A STUDY ON
FIRE RISK INDEX METHOD
FOR HISTORIC TIMBER MUSEUMS :
ISLAMIC MUSEUM, MELAKA
AND
STAMP MUSEUM, MELAKA

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JKR

CAUSE OF FIRE

Arson

Human error

Faulty equipment

Natural Disaster

A study done by Dong Mei Huang et al. (2010) shows that the causes of fire for historic timber building usually started by arson, human error, faulty equipment and natural disaster.

Problem statement

No	Date	Building	Year of Built	Function	Estimate loss (RM)
1	17 Sept. 1992	Muzium Negara M'sia, KL	1959	Museum	100,000
2	1999	Panggung Bandaraya, KL	Info not available	Museum	Info not available
3	2 Dec. 2001	Muzium Rakyat. Kecantikan dan Layang-layang , Melaka	Info not available	Museum	Info not available
4	20 Oct. 2003	Rumah Pak Ali, Kg. Kerdas, Gombak	1876	Museum	>1 millions
5	27 June 2005	23 Shop houses pre-war, Meru Klang	1920-1930	Shop house	5 millions
6	27 June 2005	13 Shop houses pre-war kg. Sentosa off, Jln. Klang Laman, KL	1920-1930	Shop house	>500,000
7	17 July 2006	Shop houses, Jln. Laksamana, Bandar Hilir, Melaka	>1806	Shop house	Info not available
8	27 July 2007	Sarawak Club, Kuching	1876	Club house	Info not available
9	24 July 2007	Kelab Sukarelawan Polis Diraja M'sia, Ipoh	1910	Club house	Info not available
10	30 Sept. 2007	PULAPOL Senior Police Quarters, Jln. Semarak, KL	1940	Quarters	Info not available

Statistics from the table has shown that from 1992 to 2007 fire has damaged and destroyed many heritage buildings in Malaysia with a total loss of approximately up to RM5 million (Salleh, 2007).

Problem statement

Date	Museum name	Cause of fire	Fire prevention equipment	Estimated loss
5/04/1958	**Museum of Modern Art,** New York, USA	Origin was workmen repainting second floor galleries who were smoking on the job.	Detectors but no sprinklers.	**USD 700,000** (Loss of one life, 33 injuries, several galleries, two major paintings, including a Monet, seven paintings severely damaged.)
09/08/1970	**Henry Ford Museum,** Michigan, USA	Origin suspected to be an overheated hair curling iron in a dressing room.	Detectors but no sprinklers on part of the building.	**USD 2 million** (Loss of several historic displays of shops and equipment.)
30/09/1970	**Smithsonian Institution National Museum of American History,** Washington D.C.USA	Origin was electrical short in the exhibit.	Detectors but no sprinklers.	**USD 1 million** (Loss of two galleries and their exhibits, with some water damage.)
22/02/1978	**San Diego Aerospace Museum and International Aerospace Hall of Fame,** California, USA	Arson. Arsonists were two youths seen running away.	No detectors, no sprinklers	**USD 16 million** (Loss of the building and entire collection, including 40 planes and library.)
08/07/1978	**Museum of Modern Art,** Rio de Janerio, Brasil	Suspected origin from smoking or defective wiring.	No detectors, no sprinklers	**USD 50 million** (Loss of most of the interior, the roof, and 900 works of art (90% of the collection).
31/12/1984	**Byer Museum of Art,** Illinois, USA	Suspected electrical origin.	Detectors but no sprinklers.	**USD 3 million** (Loss of the upper two floors and roof, with extensive water damage.)

List of Museums Fire in World from 1958 – 2003.
(Modified from www.museum-security.org)

