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The Development of Fire Risk Assessment Method for Heritage Building

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Abstract

This paper examines the criteria and attributes for assessing fire risks in buildings. Using the Analytical Hierarchy Method (AHP) a survey questionnaire was developed based on the identified criteria and attributes of fire risks for heritage buildings in Malaysia. The survey questionnaire was administered to consultant, Fire Rescue Department (FRDM) personnel, maintenance professionals and insurance professional. The data were analysed using ExperChoice2000 software. The result of the research is the weightage for each criterion and its respective attributes.

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Keywords: Fire risk assessment; heritage building; AHP

1. Introduction

As those involved in fire risk assessment of heritage building seek to decide priority for maintenance budget or to set premium for insurance, they are confronted to the subjective nature of assessment. Often

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the assessment is tied to the background of the assessor. Maintenance engineers, insurance surveyors, or fire authority officers due to their different academic training and professional perspective may give contradictory opinion. The purpose of this research was to review published research to better understand the relevant assessment attributes and to assign ranking and weightage to the attributes. A simple objective instrument was developed in the past by a researcher which was based on the opinion of a single person. In this research the improvised instrument was not only refined with a technique known as Analytical Hierarchy Method (AHP) but also based on the opinion of a panel of expert. The objectives of the research are summarized as follows:

i. To identify the fire hazards and consequently the fire risks in heritage buildings.
ii. To determine the relative of risk associated with each attribute of fire hazards.
iii. To develop a risk assessment instrument specifically for heritage buildings.

2. Methodology

The methodology used in this research is as summarized in Figure 1. The goal of the study was to develop a method of evaluating fire risk in heritage building. Using the AHP method and principle an interview checklist was developed from criteria and attributes in Chow [1],Watts & Kaplan [2] and Zhao et.al [3]. The criteria and attributes are summarized in Table 1. Using the checklist the opinion of a panel of experts from four different backgrounds was solicited in structured interviews. The expert panel back grounds are as follows:

i. Maintenance
ii. Insurance
iii. Fire Consultant
iv. Fire and Rescue Department of Malaysia

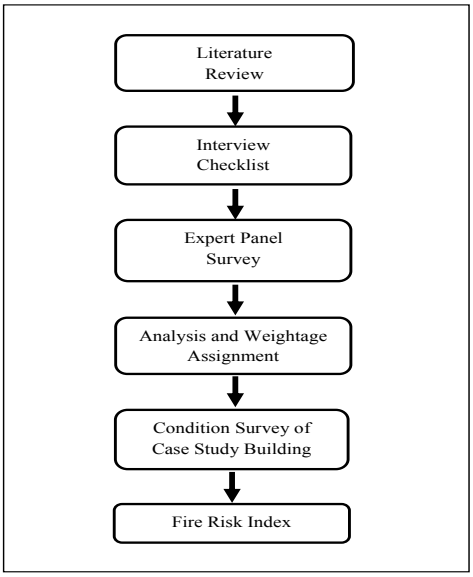

Figure 1. Flow Chart of Process

Table 1. Criteria and Attributes – Listed according to AHP Principle

GOAL OF STUDY To Evaluate Fire Risk In Heritage Buildings			
CRITERIA			
Passive Protection System	Active Protection System	Fire Management	Building Characteristic
ATTRIBUTES **(extract from literature reviews)**			
Compartmentation	Detection and Alarm System	Housekeeping and Maintenance	Building Contents
Egress/Evacuation Route	Automatic Suppression System	Management Fire Safety Plan	Building Fabric/ Material
Corridor Width	Fire Hydrant	Security	Architectural Features
Number of Exit	Portable Fire Extinguisher	Staff Training	Building Status
Maximum Travel Distance	Emergency Lighting	Fire Officer/Marshall	Historical significance
Exit Signages	Hose Reel and Stand pipe	Emergency Response	
Site Accessibility	Communications	External Exposure to Fire	

From the Expert Panels interviews the findings were processed using Expert Choice software and a set of weightage for each criterion and its respective attributes was obtained (Table 2). As risk is a direct opposite of safety [4], the risk index is measured by measuring the safety and converting it to the direct opposite score (Figure 2). Based on the weightage, an objective worksheet in the form of condition survey checklist was developed based on requirement from the Malaysian Uniform Building By-law (1984) (Table 3). The observation of an assessor was recorded and graded based on 1 to 10 scales. The result from the condition survey was calculated by multiplying the assessment grade with the weightage of each attributes and subsequently the weightage of each criterion (Figure 3 and Figure 4).

