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Research paper

Measuring the Level of Defect Condition in the Museum Building

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Abstract

Assessment of buildings is one of the main components that are essential to assess the condition of the building. Without evaluation, it is difficult to determine the current condition of a heritage building, so failure to check can contribute to future assets. The objective of this study is to assess the level of defect condition in a heritage building. This study has selected nine buildings of the museum as a place of study. The location of the museum building is located in three states of Kelantan, Terengganu, and Pahang. All of the museum buildings have been implemented by using Building Defect Assessment (BDA) and used as a survey tool to assess the level of disability at museum building. Defects of each element in the building of the museum have been recorded. As a result of the BDA suggests that score full points used to provide the level of evaluating the overall condition of the museum building is good, and the need for action to maintenance requirements such as monitoring, repair, a replacement for preventing defects or serious damage.

Keywords: *Measuring, building condition, physical element, heritage museum*

1. Introduction

Malaysia is rich in heritage buildings. Based on the results of the inventory survey conducted by the National Museum of Ireland in 1992, it is estimated that approximately 35,000 pre-war buildings were studied in 265 cities across the country need to be maintained [1]. However, most of this heritage building is well maintained and mostly are in a dilapidated condition due to numerous defects [1]. Unfortunately, these heritage buildings are threatened with destruction because they are ignored by the owners and demolished at the request of the lack of development and concern for the community to conserve the heritage buildings [2].

Heritage buildings that exist in a country should be preserved because it has the emotional, cultural, and usability invaluable [3]. Without ongoing conservation efforts, this heritage building is feared that the building will continue to be lost in time [4]. Therefore, the conservation of heritage buildings should be done from time to time so that future generations have the opportunity to be seen in its current form because it was built hundreds of years ago, such as museums, galleries, houses, palaces, mosques and other [5].

Museum building is a very valuable national history. To maintain this building, conservation or maintenance should be carried out to ensure the integrity of its design and the architecture [6]. The principle of conservation should be practiced is the repair, maintenance, rehabilitation, reconstruction and adaptation [7]. Historical marker such as buildings, monuments can be used as reference material for future generations [7].

The Museum building is also a major asset for all types of organizations including public sector [8]. Importance of assets as human resources, finance and information, which can contribute to the success of an organization when managed effectively and efficiently [9]. To maintain the value of the assets, it must be managed in a professional manner. It has been proven that not only capital to ensure that the value of the assets can be maintained, but could also be upgraded through asset management effective and creative assets [10].

This research focuses on the evaluation of the condition of the museum building, which is one of the key processes in asset management and comprehensive asset management asset. This assessment is important for building assets to support the core operations of a building as a museum, which should operate efficiently and effectively in providing quality work to build the population, namely consumer.

This paper discusses the museum building condition assessment based on analysis of building defects assessment (BDA). The contents of this paper is the introduction, literature review, methodology, results and discussion and conclusions of the study.

2. Literature review

Malaysia has taken steps to launch a campaign to preserve heritage buildings to promote the museum as a tourist destination. Based on these observations, matters become a tourist attraction, especially for foreign tourists is the beauty of the structure of the museum, the museum of architecture, interior decoration museums, art exhibitions, and collections of old. Therefore, maintenance is required on the museum building to provide space and a good and safe environment for the collection and visitors to the history [11].

In general, the assessment of the museum building was not officially formulated. Still no parameters or system to assess the state of the museum building in detail to obtain reasonable assurance whether the building still provide a conducive environment. Not only is the museum building and other buildings associated with other heritage has not created [12].

Maintenance activities to maintain heritage buildings including the convenience of users to always be in good condition. Although some newly built building is still in good condition and are able to upgrade and provide a quality environment, it will not always fresh throughout life [13]. This is because all the facilities are getting older and always use a process of renovation and refurbishment [14]. More seriously, there are also problems associated with the maintenance that occurred before the building was completed [14]. Features of the museum building includes exhibition halls, rooms, toilets, etc. In managing or maintaining the performance of these facilities, building condition assessment is one of the proactive steps that can be implemented.

