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A METHODOLOGY TO INVESTIGATE UNIVERSITY BUILDING CONDITION FOR LIFE CYCLE COST OF MAINTENANCE

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ABSTRACT

Education buildings are important assets in the universities that are purposely built to provide a conducive and secure environment to the staff and students in facilitating them to execute teaching, learning and academic programmes, research, consultancies, and administrative activities for the development of knowledge, skills, culture, and personality. Nonetheless, in the face of multiple effects of inflation on the economy, the maintenance work for the facilities in university education buildings has become very complex and a thorny issue. There has been a demand to re-examine and improve the practice of university building maintenance methodology by emphasising the optimisation of maintenance life cycle cost to facilitate the university agencies in measuring their long-term financial capability to pay maintenance costs based on the efficient use of capital and resources throughout the service life. This paper is prepared to present the methodology to investigate the university building maintenance condition and operational performance as inputs for developing a life cycle cost of maintenance database prototype. The methods designed for the study are a qualitative research strategy incorporating three fieldwork approaches, i.e., the semi-structured interview, building condition assessment (BCA), and quick response codes (QR) approaches. The methodology is proposed to investigate the operational performance and maintenance condition of teaching and learning facilities in the chosen university building case study to produce outputs for the development of prototype of life cycle cost database requirements of university building, which would add value to the core services of the university and in line with the key drivers of Malaysian Science, Technology, Innovation, and Economy (MySTIE) framework.

Keywords: Methodology, University Building, Maintenance, Life Cycle Cost

1.0 INTRODUCTION

Education buildings are important university assets purposely designed and built to provide facilities for teaching, learning, research, academic and administrative activities. The educational buildings of universities are usually built with suitable teaching and learning facilities to accommodate diverse departments and faculties for offering different specialisations of subjects and educational programme areas. Commentators pointed out that

the operational performance and maintenance condition of the teaching and learning facilities of education buildings is deemed important to be maintained effectively for providing a secure, pleasant and fosters an indoor learning environment and atmosphere to the individuals and communities in the universities (Abiodun & Odemakin, 2019). In the Malaysian context, the education sector has received the highest budget from the national development budget for every 3 years, where a huge amount of money was spent to pay for the maintenance cost in preventing the decay of teaching and learning facilities in the education buildings. For example, in 2004, the Malaysian government had spent RM304 million for the maintenance of teaching and learning facilities of university education buildings, nonetheless the expenditure had been significantly increased to RM600 million in 2008, which is nearly double than the amount spent for university building maintenance in 2004 (Olanrewaju et al., 2010, 2011; Bidi et.al., 2020). The university building maintenance work has become very complex to implement at the optimum cost, as the future ownership costs were normally ignored and calculated separately from design and construction costs. Hence, there has been a demand to relook and improve the practice of university building maintenance methodology by emphasising the optimisation of maintenance cost and long-term financial capability in paying maintenance cost based on the efficient use of capital and resources throughout the service life. Therefore, this paper is prepared to present the methodology to investigate the university building maintenance condition and operational performance as inputs for developing the life cycle cost of maintenance of the university building. The methodology presented in this paper is proposed to investigate the operational performance and maintenance condition of the teaching and learning facilities in the chosen university building case study to produce outputs for the development of prototype of life cycle cost database requirements of university building, which would add value to the core services of the university to be in line with the two (2) key drivers of the Malaysian Science, Technology, Innovation, and Economy (MySTIE) framework, namely augmented analytics, and data discovery (science and technology driver) and education (socio-economy driver) Academy of Sciences Malaysia (2020).

2.0 OVERVIEW OF LIFE CYCLE COST (LCC) APPLICATION IN BUILDING MAINTENANCE

Life Cycle Cost (LCC) is an economic assessment technique that can be applied to estimate all costs related to the ownership of the building, which includes the initial capital costs, financial costs, operation costs, maintenance and replacement costs, and the salvage costs throughout anticipated life (Davis Langdon Management Consulting, 2007; BS ISO 15686-5, 2008; Langdon, 2010). Commentators advocated that the availability, accessibility, currency, and reliability of the cost data used as quality inputs in LCC analysis are of paramount importance that should be emphasised in the initial phase of LCC analysis to ensure the estimation process would be able to produce reliable output (Ayob, 2014; Ayob & Abdul Rashid, 2016a, 2016b).

