Assessing the Building Condition of Historic Timber Mosques in Kelantan

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ABSTRACT

Historic timber mosques, aged over 100 years old, can rarely be found today in Malaysia. Most timber mosques have been demolished and reconstructed using bricks or other materials considered sturdier and stronger. In Kelantan, a few timber mosques can still be found; nevertheless, some are conserved very well, and some are deteriorated and demolished. This study aims to help preserve the remaining mosques in Kelantan by focusing on two objectives: to review timber as a construction material, especially for mosques, and to investigate timber defects found at the selected historic timber mosques in Kelantan. Three historic timber mosques in Kelantan were selected as the case studies: Mulong Old Mosque, Tok Pulai Chondong Mosque, and D'Raja Long Yunus Mosque. Building Condition Assessment (BCA) at each mosque and interviews were done to reveal the maintenance works. Findings showed 80 defects found in the three case studies, mostly cracks followed by rot and discolouration, considerably due to lack of periodic or regular maintenance.

Keywords: *Building Condition Assessment, historic timber mosque, timber defect, timber conservation*

INTRODUCTION

Such as steel and reinforced concrete; timber has been one of the three structural elements employed in the construction of significant buildings (SkyCiv, 2019). Therefore, timber may contribute the most excellent effect in reducing construction's environmental effects. Furthermore, timber's strength is similar to reinforced concrete, even though timber cannot compete in compression with modern high-strength concrete (Ramage et al., 2016). Compared to other common structural materials, timber has a low density. This leads to effectiveness for long-span or high structures where the structure's weight does not account for a large portion of the load. This indicates that timber is an efficient material in structures when the own weight of the structure is the only significant portion of the load to be resisted.

In Malaysia, most timber construction reflects the historic timber mosques in Kelantan (Johar & Ahmad, 2010). However, they are more exposed to defects and deteriorations, mostly due to moisture and termite attacks. Furthermore, conserving timber structures has been challenging in Malaysia (Zolkafli et al., 2015). The depletion of high-quality timber and the shortage of trained workers in timber building restoration is the most apparent obstacles in historic timber structure repair and conservation. As a result, many would choose other materials over timber since it is more convenient and cheaper. Therefore, this study was carried out to help preserve the remaining mosques in Kelantan by focusing on two objectives: to review timber as a construction material, especially for the mosque, and to investigate defects found at the selected historic timber mosques in Kelantan.

TIMBER MOSQUE IN MALAYSIA

Timber mosques in Malaysia exhibit traditional Malay identity that has now been replaced by other modern designs (Treble, 2015). From the Northeast coastal states of Peninsular Malaysia to the Southern regions of Peninsular Malaysia, timber mosques serve as a national heritage for Malay rural cultures (Saberi et al., 2015). The structure and construction of traditional mosque architecture in the Archipelago and mosque architecture created during the early Islamic civilisation are unique (Wahid et al., 2021). It is significantly simpler and influenced tremendously by the availability of building materials and the sole use of timber in construction. As a consequence of the lack of durability of timber, historians have nearly forgotten about the traditional mosques in the Archipelago (Surat, 2008), even though the architecture of these mosques is one of the most important architectural remains of Islamic civilisation (Wahid et al., 2021).

Traditional mosque architecture in Malaysia is part of a Southeast Asian vernacular heritage that covers the Indonesian Archipelago, the Malay Peninsula, Thailand, and the Philippines. The pyramid or *meru* form of a wood roof, which is either set on stilts or covers masonry collonaded wall with a tiled floor, has been stressed throughout history (Mohamad Rasdi, 2012). Timber mosque architecture in Malaysia is also associated with the traditional vernacular style of a Malay house. Three varieties of mosques in this category are three-tier pyramidal roof forms, two-tier pyramidal roof forms, and the gable roof form.

Timber Defects and Timber Conservation

When timber is utilised as a structural element in structures, it remains part of the carbon cycle and is thus susceptible to fungus and animals breaking it down (Johar et al., 2013). Wood degradation agents are classified into four categories which are biological, physical, mechanical, and chemical. Some agents are substantially less damaging and frequently cause aesthetic value dissatisfaction. Biological agents and moisture issues are prevalent faults leading to significant wood degradation. Defects such as termites, dampness, and fungi are commonly found in traditional timber construction. The roof has been identified as the most common location for defects, with dampness-related issues caused by ineffective roof parts seeming to be the most common. The worst defects were caused by a lack of maintenance and repair or natural disaster.

Preservatives can be impregnated into the fibre of wood using stress treatment, ensuring that the protection stays in place whenever the wood is subjected to splits, abrasion, and other in-service adjustments. Preserved timber buildings are an environmentally friendly and cost-effective method for extending existing structures' durability and service life (Bernhardt, 2017). Exposed to the weather without any proper treatment, timber can be easily degraded (Wibawa et al., 2020). Timber needs to be preserved and treated for internal deterioration, moisture, dry rot, and attack by an insect. When applied to seasoned timber, paint protects it from moisture and extends its life forever if it is refreshed regularly. Many methods have been used for impregnating wood with chemical substances to defend it from dry rot and pests. The most common preservation technique includes creosoting, tarring, painting, and charring (Baddi, 2019).

