



THE DEVELOPMENT OF FIRE RISKS
ASSESSMENT FOR
HERITAGE BUILDINGS:
A CASE STUDY OF “THE RESIDENCY”,
KUALA LUMPUR

BY

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A dissertation submitted in partial fulfilment of the
requirements for the degree of Masters of Science in
Building Services Engineering

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ABSTRACT

This research is aim to develop risk assessment method for heritage building. Based on the works of previous researchers the method was refined with a technique known as Analytical Hierarchy Method (AHP). The original method, based on the opinion of single person, was also improved by using a panel of expert. The new method was then tested at "The Residency", which is the official resident and office of the first Prime Minister of Malaysia, Y.A.M. Tunku Abdul Rahman Putra al-Haj. The 128 years old building is gazetted as heritage building under National Heritage Act (2005) and the building now is part of the exhibition in Memorial Tunku Abdul Rahman complex which was operated by Malaysian National Archives.

ملخص البحث

هذا البحث يهدف لتطوير منهج لقياس و تقييم المخاطر في حالات المباني الأثرية التراثية. اعتماداً على أعمال الباحثين السابقين، فإن المنهج كان يعرف بالأسلوب المعروف بالمنهج الهرمي التحليلي (AHP). الطريقة الأصلية، المعتمدة على رأي شخص منفرد، أيضاً تم تحسينها بإدخال لجنة من الخبراء. المنهج الجديد قد تم اختباره في حالة (الريزيدنسي)، وهو المقر الرسمي لمسكن و مكتب رئيس وزراء ماليزيا الأول، سعادة صاحب السمو تنكو عبد الرحمن بترا الحاج. هذا المبني ذو المائة و ثمانية و عشرين عاماً (١٢٨)، تم تسجيله كمبني أثر تراثي تحت قانون التراث الوطني لعام ٢٠٠٥، وهو الآن جزء من معرض مجمع صاحب السمو تنكو عبد الرحمن التذكري الذي تديره هيئة الوثائق الوطنية الماليزية

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Building Services Engineering.

Md. Najib Bin Ibrahim
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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Building Services Engineering

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DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at HUM or other institutions.

Khirani Abdul Hamid

Signature Date

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

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**FIRE RISKS ASSESSMENT FOR HERITAGE BUILDINGS:
A CASE STUDY OF "THE RESIDENCY" KUALA LUMPUR**

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*This work is dedicated to my
husband and children.*

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Bismillahirrahmanirrahim...

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
BFSM	Building Fire Simulation Model
BOCA	National Building Code, USA
CO ₂	Carbon Dioxide
CRISP	Comparison of Risk Indices by Simulation Procedures
FRDM	Fire and Rescue Department Malaysia
FSES	Fire Safety Evaluation System
HFRI	Historic Fire Risk Index
KAED	Kuliyyah of Architecture and Environmental Design
MVAC	Mechanical Ventilation and Air Conditioning
NCPTT	National Center for Preservation Technology and Training, USA
NFPA	National Fire Protection Association, USA
PA	Public Address
PFE	Portable Fire Extinguisher
TAN	Technical Advice Notes by Historic Scotland
UBBL	Uniform Building By-Law
UK	United Kingdom
USA	United States of America

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

The overall intention of this study is to assess the fire risk in an old heritage building that is being adaptively re-used. The study starts off with literature study to understand the basic principles of fire, reviewing codes, standards and laws relating to fire and heritage buildings in Malaysia and other countries and lastly identifying the factors and attributes to fire risks and hazards in heritage buildings. Next, the methods of evaluating fire risks in existing buildings that has been done by other researchers are being studied. The most suitable and appropriate method that is aligned with the aim and objectives of this study shall be selected. The selected method shall be used as a tool to assess the selected case study i.e. the Memorial Tunku Abdul Rahman, a-128 year-old heritage building.

1.2 BACKGROUND

Evaluation and assessment of fire risks is a difficult procedure as it involves many factors or attributes which sometimes are conflicting with one another. The process is much more complicated when it involves existing buildings where only limited information is available as in the case of heritage buildings.