This includes aspects such as the configuration space, indoor air quality, ventilation, thermal comfort, lighting and sound. Matters relating to the quality of the building is the center of the interaction between the environment and buildings, including the user's movement, aesthetics, lighting, space flexible and responsive, and open space and security concerns [15]. Security is one aspect that must be guaranteed to ensure sustainable development through the implementation of the Asset Management [15].

Extracted from a report issued by the United States Government Accountability Office (GAO) there are significant differences between costs required for the operation and maintenance of facilities rather than the cost to design and build the facility. In addition, the report also revealed that there are shortcomings in the regulation of asset management implemented by the government [16].

3. Research methodology

The data required for this evaluation obtained through evaluation of the state of the museum building. The collection of data in the analysis using the disability assessment (BDA). Examinations conducted also be viewed appropriately. This examination is limited to parts that can be accessed. No test against damage or damage done. Similarly, the test structure or a detailed inspection of electrical wiring or mechanical systems are not implemented. Any information and images related to disability and damage have been collected for analysis.

Area museum buildings have been identified through previous studies and because of the small number of researchers, all physical elements in the museum is required to participate in this study to enable researchers to collect data.

3.1. Research sample

The scope of research is focused on nine museum buildings in Peninsular Malaysia, obtained from the state museum institution and state museum corporations. The selection criteria used are based on the previous case study frequency. The location of the museum building was chosen based on the lack of heritage study in the states. According to the statistics of previous studies, there are five states with less than five case studies during the period 2010 to 2017. Thus, this study has chosen three states to conduct the study.

This study chooses three museum building in each state. Where, the museum building a located at Kelantan, Terengganu, and Pahang. This study was chosen nine museums as a case study.

The condition of the inspected building components is assessed using building defects assessment (BDA). This building defects assessment serves as a guideline for inspectors to assess a building damage based on the degree of damage and priority of the component [8]. To facilitate examiners to assess the condition of the museum building examined, these codes and protocols have their own scoring system [9]. Table 1 shows the list of the museum in each state in Malaysia and the total of the previous study in the heritage building.

Table 1: List of museums in the study area

State	Number of museums	Previous study (2010-2017)
Johor	7	5
Melaka	34	11
Negeri Sembilan	6	5
Wilayah Persekutuan	23	6
Selangor	7	5
Pulau Pinang	18	15
Perak	13	14
Kedah	7	4
Perlis	2	5
Kelantan	**9**	**2**
Terengganu	**3**	**2**
Pahang	**6**	**1**
Sabah	8	3
Sarawak	17	4

3.2. Data collection

Criteria of checking for building condition of the museum building are divided into three aspects of a building structure, building fabric and building service aspect. The structured aspect of this building consists of the main components of a building such as foundation, column, beam, truss, and stair. While building fabric aspect is the condition of the building component that can be seen after entering a building space such as a ceiling, internal walls, external walls, floor, roof, door, window, and the arch. Finally, the aspect of building services comprises electricity, air conditioning, fire protection and sanitary and plumbing.

The condition of the inspected building components is assessed using the Building Inspection Code Standards issued by the Royal Malaysian Surveyors Association (RISM) and the Building Defects Assessment (BDA). These codes and protocols serve as guidelines for inspectors to assess building defects based on the extent of damage and the component's priority. To facilitate the examiner to assess the condition of the examined condition, code and protocol have its own scoring system [8-9]. Based on this code, the examiner can assess the condition of a museum building carefully and overalls.

Damage or defect of identified buildings is assessed and recorded at the inspection site. This step is aimed at ensuring that the assessment is accurate and avoid any doubt. Every successful damage detected will be recorded by recording a photograph so as to determine the location of the damage and as evidence.

3.3. Data analysis

Every defects identified and evaluated in accordance with the terms of priorities. The scores determine the degree of disability either excellent, good, fair, poor or very poor. In addition, the cause of damage was also identified. This information is recorded in the form of sheets Building Defects then all the data collected from the defect can be seen more comprehensive.

