Comparative Study of Condition Survey Investigation on Building Affected by Bridge Piling Installation

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ABSTRACT The building rating system enables the assessor to determine the performance of the building based on approved standards. This paper aims to evaluate the effect of the bridge piling installation on the surrounding building, assess the building condition by using approved standards and propose appropriate rehabilitation to the defects. In this study, the condition assessment of a residential building was performed using three (3) standards; CSP 1 Matrix, BARIS and QLASSIC 2006. There is a similarity between the concept of the CSP 1 Matrix and BARIS. However, BARIS has a more detailed score evaluation than CSP 1 Matrix. QLASSIC 2006 covers more specific components that can be evaluated according to Structural, Architectural, Mechanical and Electrical (M&E) and External Works. Based on the CSP 1 Matrix and BARIS analysis, the building is in Fair condition and requires attention for repair works. The data obtained from QLASSIC analysis is 17.44%. This percentage indicates that most of the elements do not comply with the standards from CIBD, and the performance of the building is poor. The causes of the defects are determined, and their respective rehabilitation is discussed. The effects of the Tebobon 3 Bridge construction on the surrounding building are analysed, and the finding shows that the bridge has no significant impact. The data assessed is before visual inspection basis. Hence, the scope of the study shall be expanded by conducting a Destructive Test (DT) and Non-Destructive Test (NDT) on the defects encountered by the building to determine the significance and their level of severity as well as verify the results from visual inspections. This study can also be widened to assess different categories of buildings by using a similar building rating system. So, using these methods, the quality and performance of other types of building categories can be assessed.

KEYWORDS: CSP 1 Matrix; BARIS; QLASSIC; Defects; Condition Assessment
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INTRODUCTION

Construction defects are known as imperfections in a structure or a building. A defect is considered a failure in performance, functionality, or requirements (Mazlan *et al*., 2015 & Sarman *et al*., 2015). The defects present in many forms, namely sub-structure, structure, services, building facilities, and other related facilities in a building or construction.

In recent years, Malaysia's highway system's development, especially bridges, has been overgrown due to the high capacity of vehicles, especially in urban areas. In order to accommodate the increased traffic volume, the planning of constructing an efficient road network needs to be done. As part of a highway system, the bridge is essential in connecting two land masses. It also provides a convenient channel connecting the cities of a country. However, the construction of a bridge will have several consequences for the surrounding area. Hence, there is a need to conduct a condition assessment of the existing building affected by the construction of the bridge to identify any defects encountered by the building. Figure 1 shows the location of the bridge and the proposed building to be assessed in this research.

Figure 1 shows the aerial view of the assessed area. The location of the bridge and the housing area is at Jalan Sepanggar, Kota Kinabalu, Sabah. The distance between Tebobon 3 Bridge and the nearby housing area which is Royal Malaysian Customs Quarters is less than 100 metres. Since this building is the nearest building available, so a visual inspection will be performed on this proposed building.

Figure 1. The aerial view of the proposed location area.

According to Che-Ani *et al.* (2010), visual inspection is a physical review of a state of building elements and services conducted by a competent assessor to evaluate the performance of the building and to determine the maintenance needs of the facility. Visual inspection is necessary for the on-going building construction or newly built building, and applicable to the assessment of the current condition of the existing building.

Condition assessment for an existing building is crucial to determine the safety and performance of the building components. Condition and building performance are linked together as the condition of the building can be determined based on the assessment conducted on the building's components. From the monitoring and assessment made on the building, the surveyor can detect any deterioration encountered by the building.

In Malaysia, Royal Institute of Surveyors Malaysia (RISM) provides the general protocol for condition survey as a guideline to assess and detect any damages in a building (Mazlan *et al*., 2017 & Sarman *et al*., 2018). Traditionally, condition assessment of a building is conducted by using a descriptive information. According to Hairudin *et al*. (2020) and Sarman *et al*. (2020), one of the approaches in conducting the assessment of building namely the utilization of Condition Survey Protocol (CSP) 1.

The earlier the defects can be detected, the easier the process of maintaining the building. If the deterioration encountered by the building components is severe, the performance of the components will be interrupted. Higher cost of maintenance and rehabilitation usually happen due to insufficient building inspections.

The main objectives of this study are:

i. To study the effect of the on-going bridge construction on the surrounding buildings.
ii. To assess the existing building condition by using (CSP) 1 Matrix, BARIS and QLASSIC.
iii. To analyse the defect causes and to propose appropriate rehabilitation approaches to the defective buildings for improving the quality and performance of the buildings

LITERATURE REVIEW

According to the Queensland Department of Public Works in Australia (2012), condition assessment is a technical evaluation of the physical condition of the building elements using a consistent approach designed to deliver consistent, relevant and useful information. According to Uzarski and Burley (2017), a similar category of the building's components may reflect similar characteristics (e.g., materials) and lead to common inspection procedures and requirements. The inspection is conducted to identify the significant defects, previous and future maintenance issues, and other concern related to the defects. (Lee, 1987; Hollis & Gibson, 2000; Hoxley, 2002).

The condition analysis involves in two different matter which are the process of calculating rate of the inspected data and the determination of condition at any level in the asset hierarchy (condition aggregation). Based on the data collection, the results are presented in measurements of severity of the inadequacy of a component (Mayo & Karanja, 2018).

The evolving of rating criteria for building inspections has broadened from their first invention. One of the earliest contributions was made by Pitt (1997), followed by Alani *et al*. (2001), Che-Ani (2008a, 2008b, 2009), Mahmood (2009) and RICS (2009). The (CSP) 1 Matrix was invented as a rating tool for an economical property condition assessment (Che-Ani *et al*., 2008a). Since the data inputs which have been mentioned above are influenced by the condition and damage assessments, hence this matrix is applicable and convenient for any type of buildings.