METHODOLOGY

Three historic timber mosques in Kelantan (Figures 1 - 3), aged more than 100 years old and built with 100% or mostly timber, were chosen as case studies: Mulong Old Mosque (122 years old), Tok Pulai Chondong Mosque (166 years old), and D'Raja Long Yunus Mosque (151 years old). Building Condition Assessment (BCA) was carried out at each mosque to identify the timber defects and analysed with BARIS using the Defect Analysis method. Interviews were also done with representatives from the management team at each mosque and Majlis Agama Islam Kelantan (MAIK).

Figure 1: Mulong Old Mosque
Source: (Author, 2022)

Figure 2: Tok Pulai Chondong Mosque
Source: (Author, 2022)

Figure 3: D'Raja Long Yunus Mosque
Source: (Author, 2022)

ANALYSIS AND FINDINGS

This section presents the results of three selected case studies collected through semi-structured interviews and building condition assessments. By using comparative analysis, the construction of the selected mosques and defect analysis are discussed in the following sections.

The Construction of Mulong Old Mosque, Tok Pulai Chondong Mosque and D'Raja Long Yunus Mosque

The Mulong Old Mosque, currently named the Ar-Rahman Mosque, was built in 1900 as the Balairung Seri and refurbished into a mosque in 1958. Widely known as Masjid Kedai Mulong and Masjid Pameran, it is in Ketereh, Kota Bahru District, within 20x60 square feet. The mosque was built with 100% timber as the material, where the main structure was made with *chengal*, and the roof was made with *singgora* and *pemeleh*. Conservation work was done in 2009 to make good and replace the wall timber and restore the original roof material. The National Heritage Department (JWN) currently designated the mosque as the Heritage.

Categorized as the Mukim Mosque, the Tok Pulai Chondong Mosque is well known for its 57 feet of leaning minaret, which resembles the Leaning Tower of Pisa in Italy. It was built in 1856; however, it burnt down in a fire incident in 1857 and was reconstructed with the same timber structure in the same year. Located in Pulai Chondong, Machang District, it was built within 40x70 square feet with 80% to 90% timber with a 10% mix of concrete. The main mosque was built with wood logs, while other parts are made of *chengal*.

Meanwhile, the D'Raja Long Yunus Mosque, categorized as the Urban and Colonial Mosque, was built in 1871 and refurbished with an extension of a three-storey concrete building in 1985. It is widely known as Masjid Sultan because it is next to the Kelantan Royal Mausoleum (also known as the Langgar Royal Mausoleum). Built within 95x78 square feet, the original part (70% to 80% of the whole mosque) remains a timber structure, mostly built with *chengal*, *pemeleh* as the roof, and *kayu panjang* as the column.

BCA of Mulong Old Mosque, Tok Pulai Chondong Mosque and D'Raja Long Yunus Mosque

BCA was carried out on the three timber mosques, including defects description, location of the defects, possible causes of the defects, and assessment of defects based on BARIS (Table 1). As a result, ten defects were found during the assessment: cracks, rot and dry rot, mould, sap stain, discolouration, peeling paint, termite and beetles attack, broken parts, scratch marks, and chip marks. Eighty defects were found at the three mosques, where 19 defects were found at Mulong Old Mosque, 26 defects at Tok Pulai Chondong Mosque, and 35 defects at D'Raja Long Yunus Mosque (Table 2). Therefore, the first mosque can be rated as 'good', while two others are rated 'fair'.

Table 1: Overall Building Rating

No	Building Rating	Score
1	Good	1 to 4
2	Fair	5 to 12
3	Dilapidated	13 to 20

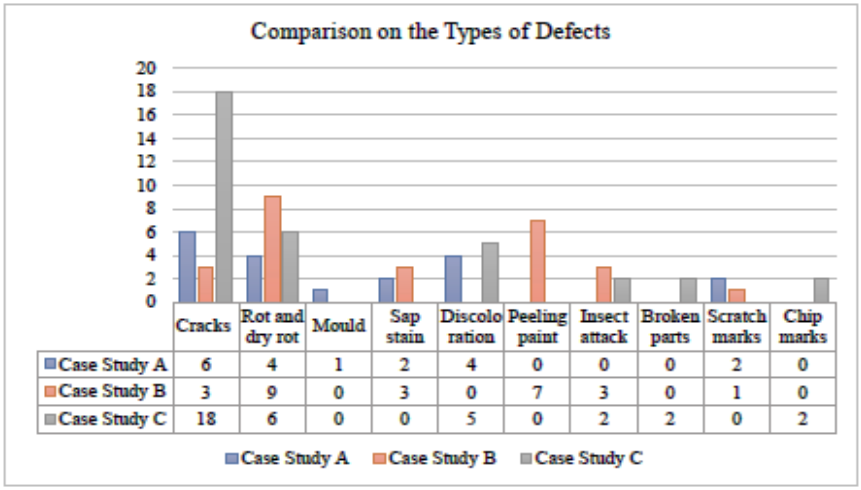
Source: (CPBS 101, 2022)