The LCC has been identified as an ideal economic solution technique that is useful facilitate the university agencies in making wise and feasible decision-making to determine the most optimum building maintenance cost of assets and facilities to be paid for preventing financial adverse effect on paying long-term maintenance cost over the anticipated service life (Bidi & Ayob, 2015; Akomolafe et al., 2018). In addition, the outcome of LCC analysis can be applied as input for the decision makers to compare the most cost-effectiveness between the competing maintenance and repair methods to achieve the best value for money decision-making in attaining feasible facility management practice In addition, the LCC outcome can

assist the building owners to measure financial capability and potential cost saving in maintaining the assets and facilities throughout the long in-use phases (ASTM International, 2010; BS ISO 15686-5, 2008; BSI, 2008 as cited by Ayob, 2014; BSI, 2013).

According to Ayob (2014), the LCC technique has been unsatisfactorily utilised in the Malaysian construction sector due to the challenges faced by the LCC practitioners in obtaining quality data to be used as input for producing a thorough and trustworthy LCC analysis. Ayob (2014) and Bidi et al. (2020) had identified the following as the key reasons that hindered the application of LCC practice in the Malaysian construction industry:

i. The construction industry confronts difficulty in conducting comprehensive LCC analysis due to a lack of reliable cost data for each category of cost components of LCC (Ayob & Abdul Rashid, 2016a; Bidi et al., 2020)
ii. Only a few cost estimation practitioners in the Malaysian construction industry have utilised the LCC technique for building projects (Bidi et al., 2020)
iii. New construction expenses of assets and facilities are included in the construction budget, but the maintenance costs are calculated separately with no connection and interaction with the initial capital cost in the investment decision making (Ayob, 2014; Ayob & Abdul Rashid, 2016a, 2016b; Bidi et al., 2020).

Building maintenance in Malaysia is a major concern due to poor maintenance practices in both the public and private sectors (Hauashdh et al., 2020). Facility management requires a collaborative effort from all agencies involved in the asset and facilities' life cycle phases, including the end users. A specific agency or ministry that overlooks the maintenance of the government and public buildings in Malaysia is the Ministry of Works (KKR) and its federal technical department, i.e., Public Works Department (PWD) that oversees the construction and management of the government and public building and infrastructures such as schools, hospitals, airports, harbours, roads, bridges, soil protection and other related engineering works (PWD/SIRIM, 2020). All maintenance activities in the government and public buildings are under the custody of the PWD. Therefore, approval must be acquired and granted by the PWD before implementing the maintenance works at the site. Maintenance activities in government and public buildings must also be aligned with PWD maintenance guidelines. The PWD, as the established technical agency, operates not only in all states of Peninsular Malaysia but also in Sabah and Sarawak. The Maintenance Order for Government Buildings in Putrajaya that published in the Government General Circular No. 1 for the Year 2003 dated 11 February 2003 (PWD, 2003) has written an important provision for circulation to the facilities management stakeholders that the building maintenance practices in government and public buildings have to be conducted correctly and efficiently to preserve the government's reputation (Zakiyudin et.al., 2014).

2.1 Overview of Methodology Applied in LCC Studies of University Education Building Maintenance

A systematic review was conducted to identify articles that discuss the research methodologies applied in the LCC studies of university education building maintenance. A set of inclusion and exclusion criteria is used to identify related academic publications that have reported the outcome of studies in LCC of university education building maintenance,

covering all years until 15 March 2024 from an established online databases, i.e., Google Scholar, Emerald, SAGE Scopus, ISI Index, MyCite, SpringerLink, ISRA publications, as well as other related databases. The searching strategy implemented in the study is designed with a systematic analysis of literature that evaluates the internal validity of each article following the advice given by the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher et al., 2015; Page et al., 2020; Bello et al., 2021). The study has identified eleven (11) articles that have discussed or presented the required data of methodologies applied in the LCC of university building maintenance. The data that retrieved from the review outcome of eleven (11) articles is presented according to the following forms, i.e., name of the author(s), the title of the article, date of publication, name of publication journal/conference, and applied methodology, as shown in the Table 1.

