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The Application of UAV and CSP1 Matrix for Building Inspection at Mosques in Area of Pagoh – Muar, Johor

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Abstract. Carrying out building inspection is very essential when it comes to conserving the condition of a building. The aim of performing building inspection on Pekan Pagoh mosque, Pekan Panchor mosque and Sultan Alaudin Riayat Syah 1 mosque is to evaluate their condition using Condition Survey Protocol 1 (CSP1) method. Condition Survey Protocol (CSP1) is used as an evaluation apparatus as it is appropriate for various structures to classify the data based on its condition and destruction evaluations. CSP1 Matrix has also been developed in order to reduce the process of interpreting the data which would then support shortening on-site inspection time. It would be difficult to determine a building existing condition without suitable inspection and that would result a possible failure of the building in the coming years. Therefore, an UAV is used to aid in the visual inspection and CSP1 Matrix is used to analyze the condition of all three mosques and identify the seriousness of each defect detected. Thus, the total score for all mosques were calculated whereby for Pekan Panchor mosque, the score is 3.4, 2.9 for Pekan Pagoh mosque and 4.1 for Sultan Alaudin Riayat Syah 1 mosque.

INTRODUCTION

The act of analysing the condition of a facility is crucial for an effective maintenance planning so that the factors affecting a building defect could be identified and thus determines the quality of maintenance. It could also be referred as condition assessment which would observe and inspect both the exterior and interior of a building to aid in the identification of damages in the building and its component. There are several types of defects that would commonly exist such as cracking, peeled of paint and vegetation.

Condition Survey Protocol (CSP1) is used as a rating apparatus as it is very suitable for various structures to classify the data based on its condition and harm evaluations. CSP1 Matrix has also been developed in order to shorten the process of interpreting the data which would then help shortening on-site inspection time. It is then proven to be useful and reliable in carrying building inspections. [1].

All elements of historic buildings tend to deteriorate but at a greater or lesser rate depending upon function and location and will rapidly decay and degrade when building maintenance has been neglected [9]. According to Ting Kien Hwa [8], it is mentioned that maintaining architectures that has aged more than 50 years in good condition will create a better image for Malaysia and showing respect to its history. This brings all the more reason for a visual inspection to be carried out.

Three different mosques were selected in area of Pagoh, which are Masjid Panchor, Masjid Pekan Pagoh and Masjid Sultan Alaudin Riayat Syah 1. The mosques are differentiated by their year of built and from that a comparison can be made in terms of condition between the three different mosques. The issue studied is the defection of the building as the strength of a building cannot be based on the eyes of brutes but instead more meticulous. According to British Standard Institute [10], defect is the nonconformity of a component with a standard or specified characteristic. Defect is used sometimes as a synonym for “failure”, but the preferred meaning is to

indicate only a deviation from some (perceived) standard that may, but will not necessarily, result in failure. This study aims to identify the type of defect by visual inspection and identify defect using CSP1 method to rate the overall building condition.

METHODOLOGY

There are two main stages to perform this study for the assessment of building condition which first is visual inspection and the second is assessment of condition evaluation by using CSP1 Matrix.

Conducting the Visual Inspection

Visual inspection is the first step performed on structures of all the three mosques. It serves the purpose of acquiring and analyzing data which could then be proceeded with quality control. The gathering of data however was carried out by an UAV called Phantom 3 Advanced and with the help of its advance features, it was almost effortless. Phantom 3 has a core design that lifts the center of gravity closer to the Phantom's heart, improving balance, making it more agile and impressively precise. Furthermore, it could fly for as long as 23 minutes and has a range of 5km provided with a live 720p HD view of everything the camera sees. This significantly made it easier to reach both the roof and minaret easily. [2] Figure 1 shows the Phantom 3 drone and the process of calibration.