In addition, a summary of the test results as the number of defects, the score and the rating for each building BDA museum collected. These results are compared with the age of the building the museum to see the relationship between the state and age of the building of the museum. This comparison is presented in the form of bar charts and tables.

3. Result and discussion

The assessment of the physical condition of the museum building was carried out on nine museums in Kelantan, Terengganu and Pahang states. Table 2 below shows the Museum Code for each museum building and year of its establishment.

Table 2: Museum Code and the year establishment

State	Museum Code (MC)	Built	Age
Kelantan (K)	K01	1880	138
	K02	1902	116
	K03	1939	79
Terengganu (T)	T04	1920	98
	T05	1930	88
	T06	1976	42
Pahang (P)	P07	1888	130
	P08	1910	108
	P09	1929	89

To study the relationship between the age of the museum building with the number of defects, scores, and ratings, the age of each museum building is identified. Overall, 3231 building defects were detected and the accumulated marks based on the BDA assessment were 664.8. This means the rating BDA for the nine museum buildings inspected were 73.86%, is at a good level.

4.1. Number of building defects for each museum

Based on the inspection of the building condition, a total of 3231 building defects have been detected in nine museum buildings involved in the study. The highest number of defects was recorded at T05 of 604 defects while the lowest defect was detected at T06 of 236 defects. Figure 1 shows the number of defects detected for each museum building.

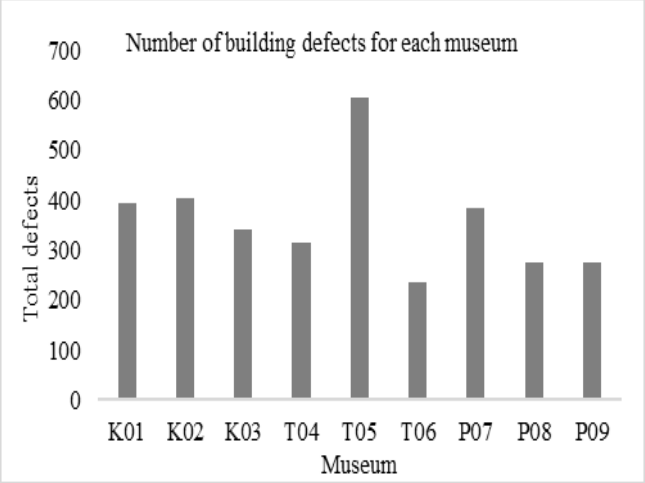

Fig. 1: Number of building defects for each museum

Table 3 presents the number of museums according to the age range and number of building defects. Museum buildings 1 to 50 years old have the least number of defect of fewer than 250 numbers. While buildings aged 51 to 100 years have a number of the defect between 200 to 800 numbers. For buildings over 100 years, the number is between 400 and 600 numbers.

Table 3: Number of age museum compare with a number of defects

Age	Number of museum	Number of defects				
		0-200	201-400	401-600	601-800	801-1000
0 - 50	1	0	1	0	0	0
51 - 100	4	0	1	2	1	0
> 100	4	0	1	3	0	0
	9	0	3	5	1	0

Table 4 below shows the number of defects and damage according to the building elements of each museum building studied.

Table 4: Number of defects and damage by building elements

No.	Element	K01	K02	K03	T04	T05	T06	P07	P08	P09	Total
1	Foundation	2	2	2	4	1	2	5	3	1	22
2	Column	134	10	12	9	8	7	11	9	9	209
3	Beam	5	10	12	9	6	7	11	9	9	78
4	Truss	4	1	2	2	2	1	1	3	3	19
5	Staircase	6	4	2	2	1	2	1	2	2	22
6	Ceiling	24	44	46	23	109	40	66	30	49	431
7	Floor	5	45	24	47	71	18	54	34	39	337
8	Internal Wall	58	56	91	43	78	59	63	38	39	525
9	External Wall	16	108	86	43	205	60	66	64	49	697
10	Roof	22	18	10	37	12	8	22	14	14	157
11	Door	5	28	16	33	54	12	23	23	21	215
12	Windows	1	40	20	21	36	8	32	36	12	206
13	Arch	0	1	0	0	0	0	0	0	0	1
14	Electricity	13	10	5	7	4	3	10	3	5	60
15	Air Condition	30	14	8	25	8	3	7	2	13	110
16	Fire Protection	2	2	1	1	1	2	3	1	1	14
17	Sanitary	66	10	5	9	8	4	11	6	9	128
	Total defects	393	403	342	315	604	236	386	277	275	3231