Table 2: Defects Rating Comparison

BUILDING RATING	NUMBER OF DEFECTS Mulong Old Mosque	Tok Pulai Chondong Mosque	D'Raja Long Yunus Mosque
Good	11	12	11
Fair	8	14	24
Dilapidated	0	0	0
OVERALL BUILDING RATING	Good	Fair	Fair

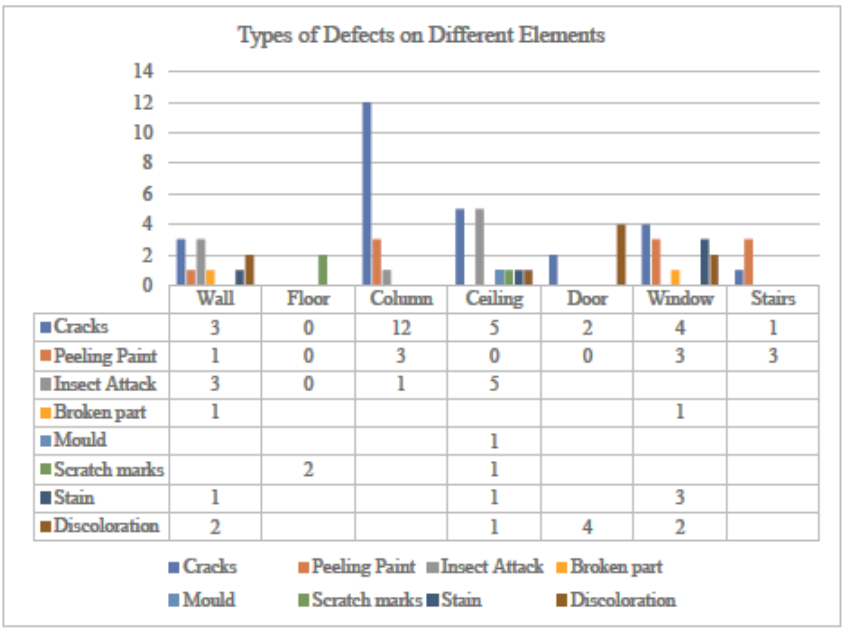
Source: (Author, 2022)

Defects Analysis based on the type of defects and elements of mosques is summarized and shown in Figure 4 and Figure 5. The most found defect was crack, which can be separated into the hairline, split, and checked cracks. Similar results were recorded at Perak heritage mosques as cracks are major defects found (Alauddin et al., 2018). Frequent changes in weather and the surrounding environment are the possible causes of this defect. Meanwhile, the highest number of defects were found on the external wall, where the parts are mostly exposed to outside weather as the outermost layer of the building.



	Cracks	Rot and dry rot	Mould	Sap stain	Discoloration	Peeling paint	Insect attack	Broken parts	Scratch marks	Chip marks
Case Study A	6	4	1	2	4	0	0	0	2	0
Case Study B	3	9	0	3	0	7	3	0	1	0
Case Study C	18	6	0	0	5	0	2	2	0	2

Figure 4: Comparison on types of defects
Source: (Author, 2022)



	Wall	Floor	Column	Ceiling	Door	Window	Stairs
Cracks	3	0	12	5	2	4	1
Peeling Paint	1	0	3	0	0	3	3
Insect Attack	3	0	1	5			
Broken part	1					1	
Mould				1			
Scratch marks		2		1			
Stain	1			1		3	
Discoloration	2			1	4	2	

Figure 5: Types of defects on different elements
Source: (Author, 2022)

CONCLUSION

The BCA shows a total of 80 defects were found at the three selected historic timber mosques, where the defects are cracks, rot and dry rot, mould, sap stain, discolouration, peeling paint, insect attack, broken parts, scratch marks, and chip marks. The highest number of defects found in the case studies are cracks, with a total of 27, followed by rot and dry rot, with 19 and discolouration, with 9. It can also be concluded that the timber defects are caused by improper maintenance, with no periodic or regular maintenance. Therefore, this study recommends that improvements be made in the mosque management to ensure a proper inspection and maintenance plan at the three mosques. Moreover, experts should also periodically perform maintenance and treatment for timber to prevent more damage to the timber.

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AUTHOR CONTRIBUTIONS & CONFLICT OF INTEREST

N.N.R.A.N.M. conceived of the presented idea. R.R.R. wrote the manuscript with support from H.K. on th technical part. W.Z.W.I. supervised during data collection (BCA) at the case study and N.N.R.A.N.M. led the interview sessions.

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