Hence to begin this study, a background of the current scenario of fire safety in heritage building shall be explored in order to give an overall interpretation of the current situation and scenario.

1.2.1 Overview of Heritage Building and Fire Risks

1.2.1.1 *International Scenario*

The incidences of fire in adaptive re-used buildings have been reported all over the world and the statistics are alarming. It is reported in Fire Risk Management Journal (February 2008) that a survey conducted in the United Kingdom reveals an average of seven heritage buildings are lost or damaged by fire each month. This survey suggests that by 2026 an estimate of 2,000 heritage buildings in the United Kingdom could vanish due to fire incidents.

1.2.1.2 *Malaysian Scenario*

Fire occurrences in heritage buildings often have disastrous consequences. This is due to the large amount of timber being used in the construction as well as the weak fire resistance in the building structure and fabric (Ab. Wahab, 2001). In Malaysia fire statistic shows that from 1992 to 2008, fire involving heritage buildings has resulted in an estimated total loss of RM 5 millions (Salleh & Ahmad, 2009).

In Kuala Lumpur the most tragic lost occurred when the historical “Rumah Pak Ali” in 2003 was completely destroyed by fire. The 127 year-old timber house was the pride of the family as well as the surrounding community. It was in particular a popular tourist spot, drawing and attracting crowds and bus loads of tourists eager to learn about the architecture and culture of the Malay community. Unfortunately it was gone overnight when fire razed and burnt the house leaving only charred remains and a sad reminder of the destructive impact of fire. In December 2008, a fire incident had destroyed seven shops at the UN gazetted - World Heritage Site in Lebu Armenian Penang. The estimated value of damage is at RM600,000 however, the heritage value lost is irreplaceable.

Lessons from these incidences of fire outbreak in heritage buildings such as “Rumah Pak Ali” and “Lebuh Armenian” demonstrate that this category of building is fragile and has high fire risk. Creative solutions must be developed to meet fire and life safety objectives without compromising the historic or architectural significance of the historic building(Watts and Kaplan, 2001). Therefore before being an adaptively re-use building, the level of fire hazards and risk of the heritage building should be evaluated to ensure such risk is being minimised or even possibly eliminated.

1.2.2 Heritage Buildings In Kuala Lumpur

Badan Warisan Malaysia described the “heritage building” as a built up structure that are significant and worth preserving due to its artistic, historical, architectural, social or scientific value. National Heritage Act 2005 categorised heritage building as a “tangible cultural heritage”. Section 67 of the Act outlines that the Cultural, Art and Heritage Ministry will have the power to gazette any building within the register that seems fit to be gazetted as Heritage Buildings.

Within the Kuala Lumpur vicinity there are twenty six heritage buildings that have been gazetted by Culture, Arts and Heritage Ministry (The Star 22, December 2006). However, there are still many more buildings that merit being in the heritage list but have yet to be listed as such. The Malaysian Institute of Architects (PAM) (Architectural Heritage – Kuala Lumpur Pre-Merdeka (2007), listed 84 buildings as heritage building within the city centre alone, which are dated from pre-independence/pre-war/colonial era and which are architecturally unique and charming and most importantly worth conserving due to its historical status.

1.2.3 Conservation and Adaptive Re-use of Heritage Buildings

Adaptive re-use is the conversion or functional change of a building from the purpose or use for which it was originally constructed or designs (NFPA 914, 2007). Adaptive re-use is one of the effective methods for conservation. Feilden (2004) cited that, the best way of preserving buildings as opposed to objects is to keep them in use – a practice which may involve what the French call “*mise en valeur*”, or modernization with or without adaptive alteration.

Bacon (2001) described adaptive re-use as a method of renovating old building to accommodate new use and is a common means of preserving heritage buildings by providing economically viable alternatives to vacant deteriorating structures, underused structures or building demolition. In Kuala Lumpur, there are many buildings that adopted this concept of conservation, however, in doing so many did not consider the fire safety risks associated with adaptive re-use building and hence exposing the building to the fire hazard risks. When a building’s original function changes there are inevitable changes in the range of hazards and risks which may be associated with the building (Kidd, 2001) .

