3	0.50	Low fulfillment of the assessment criteria in the checklist
4	0.75	High fulfillment of the assessment criteria in the checklist
5	1.00	Full fulfillment of the assessment criteria in the checklist

Table 5.

Table 5: Sample of auditing checklist analysis for checklist 1

DESIGN CRITERIA 5: DOOR	Hospital A

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	Attributes	Ref	Design Criteria	Yes				No
				5	4	3	2	1
i	Exit door	UBBL1984-173(1)	Shall be openable from the inside without the of key or any special knowledge.	/				
		UBBL1984-173(2)	Shall close automatically when released.	/				
		UBBL1984-173(2)	All door devices shall release the door upon power failure or actuation fire alarm.	/				
		UBBL1984-186(1)	Shall open only in the direction of exit.	/				
		Furness & Mucket (2007)	Should open in 90° and clear from any obstruction.	/				
		NFPA101 - 18.2.2.5.3	A single door shall be permitted in a horizontal exit if all the following apply: 1) Exit serve one direction only.	/				
			2) Door is a swinging door or horizontal sliding door.	/				
			3) Door is not less than 1055mm in clear width.	/				
		NFPA101 - 18.2.2.5.6	An approved vision panel shall be required in each horizontal exit door.				/	
ii	Fire door	UBBL1984-164(1)	Shall be fitted with automatic door closer	/				
		UBBL1984-163 [a(iii)]	A clear vision panel may be incorporated with dimension not exceed 0.065 square metre and glazed with glass.				/	

Next, all detailed criteria for each design criteria were categorized according to the color codes. Each color code represent different general criteria outline by [7]. The general criteria are maximum travel distance, number of exits, width of exit routes, elevator, exit door, signage, emergency lighting, maintenance of exit route and fire evacuation/emergency plan [7].

Simultaneously, the grade score for detailed criteria were used to generate an average grade score for each general criteria mentioned before. The average grade score was generated by using formula mean. Average or mean is defined as a measure of central tendency of data computed by taking sum of all data and divide by the number of data [8].

Previously, there were several weighting systems available from previous research. However, based on the Fifth Schedule: Designation of Purpose Groups (UBBL 1984), the weighting system that suitable to be selected corresponds to this study fall under number II of purpose group which is Institutional. According to UBBL (1984), the institutional building shall include the hospital, schools and another similar establishment where such persons sleep in the premises. Thus, this research adopted weighting system from [7] related to MoE only. The weightings in Table 6 together with the average grade score was used to convert the ratings from the audit checklist into resultant score.

Table 6: Weightings of fire safety criteria and attributes

Criteria	Attributes	Weightings
Passive protection system	Maximum travel distance	0.23

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	Number of exits	0.22
	Width of exit routes	0.12
	Elevator	0.04
	Exit door	0.15
Active protection system	Exit signage	0.04
	Emergency Lighting	0.08
Fire safety management	Maintenance of exit route	0.15
	Fire evacuation/emergency plan	0.09

Source: [7]

The resultant score and total number of higher grade were used to identify which hospital's building mostly complied with requirement outlined before. Thus, it can achieve the aim of this study which to develop the best practice of MoE for hospital's building.

IV. RESULTS AND DISCUSSION

The data obtained from auditing checklist was analyzed by using method adopted from [7]. The score for each of the three main criteria attributes were calculated and the following results were obtained.

Table 7: Determination of the score for MoE auditing of the hospital's buildings.

Design Criteria	Ratings			Corresponding point (S)			Weightage (W)			Attribution score (S x W)		
	A	D	E	A	D	E	A	D	E	A	D	E
Maximum travel distance	5	4	4	1.00	0.75	0.75	0.23	0.23	0.23	0.23	0.17	0.17
Number of exits	5	5	5	1.00	1.00	1.00	0.22	0.22	0.22	0.22	0.22	0.22
Width of exit routes	5	5	5	1.00	1.00	1.00	0.12	0.12	0.12	0.12	0.12	0.12
Elevator	2	1	1	0.25	0.00	0.00	0.04	0.04	0.04	0.01	0.00	0.00
Exit door	5	5	4	1.00	1.00	0.75	0.15	0.15	0.15	0.15	0.15	0.11
Passive protection system score										0.73	0.66	0.63
Exit signage	3	3	3	0.50	0.50	0.50	0.04	0.04	0.04	0.02	0.02	0.02
Emergency Lighting	5	4	4	1.00	0.75	0.75	0.08	0.08	0.08	0.08	0.06	0.06
Active protection system score										0.10	0.08	0.08
Maintenance of exit route	5	3	5	1.00	0.50	1.00	0.15	0.15	0.15	0.15	0.08	0.15
Fire evacuation/emergency plan	5	3	5	1.00	0.50	1.00	0.09	0.09	0.09	0.09	0.05	0.09
Fire safety management score										0.24	0.12	0.24

Table 8: Determination of final score for MoE auditing of the hospital's buildings.