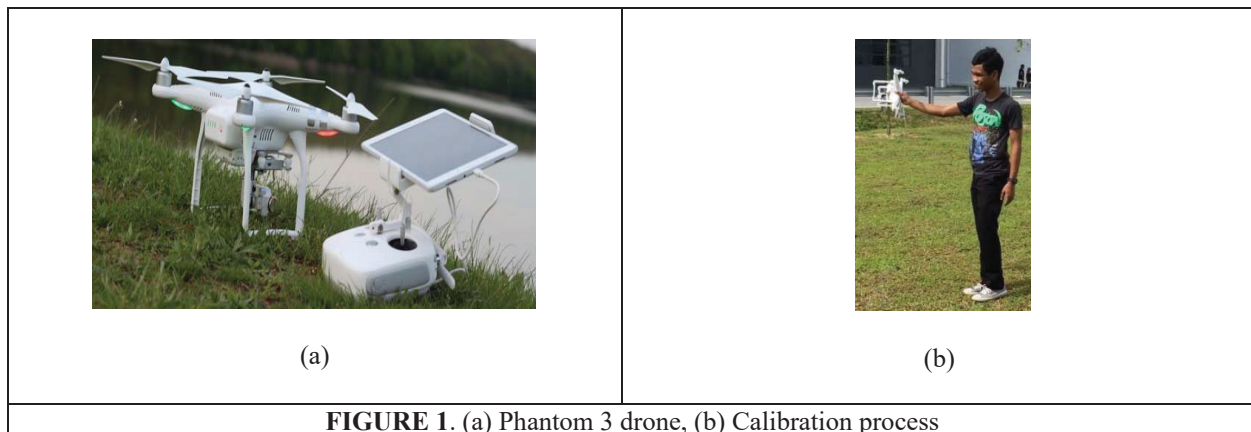


FIGURE 1. (a) Phantom 3 drone, (b) Calibration process

Condition Evaluation by using CSP1 Matrix

The condition and the priority assessments are the data required for the CSP1 Matrix as showed in both Table 1 and Table 2 . For each numerical score (1 to 5), it is accompanied by a scale value and description. This inevitably aid surveyors in rating a building's defects which then determines the exact condition implied by the scale values. [4]

Condition and priority rating are assigned for each recorded defect. Then, each rating is multiplied to determine the total score for each defect. The scores ranged from 1 to 20 where the colour (green, yellow or red) is the applied to indicate the score in each of the 3 parameters: Plan Maintenance (1 to 4), Condition Monitoring (5 to 12) and Serious Attention (13 to 20). This method made it easier to identify the level of seriousness of each defect recorded during the building inspection. [5]

Maintenance standards and/or definition of defects used by the surveyors/clients must be assigned carefully for each rating to reduce the risk of misinterpreting the level of defects. It is crucial to deal with red-coded defects first as this could influence the overall building condition other than exposing danger to people who are still using the building. Other than that, this could also help surveyor provide clients with well-informed defect summaries. [5]

TABLE 1. Condition Assessment Protocol 1[11]

Condition	Description	Scale Value
1	Good	Minor Servicing
2	Fair	Minor Repair
3	Poor	Major Repair/Replacement
4	Very Poor	Malfunction
5	Dilapidated	Damage/Replacement of Missing Parts

TABLE 2. Priority Assessment [11]

Priority	Scale Value	Description
1	Normal	Functional : cosmetic defect only
2	Routine	Minor defect, but could become serious if left unattended
3	Urgent	Serious defect, doesn't function at an acceptable standard
4	Emergency	Element/structure doesn't function at all; OR Presents risks that could lead to fatality and/or injury

RESULTS AND DISCUSSION

For this study, CSP1 matrix concept has been utilized to establish the reliable and precise result [6]. Table 3 and Table 4 show Matrix Assessment and Planned Maintenance used for this study.

TABLE 3. Matrix Assessment [11]

Scale		Priority Assessment			
		E4	U3	R2	N1
Condition Assessment	5	20	15	10	5
	4	16	12	8	4
	3	12	9	6	3
	2	8	6	4	2
	1	4	3	2	1

TABLE 4. Planned Maintenance [11]

No	Matrix	Score
1	Planned Maintenance	1 to 4
2	Condition Monitoring	5 to 12
3	Serious Attention	13 to 20

After scoring every defect, the overall building rating is calculated which summarises the building's condition. The score of each defect is added up and divided by the total number of defects to get the overall building rating. The building is then rated Good, Fair or dilapidated, according to the score (out of 20). Table 5 shows the overall

building ratings [6-7]. All of the information gathered for the CSP1 Matrix is recorded in the Schedule of Building Condition form. For reporting purposes, the CSP1 Matrix comprises a photograph box, a defect plan tag and an executive summary, as shown in Figures 2 and 3. Figure 4 is the summary of defect finding on one of the mosques. As shows in Figure 5, in spite of being built around the 1970s, it shows that with proper care and maintenance can still be in a good condition such as the ones built in 2006 and 2017.