Problem statement

Date	Museum name	Cause of fire	Fire prevention equipment	Estimated loss
17/10/ 1985	**Huntington Gallery,** California, USA	Suspected origin was an electrical on the elevator at night, which burst explosively into the first floor.	Smoke detectors in the museum but not in the elevator or elevator shaft. No sprinklers.	**USD 1.5 million** (Loss of elevator and elevator shaft, one minor painting, and extensive smoke damage.)
11/05/ 1988	**The Cabildo Building, Louisiana Museum of Art,** New Orleans, USA	Origin was workmen welding gutters on the exterior igniting an interior hollow space.	Detectors in the museum, but no detectors in the hollow space, no sprinklers.	**USD 5 million** (Loss of furniture collections in the attic, roof, structural and water damage.)
17/09/ 1992	**National Museum Malaysia**, Kuala Lumpur, MALAYSIA	Suspected origin from portable water heater or smoking		**USD 30,000** (Loss of some AV equipments and documentarycollections)
20/11/ 1992	**Windsor Castle,**London, ENGLAND	Suspected origin was blow torch.	No detectors or sprinklers.	**USD 90 million** (Loss of a tower, several rooms, tapestries, and minor paintings)
19/04/ 1993	**The Yuma Arizona Art Center,** Arizona, USA	Suspected origin was electrical.	Smoke detectors no sprinklers.	**USD 1.5 million** (Loss of historic building and 39 fine art pieces with some smoke and water damage.)
09/08/ 1993	**Oakland Museum,** California, USA	Origin was defective exhibit motor in storage room.	Detectors but no sprinklers.	**USD 1 million** (Loss of gallery and some exhibits on loan.)

List of Museums Fire in World from 1958 – 2003.
(Modified from www.museum-security.org)

Problem statement

Date	Museum name	Cause of fire	Fire prevention equipment	Estimated loss
02/06/1994	**Oshkosh Public Museum,** Wisconsin, USA	Origin was workmen welding gutters on the exterior igniting an interior hollow space.	Detectors in the museum, but no detectors in the hollow space, no sprinklers.	**USD 2 million** (Loss of 10% of the collection and collection records.)
12/09/1996	**Sultan Abu Bakar Royal Museum**, Johor, MALAYSIA	Arson (Molotov cocktail)		**Undisclosed**
15/03/1997	**Sultan Abu Bakar Royal Museum**, Johor, MALAYSIA	Undisclosed		**Undisclosed**
02/12/2001	**People's Museum**, Melaka, MALAYSIA	Electrical short-circuit		**Undisclosed** (Exhibition Hall is totally damaged. Several copies of Dutch manuscripts, old paintings and artifacts were destroyed in the 9.15pm fire)
20/10/2003	**Pak Ali House,** Gombak, MALAYSIA	Electrical short-circuit	No detectors or sprinklers.	**> USD 500,000** (Building badly damaged and not reopened)

List of Museums Fire in World from 1958 – 2003.
(Modified from www.museum-security.org)

Problem statement

Frequent fires in George Town heritage buildings call for better safety awareness

Looi Sue-Chern
Updated 5 months ago · Published on 13 Sep 2017 10:04PM ·

Fire destroys three heritage shophouse on Lebuh Penang in George Town yesterday morning. – The Malaysian Insight pic, September 13, 2017.

HERITAGE shophouses in Penang's George Town are vulnerable to fire, a risk that is heightened by the building owners' attitude towards, in matters of fire safety.

A pre-war shophouse on Lebuh Cintra in the Unesco heritage city of George Town is lost to fire today. – The Malaysian Insight pic, September 13, 2017.

All buildings, including heritage ones, are subject to the Fire Safety Act 1998. Works on buildings are subject to the local council's approval and must abide by the Street, Drainage and Building Act, Uniform Building By-law, and the George Town Special Area Plan, which also provide guidelines for fire safety and fire prevention requirements.

Ang said while having sufficient facilities like fire extinguishers and running drills was important, collective effort from the local communities was also crucial in a fire response.

"People who live or work in heritage buildings should also create evacuation routes for themselves in case of emergencies," she said.

She admitted that public engagements to educate stakeholders on the benefits and importance of fire prevention had also been challenging.

Problem statement

- In terms of fire safety approach, historic building requires a relatively more sensitive approach compared to a new building

The challenge in protecting heritage structure is maintaining their heritage fabric while providing a reasonable level of safety for occupants and contents

Currently in Malaysia, there are no clear guidelines and assessment methods adopted to determine the fire risks and fire safety strategies for historic building especially for historic timber buildings.

Fire risk assessment method

Ranking Methods

1	Risk Value Method
2	Fire Safety Evaluation System (FSES)
3	Specific Commercial Property Evaluation Schedule (CPES)
4	Dow Fire and Explosion Index
5	XPS Fire
6	Hierarchical Approach
7	SIA 81 – Gretener Approach
8	Fire Risk Assessment Method for Engineering (FRAME)
9	The Fire Risk Index Method (FRIM)

VS

Quantitative Methods

1	Computation of Risk Indices by Simulation Procedure (CRISP)
2	Risk-cost Assessment Model (FiRECAM- Fire Risk Evaluation and Cost Assessment Model)
3	The Building Fire Safety Engineering Method (BFSEM)
4	Fore Evaluation and Risk Assessment System (FEIREA system)
5	Petri net to Fire Safety Measures
6	Event Tree Analysis as a Risk Analysis Method (ETA)
7	Fire Risk Assessment with Reliability index β