Design Attributes	Weightings of the fire safety attributes (W)	Corresponding point (S)			Attribution score (S x W)		
		A	D	E	A	D	E
Passive protection system	0.43	0.73	0.66	0.63	0.31	0.28	0.27
Active protection system	0.41	0.10	0.08	0.08	0.04	0.03	0.03
Fire safety management	0.16	0.24	0.12	0.24	0.04	0.02	0.04
Final scores					0.3933	0.3369	0.3400

ISSN: 2277-9655
Impact Factor: 4.116
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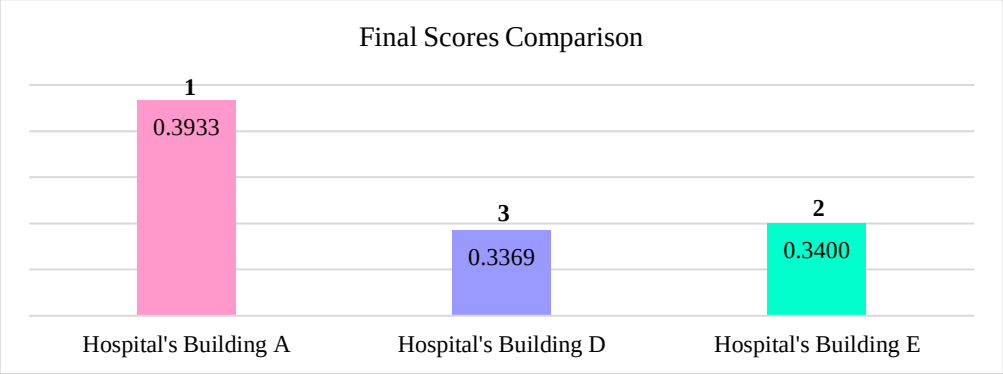

Figure 4: Comparison of three different hospital's building fire safety related to MoE

Based on data above, it is found that among these three-hospital's building, Hospital's building A gain highest result with the final resultant score of 0.3933. This score was highest among these three case studies. Then, followed with Hospital's Building E (0.3400) and lastly, Hospital's Building D (0.3369). From Table 7, it is found that Hospital's building A get the highest resultant score on passive protection system with total of 0.73 resultant score compared to Hospital's building D and Hospital's Building E, 0.66 and 0.63.

In addition, Hospital's building A scored highest resultant score for active protection system with the score of 0.10 rather than Hospital's building D and Hospital's building E, both score 0.08. On the other hand, for fire safety management attributes, both Hospital's building A and Hospital's building E get the same result which is 0.24 contrast with Hospital's building D which the resultant score only 0.12.

V. CONCLUSION

From the result of analysis, there was a risk of deaths and injuries occur if there is not action to upgrade the MoE in hospital's building. It is found that Hospital's building A most complied with regulations outlined rather than others hospital's buildings during auditing checklist. However, there were parts of the design criteria in MoE need to be upgraded. This is to ensure that, if hospital's fire happen, patients and staff may evacuate safely from the building, and it could reduce amount of losses to the building itself. Because, it is needed to be fully functionable and each design criteria are well performed. This paper recommend to further this research on evaluation of functionability of the existence MoE in hospital's building. This is to ensure the level of safety of MoE stay at the best, functionable, and well performed, since no facility was completely fire safe.

VI. ACKNOWLEDGEMENTS

The author would like to acknowledge the highest gratitude to supervisor, Sr Dr Yuhainis Abdul Talib for the guide on this paper.

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CITE AN ARTICLE

Jaafar, Adnin Syaza , and Yuhainis Abdul Talib. "DEVELOPMENT OF ASSESSMENT PROCEDURE FOR MEANS OF ESCAPE IN HOSPITAL'S BUILDING IN MALAYSIA." *INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY* 6.7 (2017): 417-24. Web. 25 July 2017.