1.2.4 Provision of Fire Safety in Heritage Building

Most of the old buildings is built with fire safety in mind and more often than not these old buildings used fire resistance materials. However these fire safety and fire precautions are predominantly outdated and fall far below the current standard of fire safety and regulations implemented worldwide (Lo, 1998; Ab. Wahab, 2001; Zhao et al., 2004;). Therefore in order to re-use Heritage Building, one must be able to relate to its fragile condition and contemplate the fire risk aspects with regards to its contemporary usage.

Chow and Lui (2008) in the study of on old adaptive re-used industrial buildings built before 1972 in Hong Kong recommended applying Total Fire Safety concept which comprises an integration of the followings:

- i. Passive building construction,
- ii. Active fire services installations
- iii. Control of risk factors
- iv. Comprehensive fire safety plan that consists of maintenance plan, staff training plan, fire prevention plan and fire action plan.

1.2.5 Approaches of Fire Risk Assessment

There are various approaches used by researchers in performing Fire Risk Assessment. Us-Shan (2008) listed four approaches that are commonly used by researchers. The said approaches are

- i. Fire safety ranking method based on multicriteria evaluation,
- ii. Statistical and probabilistic,
- iii. Computer simulation modelling
- iv. Hazard analysis using event tree or fault tree.

Lo (1999) mentioned that fire risk ranking system which relies on intuition and experience may be the most effective way to evaluate the safety level as well as the safety index of existing buildings. The statistical and probabilistic method of fire risk assessment would require a sufficient and comprehensive data collection being done. As for computer simulation, insufficient data and construction method especially of old heritage building is the biggest limitation to generate models that are based on physical, chemical, thermodynamic, and psychological principles to evaluate the safety level of a building. A hazard analysis based on event trees or fault trees may

also be difficult to implement, as the uncertainties and insufficient data may create difficulties in identifying the risk agents.

Watts and Kaplan (1998) developed the method of evaluating fire risk in heritage buildings, however the final ranking and weightage of attributes are based on their own professional judgements. Lo (1999) and Zhao et al (2004) developed fire risk assessment method for existing building in general using opinion of expert panels and synthesizing the judgements using Analytical Hierarchy Process (AHP). Us-shan (2008) has applied the similar method on his study on fire risk assessment in students housing facilities in the University of King Fahd, Saudi Arabia. However, there is no research done on the development of fire risk assessment method for heritage building using experts' opinion with AHP as a decision support tool.

The approach that will be used in this dissertation is risk ranking system as this approach is the most widely used and considered the most effective way of assessing the fire risks of an existing building such as heritage buildings. This method would rely on the intuitions and experiences of the fire safety experts, supported with AHP as a decision support tool in establishing the ranking system and assigning weightage to the fire risks attributes.

1.3 PROBLEM STATEMENT

Fire can cause severe damages to the building especially to the old building such as heritage buildings. Timber for example has a quite high combustibility level and is widely used as structural and decorative elements in heritage buildings. Some newly refurbished heritage buildings would be having interior decoration items such as special type of lighting or wiring which could potentially increase fuel load and fire risk.

Listed below are the fire hazards associated with adaptively re-use heritage buildings ;

1. Refurbishment being done without consideration and proper assessment of its fragile structural element and combustibility of the old as well as the new building material.
2. Introduction of building services items such as mechanical, ventilation and air conditioning system (MVAC), vertical transportation, certain type of lighting and wiring could affect the structural element as well as increasing the fire hazard if it is not done according to standard and specification for building within this category.
3. Modernisation and change of function could lead to additional fuel load to the building.

The ultimate goal of most fire precaution codes and standards are to protect and ensure human life safety and more often than not, the preservation of the fabric of a building, the damage prevention of architectural and other aesthetic features or the prevention of loss of its historical contents often falls second or not even being covered by many regulations. The conflict between life protection and property protection during fire incidents could be addressed if the the strategy being changed from fighting the fire when it occurred to prevention and mitigation of the fire risk from occurring.

The fire protection of heritage building is more complicated than newly built building due to its dated building materials, unavailability of documentation regarding the construction methods used, building layout that does not comply with current fire codes and standards and also their sites and location that might not be accessible by