From the above study, the highest defect and damage was on the External wall element of 697 and followed by the internal wall element of 525. Next is the ceiling element of 431. This study shows that defects and damage to these elements are due to the quality of the ventilation and lighting inside and outside the building and causing moisture in building elements. In addition, it is also exposed to environmental factors and chemical reactions. The arch element is only available in the K02 museum. The truss element can only be recorded in the visible one because the entrance path to get there is limited and not allowed by the building owner.

4.2. Overall score defect for each museum

Figure 2 shows the overall score of the defect to the building of each museum building examined under BDA. The lowest score was recorded at T05 with 59.1 while the highest score was recorded at T06 with a score of 79.5. There is a museum that collects a moderate score with 69.5. While the rest collects more than 70 scores.

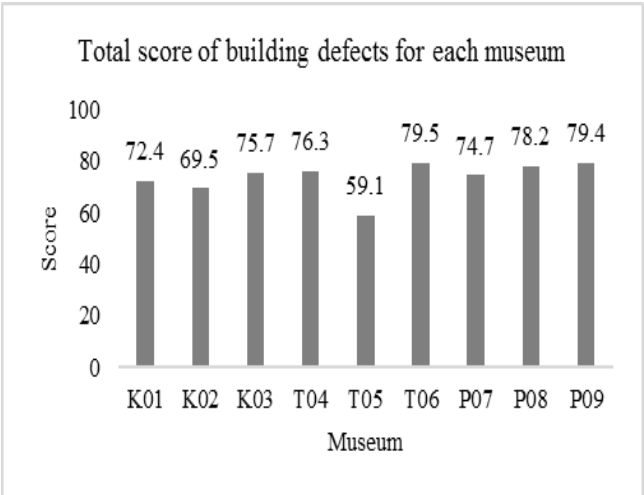

Fig. 2: Total score of building defect for each museum

Table 5 shows the number of the museum according to age range compared with the scores obtained. Comparison of the age range of buildings with a total score based on the instrument BDA for each museum, museum majority scored between 61-80 of eight museums. These eight museums, only one museum that would be tween 0-50 years, three museums within the museum group aged 50 to 100 years and four museums are more than 100 years. There are eight museums scored between 61-80 and only one museum that scored between 41-60. From eight museums with the highest score over 61 and up, four museums are aged over 100 years. These results indicate that the building is over 100 years the museum has no serious damage.

Table 5: Number of age museum compare with the score

Age	Number of museum	Score for each museum building				
		0-20	21-40	41-60	61-80	81-100
0 - 50	1	0	0	0	1	0
51 - 100	4	0	0	1	3	0
> 100	4	0	0	0	4	0
	9	0	0	1	8	0

4.3. Overall priority for each museum

Figure 3 shows the BDA rating of instruments for each museum building examined. Based on the figure, the lowest priority is 3 recorded at T05 while the highest priority is 4 recorded in the rest of the museum. This value shows that the best museum conditions are in good condition that requires monitoring and fair condition museum are requiring to more observation and monitoring. Figure 3 and Table 6 show the number of the museum based on the BDA priority of the building condition of each museum.