Table 1: The summary outcome of the systematic review of methodology applied in LCC of university building maintenance studies

No	Author & Published year	Title	Applied Research Methodology
1	Puvaneswary, T. (2014)	Activity-based life cycle cost process model of facilities maintenance for public universities	Qualitative Research Strategy: *-Semi-structured Interview approach*
2	Bidi and Ayob (2015)	Investigation of Quality of Cost Data for Life Cycle Cost Analysis in University Building Maintenance	Qualitative Research Strategy: *-Semi-structured Interview approach*
3	Ayob and Abdul Rashid (2016)	Protocol of Life Cycle Cost (LCC) data input requirements process	Qualitative Research Strategy: *-Modified the Delphi approach and focus group discussion approaches*
4	Huang, et al. (2018)	Life cycle assessment and life cycle cost of university dormitories in southeast China: Case study of the university town of Fuzhou	Mixed Methods Research Strategy: *-Case study: Literature Review:* *-ISO 14040/44 methodology, ISO, 2006a and 2006b.*
5	Li and Guo (2018)	Life Cycle Cost Analysis of Maintenance Costs and Budgets for University Buildings in Taiwan	Qualitative Research Strategy: *-Case study* *-Review of historical data on maintenance and repair*
6	Husain and Prakash (2018)	Life Cycle Ecological Footprint Assessment of an Academic Building	Qualitative Research Strategy: *-Case study* *-Literature Review*
7	Abuznaid (2018)	Investigation of LCC Analysis Practice of University Mosque Maintenance During the In-Use Phase	Qualitative Research Strategy: *- Semi-structured Interview*
8	Maisham et al. (2019)	Developing a Research Methodology for a Life Cycle Costing Framework for Application in Green Projects	Mixed Methods Research Strategy: - *-Literature review* *-Questionnaire Survey* *-Interview*
9	Bidi et al. (2020)	A study on the quality of cost data in the Life Cycle Cost analysis of maintenance during the in-use phases of a university building	Qualitative Research Strategy: *-Semi-structured Interview approach*
10	Hanak et al. (2024)	Life cycle cost modelling using 6D BIM in construction: A comparative study	Qualitative Research Strategy *-Case study:* *-Literature Review*
11	Adewale et al. (2024)	Application of Artificial Intelligence (AI) in Sustainable Building Lifecycle: A Systematic Literature Review.	Qualitative Research Strategy: *-Literature review*

Paper 1 presents the Activity-Based Life Cycle Cost (AB-LCC) process model for facilities maintenance in public universities that employed a Qualitative Research Strategy supported by semi-structured interviews. Paper 2 presents the study that chose a qualitative research strategy to investigate the quality of cost data relevant to Life Cycle Cost (LCC) analysis in university building maintenance. Its qualitative research strategy is designed with semi-structured interviews for primary data collection to achieve the goals of the study. In addition, Paper 3 outlines the study of the protocol of LCC data input requirements process for building works, which employed a qualitative research strategy and was supported by the Modified Delphi method and focus group discussion approaches. Paper 4 shows that the study used mixed methods research to examine the life cycle assessment and life cycle cost of university dormitories in southeast China, specifically referencing Fuzhou University Town in adhering to ISO 14040/44 standards and ISO 2006a and ISO 2006b methodologies. Paper 5 exhibits a study of Life Cycle Cost Analysis of maintenance expenses and budget allocations for university buildings in Taiwan, which utilised the qualitative research strategy to assess historical maintenance and repair data of the chosen case study. Lastly, Paper 6 presents a Life Cycle Ecological Footprint Assessment study of an academic building, which adopted a qualitative research strategy supported by case study and literature review approaches.

Paper 7 shows the outcome of the investigation of Life Cycle Cost (LCC) analysis for the maintenance of university mosques during their operational phase, which utilised a qualitative research strategy supported by a semi-structured interview approach. Paper 8 delineates the development of a research methodology for a Life Cycle Costing framework specifically designed for green projects, and the study employed a mixed-methods research strategy to attain the study objectives. Paper 9 presents the outcome of the investigation on the quality of cost data in LCC analysis during the operational phases of university building maintenance, and the qualitative research strategy was chosen, supported by a semi-structured interview approach to achieve the study objectives. Paper 10 offers a comparative analysis of Life Cycle Cost modelling by integrating 6D Building Information Modelling (BIM) within the construction sector, and the study adopted a qualitative research strategy supported by a literature review to achieve the study objectives. Lastly, Paper 11 shows that the qualitative research strategy was chosen in the study, and the paper presents the outcome of a systematic literature review of Artificial Intelligence (AI) applications in the sustainable building lifecycles.