TABLE 5. Overall Building Rating [11]

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


Photograph No.: 3											
<table border="1"> <thead> <tr> <th>Condition</th> <th>Priority</th> <th>Matrix</th> <th>Colour</th> </tr> </thead> <tbody> <tr> <td>3</td> <td>2</td> <td>6</td> <td style="background-color: yellow;"></td> </tr> </tbody> </table>	Condition	Priority	Matrix	Colour	3	2	6				
Condition	Priority	Matrix	Colour								
3	2	6									
Defect Description : DS/CS 05 : Crack (concrete)											
Possible Causes : Deterioration											
Recommendation : Render it with cement mortar											

FIGURE 2. Example of defect (crack)

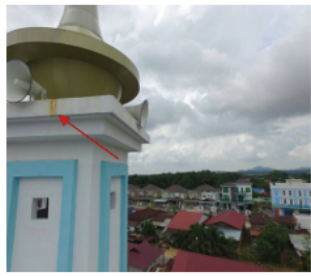
No of Defect : 14											
<table border="1"> <thead> <tr> <th>Condition</th> <th>Priority</th> <th>Matrix</th> <th>Colour</th> </tr> </thead> <tbody> <tr> <td>2</td> <td>1</td> <td>2</td> <td style="background-color: green;"></td> </tr> </tbody> </table>	Condition	Priority	Matrix	Colour	2	1	2				
Condition	Priority	Matrix	Colour								
2	1	2									
Element/components : EL/CS 03 : Column											
Defect Description : DS/CS 04 : Corrosion											
Recommendation : Paint the area affected by the rust.											

FIGURE 3. Example of defect found on the minaret

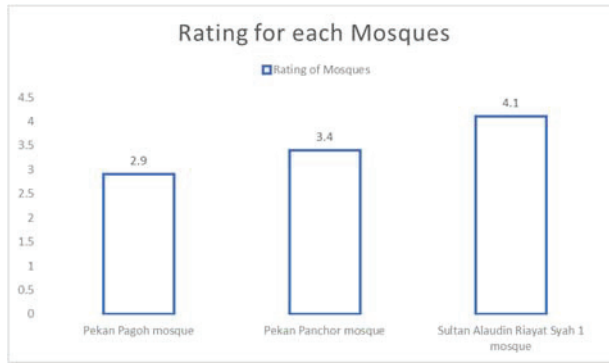


FIGURE 4. Ratings for all three mosques involved

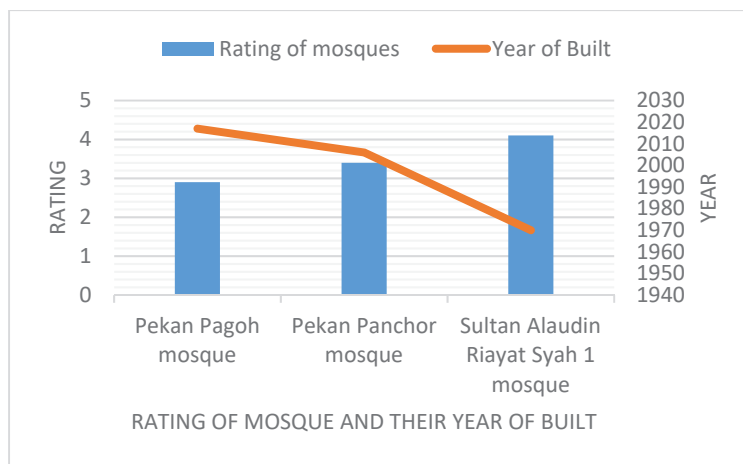


FIGURE 5. Rating of mosque (CSP1) vs year of built

CONCLUSION

In conclusion, all three mosques are in a good condition especially Sultan Alaudin Riayat Syah 1 mosque since despite its age, due to the constant maintenances made, it is still in a good condition like the other two mosques. Therefore, it is recommended that periodical inspections be carried out on this building and that any actions recommended by this report are carried out to prevent further dilapidation to the building.

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