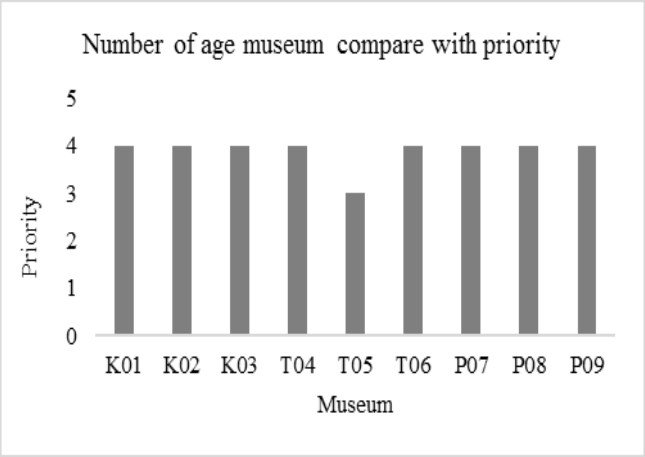

Fig. 3: The priority of each museum

If linked to the age of the museum, there is no museum in the best condition and less than the period of age (Table 6). One of the museum are in fair condition and the remaining are in good condition, despite his disability is not the same number and variety of year. This figure makes it clear that although the museum with the highest number of museums disability is between 51 and 100 years. There is also a small defect to the museum aged 51 to 100 years, although it does not have a high number of defects, but should be taken seriously and require immediate maintenance to avoid getting worse. Therefore, this situation also requires monitoring and maintenance to keep the design and function of the museum which serves as a tourist attraction to their respective countries.

Table 6: Number of age museum compare with priority

Age	Number of museum	Priority for each museum building				
		1 (Very Poor)	2 (Poor)	3 (Fair)	4 (Good)	5 (Very Good)
0 - 50	1	0	0	0	1	0
51 - 100	4	0	0	1	3	0
> 100	4	0	0	0	4	0
	9	0	0	1	8	0

4.3. The relevance of the age factor of museum building to building defect

To study the relevance of museum age factors to building defects, the relevance of the three aspects assessed as the number of the defect, overall score and overall priorities with the age of the museum building is evaluated. Table 7 shows the association between the ages of the museum with the three aspects.

Table 7: The relationship between theory and aspects of the assessment of museum buildings

Theory	Number of defects	Overall of score	Overall of priority
The higher the age of the museum building, the more defects and the damage to the building.	Not applicable	Not applicable	Not applicable

Therefore, the age and condition of the building should be noted because it is closely related to maintenance. Increase the age of the building will increase the demand for maintenance and overhaul. Table 7 and BDA analysis indicates that the association between age theory and museum the museum building assessment aspect is irrelevant. This is because the defects and damages of buildings depends on planning and frequency of maintenance works in building. Building maintenance services also include work undertaken to maintain the correct building, services and their works commonly used. The use of the planned building is a major factor in determining the standard of maintenance that is required. Classification of maintenance is divided into two, namely, the maintenance of corrective and preventive maintenance.

4. Conclusion

Maintenance work in the museum building is very important in ensuring the country's assets can be preserved while providing a conducive environment for the user. This has been demonstrated by earlier studies either from within or outside the country.

The building has its own lifespan and cannot be separated from any defect and damage although it was treated as precautionary measures during the process of design and construction. Maintenance work should be carried out over the life of the building. Therefore, to maintain the function of a building, it must be maintained adequately. Without an organized and ongoing maintenance, quality and performance of the building will begin to decline and eventually the building will deteriorate.

The result of the inspection of the condition of the building museum shows that BDA rating instruments for the whole museum reached 73.86% is good condition. Defects and damage the museum is mostly affecting fabric elements building at the museum. Among the defects detected is external walls, internal walls, and ceiling. Most of the surface and paint cracking, fading, peeling and dampness. This was due to environmental conditions and the chemical reactions around the building.

The relationship between disability and age museum is irrelevant because each museum has a difference in maintenance with different channels. This scenario also raises questions such as the quality of maintenance work as well as the selection of a replacement museum building materials appropriate to the museum environment. However, no serious building flaws have been identified in the case of museums surveyed.

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