Source: (Vandevelde, P., 2006)

Application of Ranking Method

Method	Meet the criteria	Negative features	Positive features
Risk Value Method	No: Does not meet the selected protection step		
FSES	Yes	Is not aimed at property, but at life safety	
CPES	Yes		Cost of insurance
Dow Fire and Explosion Index	Yes	Cultural heritage is out of scope	
XPS FIRE	Yes	Owned by Munich Re	
Hierarchical Approach	Yes	Workforce requirement: Delphi group	
SIA 81 (Gretener)	Yes		Insurance premium related
FRAME	**Yes**		**Life safety and business risk included, insurance premium related, arson clue**
FRIM	**Yes**		**Easy to handle**

Source: (Vandevelde, P., 2006)

Application of Quantitative Method

Method	Meet the criteria	Negative features	Positive features
CRISP	Yes	Aimed at life safety	
FiRECAM	Yes	For office buildings, specialist are needed for correct fire models	
BFSEM			
FIEREA system	Yes	Use for light industrial buildings	
Petri net for Fire Safety Analysis		Aimed at life safety, high workforce requirement	
ETA	**Yes**		**Life safety, damage area, cost benefit analysis included**
Reliability Index	Yes	Complex and time consuming	

Source: (Vandevelde, P., 2006)

Fire risk methods suitable for the research

No	Recommended tools	Positive feature	Negative Feature
1	FRAME	Life safety and business risk included, insurance premium related, arson clue	Complex and requires lots of data
2	**FRIM**	**Easy to handle**	
3	ETA	Life safety, damage area, cost benefit analysis included	Requires numeric data collection

Fire risk index method

1

Designed for timber-frame multi-storey building

2

Takes into account the life safety of occupants and fire fighters as well as property protection for appraised building

3

Easy to be used for persons without deeper knowledge about fire safety

Fire risk index method

- Divided into 17 parameters
- Each parameter is given a grade according to the grading schemes provided
- A Delphi panel has given each parameter a weight
- A high-risk index for buildings represent a high level of fire safety and a low-risk index represents a low level of fire safety
- The theoretical value is from 0.0 to 5.0

Delphi panel - panel of experts to achieve consensus in solving a problem, deciding the most appropriate course of action, or establishing causation where none.

Fire risk index method

No	FRIM Parameter	Amended Parameter	Historic building
P1	**Lining in apartment** Def: possibility of internal linings in a room to delay the ignition of structure and to reduce fire growth	Lining in rooms	Apartment changed to room to suit the building typology
P2	**Suppression system** Def: Equipment and systems for suppression of fires		In accordance to Part VIII in UBBL 1984
P3	**Fire service** Def: Possibility of fire services to save live and to prevent further fire spread		In accordance to Part VII in UBBL 1984
P4	**Compartmentation** Def: Extent to which building space is divided in fire compartments		In accordance to Part VII in UBBL 1984
P5	**Structure- separating** Def: Fire resistance of building assemblies separating fire compartments		In accordance to Part VII in UBBL 1984
P6	**Doors** Def: Fire and smoke separating function of doors between fire compartments		In accordance to Part VII in UBBL 1984
P7	**Windows** Def: windows and protection of windows, e.g factors affecting the possibility of fire spread through the openings		In accordance to Part VII in UBBL 1984

Fire risk index method

No	FRIM Parameter	Amended Parameter	Historic building
P8	**Facade** Def: façade material and factors affecting the possibility of fire spread along the facade		
P9	**Attic** Def: Prevention of fire spread to and in roof space	**Roof Space**	Attic changed to roof space to suit the building typology in Malaysia
P10	**Adjacent buildings** Def: Minimum separation distance from other buildings		In accordance to Part VII in UBBL 1984
P11	**Smoke control system** Def: Equipment and systems for limiting spread of toxic fire products		In accordance to Part VIII in UBBL 1984
P12	**Detection system** Def: Equipment and systems for detecting fire		In accordance to Part VIII in UBBL 1984
P13	**Signal system** Def: Equipment and systems for transmitting an alarm of fire		In accordance to Part VIII in UBBL 1984
P14	**Escape routes** Def: Adequacy and reliability of escape route		In accordance to Part VII in UBBL 1984