METHODOLOGY

Site inspection was carried out from the outside perimeter to the external and finally the interior part of the building. Building inspectors inspected the building in descending order, from the roof to the lowest level. The inspection process is commonly done as the external defects from the top will potentially give internal flaws to the building as well, as the top-level defects will influence the components of the lower level of the building.

Figure 2 illustrates the standard tools used for building inspection. The data from the building inspection will be assessed using three (3) mentioned steps and analysed using Statistical Package for the Social Sciences (SPSS).

Figure 2. Building Inspection Tools

RESULT AND DISCUSSION

Figure 3 shows the graph of defects with their computed score using CSP 1 Matrix. Based on the graph, Defect Tag (DF22) and Defect Tag (DF25) are among the defects with the highest scores (red

colour), which are 20/20 and 16/20, respectively. This indicates that the defect is in the damaged category, and the element requires immediate attention to repair or replace the missing part of the structure as it may present risks that could lead to fatality and injury to the occupants of the building (Che-Ani *et al*., 2008a).

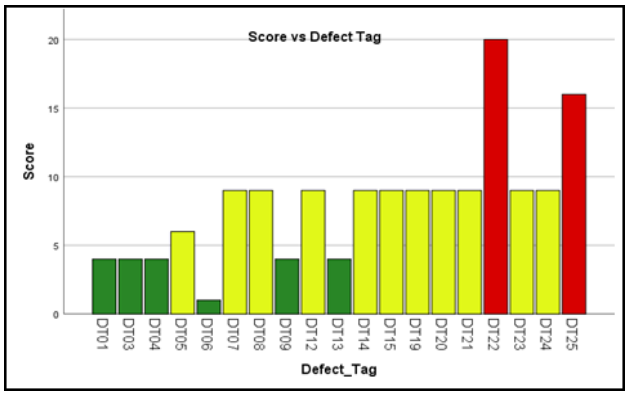

Figure 3. Total Score Defect using CSP 1 Matrix

There are defects (yellow colour) which fall under the category of defects which need condition monitoring assessment. The range score of the defects that require such review is around (9 to 12). These defects most likely need significant repairs as they cannot function at an acceptable standard (Che-Ani *et al*., 2008b). Lastly, there are six defects (green colour) with a range score of about (1 to 4) that only requires minor servicing or monitoring as the defects are most likely cosmetic defects only, and the element can function as expected (Che-Ani *et al*., 2008b).

By referring to Figure 4, the graph shows the score for the respective defects assessed by the BARIS Standard. According to the graph, the highest score obtained during the visual inspection is on the Defect Tag (DT 22), who scored 25 out of 25 (red colour). This defect falls under a critical category based on the BARIS Standard and requires immediate replacement. In addition, DT 22 acquired a detailed inspection from an expert as this defect potentially affected other structural elements of the building (PWD, 2009).

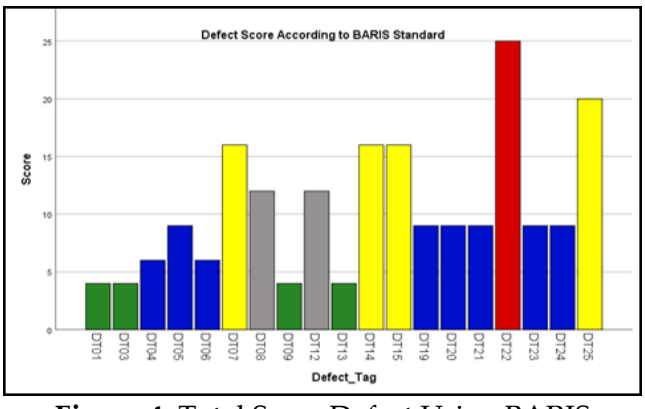

Figure 4. Total Score Defect Using BARIS

According to BARIS Standard, the defect tag DT07, DT14, DT15 and DT25 (yellow colour) falls under critical condition. These defects usually do not function under acceptable standards; however, they present risks to the occupants of the building. Two defects with an equal score of 12 (grey colour) were identified during the site inspection. This type of defect is in the average condition whereby major defects encountered by the building can be repaired without replacing any element (PWD, 2009).

Eight defects (blue colour) with a range score between 6 to 9 were found during the assessment. These defects fall under condition-based maintenance, where the building encounters only minor defects. Scheduled monitoring must be conducted for the defects to become more significant (PWD, 2009). Finally, there are four defects which are DT01, DT03, DT09 and DT13 (green colour), categorised under defects that only require monitoring. The defects are usually cosmetic and do not affect the functionality of the building.

CONCLUSION AND RECOMMENDATION

The building rating system such as CSP 1 Matrix, BARIS and QLASSIC enable the assessor to determine the current condition and performance of the building based on the approved standards. The building was assessed primarily through visual inspection. The defects were observed for one month, and every change in the defects, such as the expansion of cracks, was recorded. The building condition assessment excludes works such as piling, foundation and other related sub-structures. Hence any failures of these works are hardly assessed since they are embedded beneath the ground. Besides, the defects could only be assessed using visual inspection without lab or field testing. So, the results and analysis of data before visual inspection only. The scope of the study shall be expanded by conducting various testing on the defects. Field testing, Destructive test (DT) and Non-Destructive Test (NDT) should be performed to determine the defects' severity level. Destructive tests such as coring will verify visual observations and non-destructive testing results.

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