Table 2. Total fire Safety Score

Rank	Criteria	Criteria Score
1	Passive Protection System	
2	Active Protection System	
3	Building Characteristic	
4	Fire Management	
	Total Fire Safety Score	

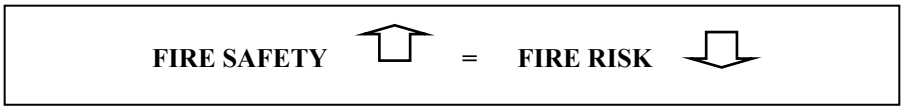

Figure 2. Relationship of Fire Safety and Fire Risk

Table 3. Sample of Condition Survey Checklist for Passive Protection System

CONDITION SURVEY SHECKLIST THE RESIDENCY, KUALA LUMPUR			
CRITERIA 1 : PASSIVE PROTECTION SYSTEM			
Attributes	Assessment Items	Observation	Assessment Grade
Compartmentation	1.Check fire rated of wall/door & compliancy with UBBL		
	2.Chech hazard segregation		
Egrees/ evacuation route	1.Alarm / suppression system installed along the evacuation route		
	2.Protection along the evacuation route		
	Clause 188 UBBL : max, travel distance to place of assembly for sprinkled route 601m and for un-sprinkled route 45m		
	Clause 178 UBBL : Route to final exit must be protected and separated		
Corridor Width	1.Check corridor width according to UBBL requirement		
	Clause 181 UBBL :…no individual access shall be less than 700mm		
Number of Exit	1.Check number of final Exit available		
	2.Check width of exit		
	Capacity at least 100 person/exit for horizontal and 75 person/exit for staircase width of exit to be at least 500mm		
Maximum Travel Distance	1.Check maximum travel distance whether it is in accordance with UBBL		
	Clause 188 UBBL : Max, travel distance to place of assembly from any point to exit for sprinkled route 60m and for un-sprinkled route 45m		
Exit Signages	1.Number of exit signage		
	2.Sustainability of signage lacation		
	3.Specification of signage		
	Clause 172 UBBL : shall be marked, strategically located, signage according to specification given, illuminated at all time		
Site Accessibility	1.Check accessibility of site according to UBBL		
	2.How many side is accessible by BOMBA		

ATTRIBUTES SCORE	=	Attributes Assessment Grade	X	Attributes Weightage

Figure 3. Calculation of Attributes Score

FINAL SCORE FOR CRITERIA	=	Total Attributes Score for the Criteria	X	Criteria Weightage

Figure 4. Calculation of Criteria Score

3. Results

The data obtained from the structured interviews and opinion surveys of expert panels were analyzed using AHP principle with the aid of its software ExpertChoice2000. The score for each four criteria were totaled to obtain the fire risk index of the building (Table 4).

Table 4. Calculation for Criteria and Attributes

Criteria 1	**:**	**PASSIVE PROTECTION SYSTEM**	**Assessment Grade**	**Attributes Weightage**	**Attributes Score**
Weightage	**:**	**0.371**	**(A)**	**(B)**	**A x B**
1.		Compartmentation	8	0.160	1.280
2.		Egress/Evacuation Route	7	0.145	1.015
3.		Corridor Width	8	0.092	0.736
4.		Number of Exit	8	0.184	1.472
5.		Maximum Travel Distance	8	0.170	1.360
6.		Exit Signages	6	0.169	1.014
7.		Site Accessibility	6	0.080	0.480
TOTAL ATTRIBUTES SCORE FOR CRITERIA 1					7.357
FINAL SCORE FOR CRITERIA 1 (Total Attributes Score X Criteria Weightage)					2.729
Criteria 2	**:**	**ACTIVE PROTECTION SYSTEM**	**Assessment Grade**	**Attributes Weightage**	**Attributes Score**
Weightage	**:**	**0.273**	**(A)**	**(B)**	**A x B**
1.		Detection and Alarm System	5	0.210	1.050
2.		Automatic Suppression System	5	0.160	0.800
3.		Fire Hydrant	8	0.090	0.720

4.	Portable Fire Extinguisher	8	0.140	1.120
5.	Emergency Lighting	6	0.094	0.564
6.	Hose Reel and Stand Pipe	0	0.154	-
7.	Communications	8	0.152	1.216
TOTAL ATTRIBUTES SCORE FOR CRITERIA 2				4.420
FINAL SCORE FOR CRITERIA 2 (Total Attributes Score X Criteria Weightage)				1.207
Criteria 3	**: FIRE MANAGEMENT**	**Assessment Grade**	**Attributes Weightage**	**Attributes Score**
Weightage	**: 0.184**	**(A)**	**(B)**	**A x B**
1.	Housekeeping and Maintenance	8	0.239	1.912
2.	Management Fire Safety Plan	0	0.152	-
3.	Security	6	0.113	0.678
4.	Staff Training	6	0.134	0.804
5.	Fire Officer/Marshall	4	0.110	0.440
6.	Emergency Response	6	0.188	1.128
7.	External Exposure to Fire	7	0.063	0.441
TOTAL ATTRIBUTES SCORE FOR CRITERIA 3				3.491
FINAL SCORE FOR CRITERIA 3 (Total Attributes Score X Criteria Weightage)				0.642
Criteria 4	**: BUILDING CHARACTERISTICS**	**Assessment Grade**	**Attributes Weightage**	**Attributes Score**
Weightage	**: 0.171**	**(A)**	**(B)**	**A x B**
1.	Building Contents	4	0.187	0.748
2.	Building Fabric/Material	5	0.199	0.995
3.	Architectural Features	5	0.114	0.570
4.	Building Status	7	0.173	1.211
5.	Historical Significance	4	0.326	1.304
TOTAL ATTRIBUTES SCORE FOR CRITERIA 4				4.828
FINAL SCORE FOR CRITERIA 4 (Total Attributes Score X Criteria Weightage)				0.826
TOTAL FIRE SAFETY SCORE (Total Final Score From Criteria 1 to Criteria 4)				**5.40**

The weightage for criteria and attributes are as per Figure 5 below.