Fire risk index method

No	FRIM Parameter	Amended Parameter	Historic building
P15	**Structure- load bearing** Def: Structural stability of the building when exposed to a fire		
P16	**Maintenance and information** Def: Inspection and maintenance of fire safety equipment, escape route etc. and information to occupants in suppression and evacuation		
P17	**Ventilation system** Def: Extent to which the spread of smoke through the ventilation system is prevented		In accordance to Part VIII in UBBL 1984

Fire risk index method (case study)

VS

Islamic Museum

Melaka Islamic Museum at Jalan Kota is just a few minutes walk from The Stadthuys. This historic timber-building museum was built in the 1850s in the English Colonial Era. The building was designed with English Colonial influence, mixed with Malay vernacular architecture and used timber as the main material for the floor, wall, doors, windows and roof structure.

The museum is a two-storey historic building with a total gross floor area of 760 m2. The museum is located on a hill slope with a grand staircase as the main entrance to the building from the street. The internal space is divided into eight exhibition areas, one library and a store room.

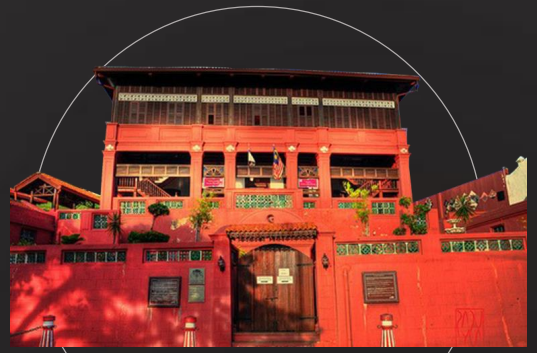
Stamp Museum

Melaka Stamp Museum at Jalan Kota is situated within the Melaka Historical City and just a few minutes walk from The Islamic Museum.Melaka Stamp Museum, also known as Photo Shop or “Sekolah Gambar”, is housed in an old Dutch building. The building previously housed the Old Melaka Museum and was originally used as the residence for Dutch dignitaries living in Malacca. This building was used as a residence until it was completely abandoned after the Second World War.

Built during the Dutch period, the Department of Museum and Antiquity have gazette it as an Old Monument according to Section 15 of the Antiquities Act 1976. This building has the shape and characteristics of western architecture but have the roofs, doors and windows are distinctly local. The building was constructed using local materials, such timber, clay roof tiles and ceramic floor tiles.

The building was restored by the Department of Museum and Antiquity in 2004 and it was handed over to the Melaka State Government. In 2007, the Melaka State Government with the cooperation from Post Malaysia decided to set up the Melaka Stamp Museum in this building. The total floor area for the museum is 659 m2. The museum is a 2 storey building with a courtyard and have a verandah facing the courtyard. There is only one entrance into the museum compound and the museum is attached with ‘Muzium Rakyat’. The ground floor has a souvenir store and 2 exhibition rooms. The drawing and stamp storage room is located at an annexed building.

Fire risk index method (case study)