Overall, based the outcome of systematised review on the eleven (11) articles as shown in Table 1, it is not misconception to state that the qualitative research strategy (with highest mode: 9 items) is the most chosen research strategy that has been applied in the LCC studies of university building maintenance rather than the mixed methods research (mode: 2 items) and quantitative (mode: 0 item, nil). The methodology for the study is based on the nature, goals, and purpose of the study, as well as the accessibility of the data and information needed for the study. In addition, the exploratory and attitudinal research categories fall under the qualitative research strategy (Naoum, 2013). The utilisation of qualitative methodologies is experiencing a notable increase and gaining widespread acceptance among researchers (Akinyode, 2018).

3.0 PROPOSED RESEARCH METHODOLOGY FOR THE STUDY

A research strategy is used to design a study methodology for data acquisition, followed by data analysis and validation to answer the research questions and objectives (Bidi, 2018). The selection of research strategy is normally based on the nature, goals, and purpose of the study, as well as the accessibility of data and information needed for the study (Naoum, 2013). The qualitative research strategy is proposed as the methodology designed for the study because it is superior to the quantitative and mixed methods research strategies in procuring data of LCC that is subjective, profound and limited in nature, which requires supplementary analysis and interpretation on the meanings, definitions, characteristics, experiences, descriptions, thoughts and emotions from the respondents' feedback (Ayob & Abdul Rashid, 2016; Pawar, 2020). The chosen qualitative research strategy is proposed to incorporate with three fieldwork approaches, i.e., semi-structured interview, building condition assessment (BCA), and quick response (QR) codes (as shown in Figure 1), to investigate the operational performance and maintenance condition of the teaching and learning facilities in the chosen university building case study and to produce results that could be used as inputs for the development of prototype of life cycle cost database requirements, which could add value to the core services of the university of chosen case study to in line with the two (2) key drivers of the Malaysian Science, Technology, Innovation, and Economy (MySTIE) framework, namely augmented analytics, and data discovery (science and technology driver) and education (socio-economy driver).

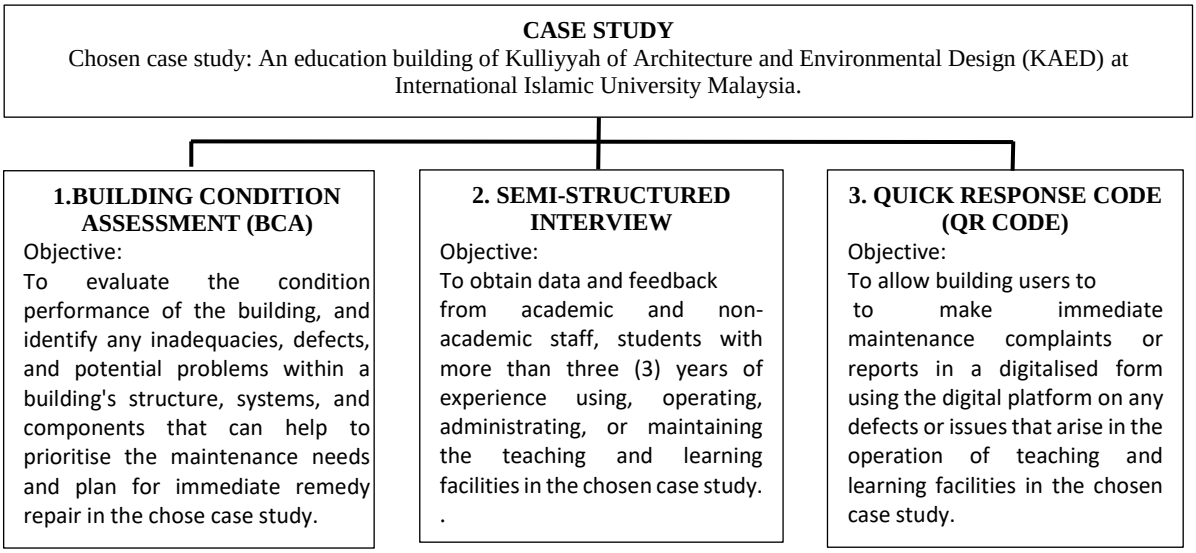

Fig. 1: The proposed research methodology for the study.