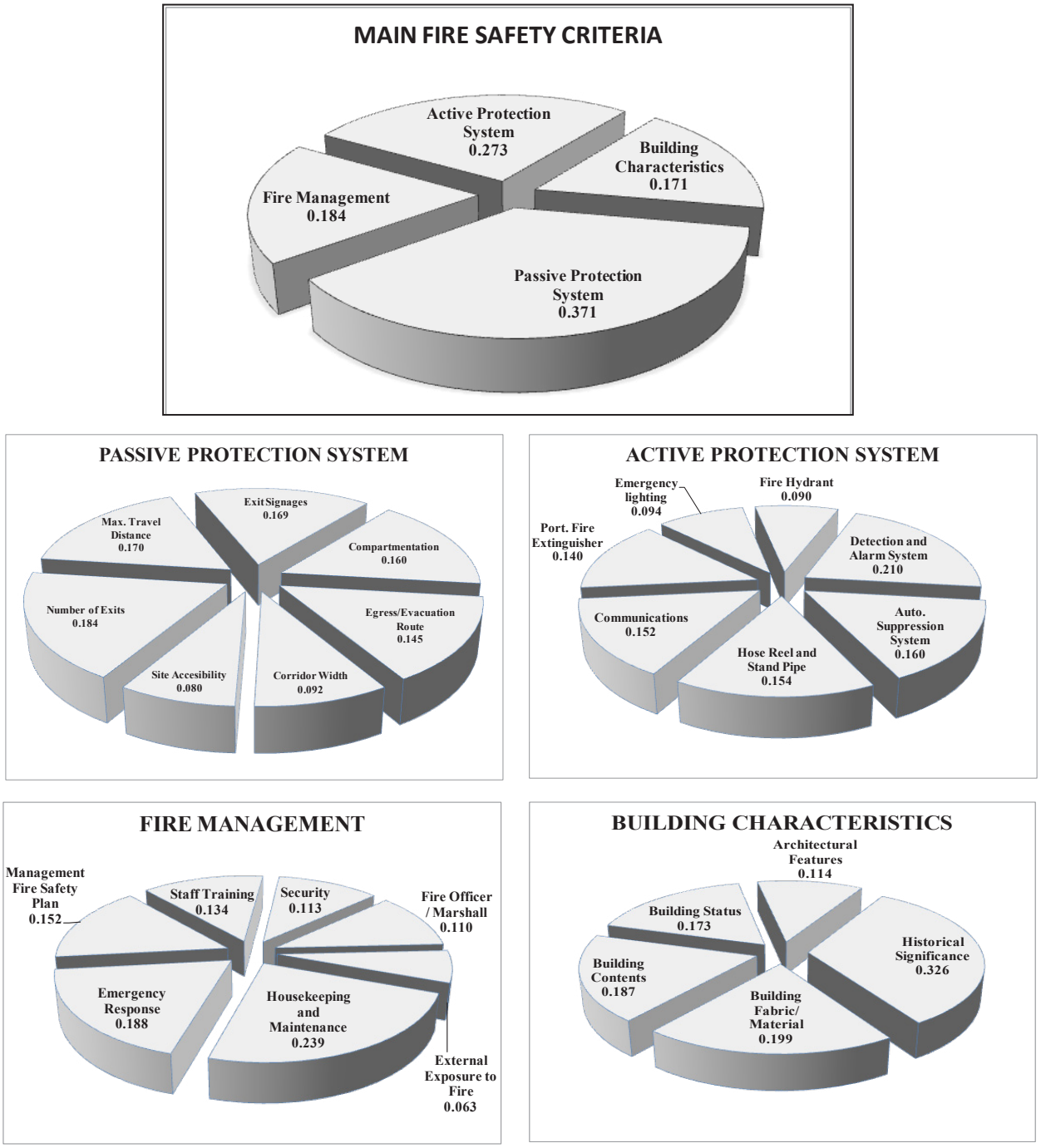

Figure 5. Weightages of main criteria and attributes

4. Conclusion

The weightage can be used in the assessment of fire risk in heritage building. In assessing fire risks in building we may assign only a person. The report from that person is subjective as it is difficult to compare the fire risks of different buildings. The weightage arrived in this research provide the tool in decision making; with the weightage the assessment will be more objective.

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