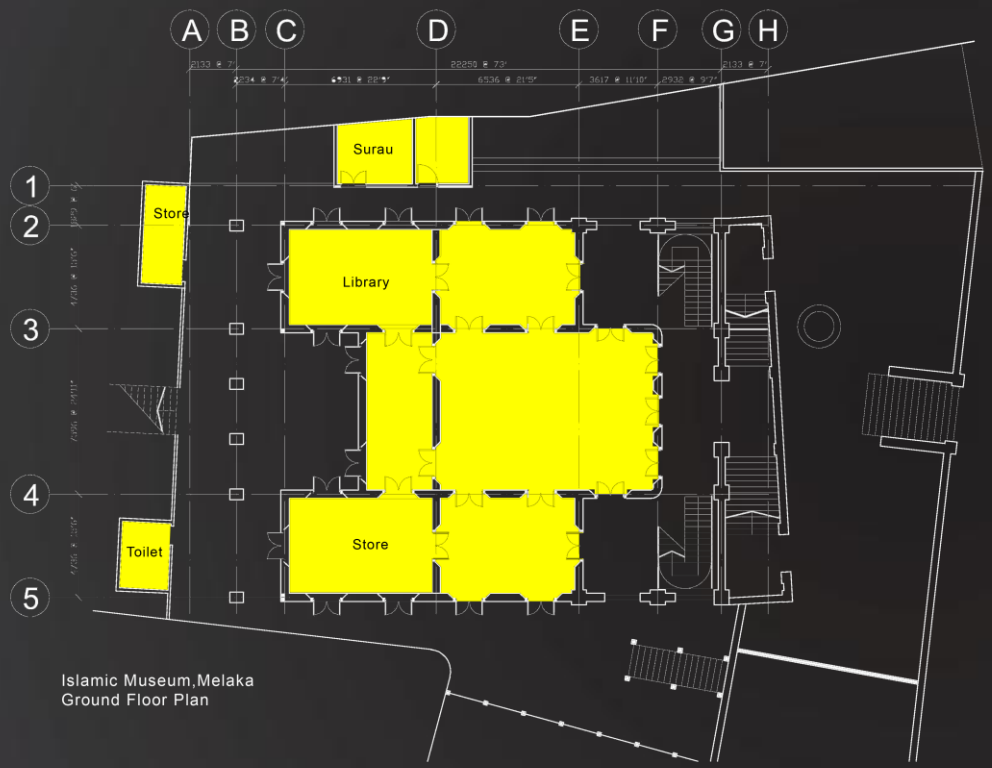


Islamic Museum

Stamp Museum

No	Criteria	ISLAMIC MUSEUM	STAMP MUSEUM
1	Structures	Timber and Masonry	Timber and Masonry
2	Typology	Museum	Museum
3	Caretaker	PERZIM	PERZIM
4	Location	Melaka	Melaka
5	Number of floors	2 storey	2 storey
6	Gross Floor Area	760 m^2	659 m^2

Islamic Museum – Floor Plan

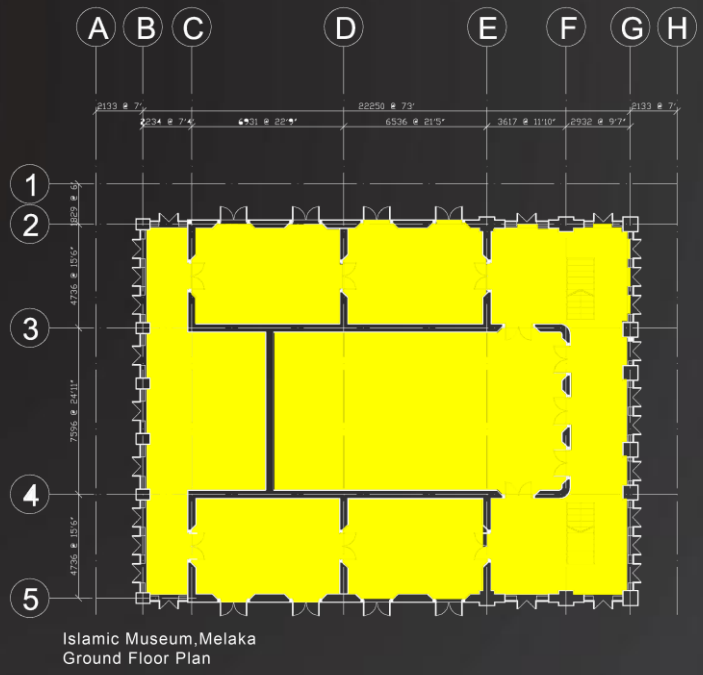


Ground Floor

nts

1st Floor

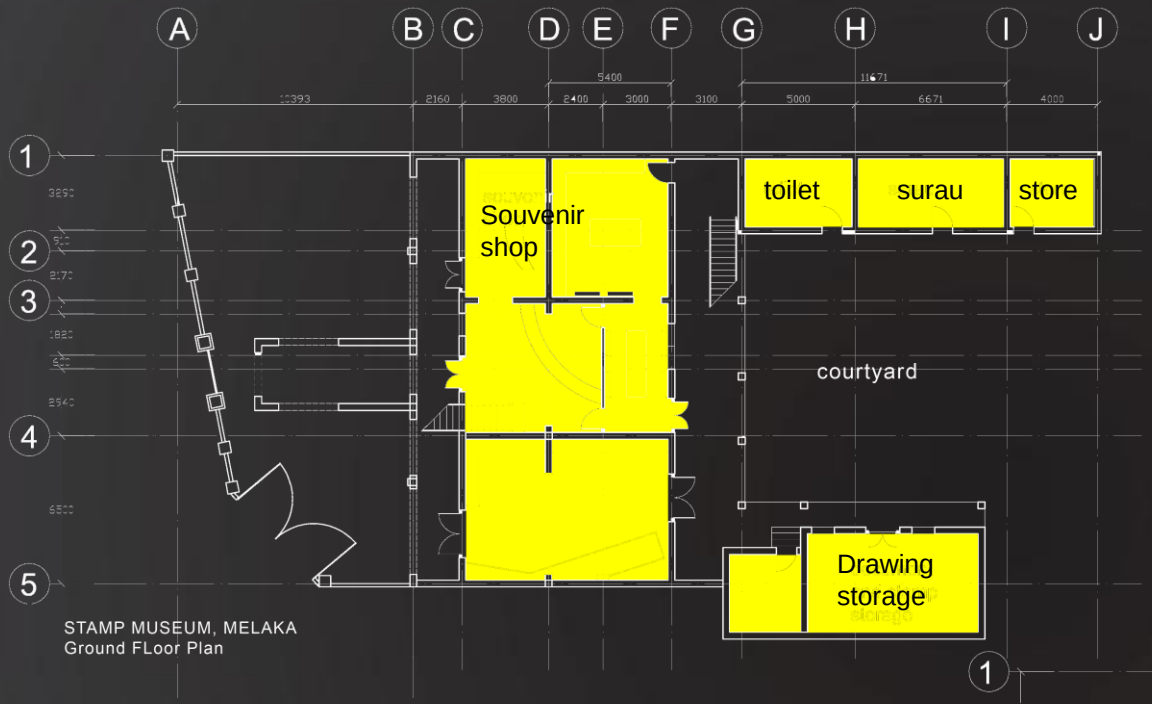
nts



Islamic Museum - Exterior

Islamic Museum - Exterior

Stamp museum – floor plAN



Ground Floor

nts

1st Floor

nts

Stamp museum - Exterior

Stamp museum - interior

findings

No	Parameter	weight	Islamic Museum	Stamp Museum	Findings
1	Lining in rooms	0.0576	0.288	0.288	Both have similar lining material
2	Suppression system	0.0668	0.000	0.000	Both do not have sprinkler system
3	Fire service	0.0681	0.215	0.215	Both building located near to the fire station
4	Compartmentation	0.0666	0.133	0.000	The interior of Islamic Museum is compartmentalized into 8 rooms
5	Structure- separating	0.0675	0.189	0.000	Stamp Museum has an open internal layout allowing fire to spread
6	Doors	0.0698	0.210	0.302	Stamp Museum has a self closing fire rated door as compared to Islamic Museum
7	Windows	0.0473	0.142	0.142	Both buildings have a similar huge wooden frame windows
8	Facade	0.0492	0.000	0.112	Islamic Museum has more combustible material as a façade of the building as compared to Stamp Museum

findings

No	Parameter	weight	Islamic Museum	Stamp Museum	Findings
9	Roof space	0.0515	0.000	0.000	Both buildings do not provide any fire suppression system in roof space area
10	Adjacent building	0.0396	0.000	0.000	Both buildings do not have any buffer zone @ setback
11	Smoke control system	0.0609	0.000	0.000	Both buildings use natural ventilation
12	Detection system	0.0630	0.000	0.315	Stamp Museum is equipped with smoke detector as compared to Islamic Museum
13	Signal System	0.0512	0.000	0.205	Stamp Museum is equipped with automated signal system as compared to Islamic Museum
14	Escape routes	0.0620	0.283	0.283	Both buildings provide adequate escape routes
15	Structure – load bearing	0.0630	0.233	0.233	Both buildings have similar structural system

findings

No	Parameter	weight	Islamic Museum	Stamp Museum	Findings
16	Maintenance and information	0.0601	0.016	0.016	Both museum have a poor fire information system in the building
17	Ventilation system	0.0558	0.000	0.000	Both building using natural ventilation
	SCORE	1.0000	1.709	2.111	
	Risk Index (=5-score)		**3.291**	**2.889**	

Stamp Museum has a lower fire risk as compared to Islamic Museum

Conclusion & Recommendations

- Based on the findings from the case study, there are substantial fire risks in historic timber building museums in Malaysia.
- Fire risk assessment helps to identify potential risks and underline parameters for Fire Safety Management Plan for the use of caretakers, in this case PERZIM.
- Fire risk assessment should be introduced in dilapidation reports or building planning approval for conservation projects.
- FRIM assessment method is suitable for historic timber building museum.
- FRIM can be used by the Authority for fire safety guidelines and checklist.
- FRIM is suitable for conservators and professionals to evaluate their design proposals for conservation projects.
- FRIM is suitable for academicians for their researches in historic buildings.