3.1 Case Study: KAED Education Building

The objective of choosing a case study is to assess the present phenomena, components and condition of the subject from a real-life context based on firsthand observation through walking to the site, visual inspection, taking photos, drawing, and information provided by the end-user community during the study visit. According to Abu Noh et al. (2017), the primary goal of the case study is to examine phenomena where various components and

interactions are present and where no fundamental rules govern which components and relationships can be observed firsthand. The selected case study is an education building of Kulliyyah of Architecture and Environmental Design (KAED) located at the International Islamic University Malaysia, IIUM Gombak Campus, Selangor, Malaysia. It was chosen as the subject of a case study because the end-user community has reported many issues with the decay of teaching and learning facilities in the KAED education building. The faculty that operated in the building case study is called Kulliyyah of Architecture and Environmental Design (KAED), which was established on 01 June 1996 to provide teaching and learning programmes in Built Environment that offered by five departments, i.e., Architecture (ARCH), Landscape Architecture (LA), Quantity Surveying (QS), Urban and Regional Planning (URP), and Applied Art and Design (AAD). The education building of KAED is equipped with various teaching and learning facilities that include the classrooms, studios, labs and workshops, ICT equipment, Internet cables, Wi-Fi connections, resource centre, restrooms, cafeteria, *musolla* (prayer rooms), lighting and air conditioning, systems in serving for various operations of activities including academic, research and community services. The recent record shows that the total population of registered students 2023 in KAED is 1,039, encompassing undergraduate and postgraduate students who utilised the teaching and learning facilities in the KAED building for learning and study (KAED Academic Office, 2023).

3.1.1 *Maintenance Management of Case Study*

Implementing a maintenance management system in educational buildings is important to preserve assets and facilities from defects and failures and to optimise their functional and operational performance in serving the community satisfactorily (Alaudin et al., 2016). Ramli and Mohd. Zain (2018) claimed that the Ministry of Education's initiatives to support the education sector have resulted in a notable expansion of the higher education market in Malaysia. Thus, a good building maintenance management system will influence the quality of students and staff in their studies and job performance. This maintenance is performed based on the operational condition of an equipment element, instead of simply setting it and forgetting it, as is the schedule. The majority of the universities in Malaysia outsource the maintenance work to facility management contractors because many educational buildings are designed and built on a large scale to house educational programmes (Olanrewaju & Abdul Aziz, 2015). For the case study, the centralised maintenance management approach was chosen by the IIUM central university agency rather than the decentralised maintenance management due to the complexity of maintaining many large educational buildings on campus by a small group of administrative staff or in-house agencies. Besides that, the decentralised facilities management is also not practical and cost-efficient because the in-house agencies may require many workers to supervise, maintain and repair each building in the vast university campus areas. To adapt the centralised maintenance management approach, an agreement known as a Service Level Agreement (SLA) is made on periodically basis between the IIUM Development Division representing the International Islamic University (IIUM) with the maintenance services provider, i.e., Daya Bersih Sdn Bhd (DBSB).

The SLA is a written contract that specifies the standards, obligations, and expected level of services between both parties in the maintenance management of all physical assets installed within the boundary of the facilities, which include but are not limited to buildings, structures,

compounds, landscape and Mechanical and Electrical (M&E) equipment/system. The SLA outlines the obligations of the service provider and the service recipient regarding the policies, processes, sanctions, and incentives. The SLA is also a useful management tool for the service recipient to evaluate the service's effectiveness, value, and quality (Ishak & Mohd Anasir, 2020). According to El-Awadi and Abu-Rizka (2015), the Service Level Agreements (SLAs) should encompass five essential components. These include: a comprehensive delineation of the services provided by cloud service providers; clear and unequivocal terms detailing the specific services offered; a set of Quality of Service (QoS) metrics designed to assess the performance and delivery of services; mechanisms for continuously monitoring these performance metrics; and formalised procedures for resolving disputes that may arise in the event of non-compliance with SLA terms. Usually, the common parameters to define the quality of the services (QoS) are delivery, response time, execution time, service availability, access time, throughput, network bandwidth, service latency, or server uptime or downtime.

For the case study, the SLA is important for the Development Division of IIUM to possess a proper centralised maintenance monitoring supervision based on the specified job scopes and Key Performance Indicators (KPIs) throughout the SLA contract period. As the education building of KAED has approached its twenty-eighth years' service life in 2024, it is imperative to reassess and evaluate the operational performance and maintenance conditions of teaching and learning facilities in the KAED building that is currently maintained by the appointed maintenance service provider under the SLA contract and the achievement of the service provider is based on the Key Performance Indicators (KPIs). To ensure a sustainable, comfortable and conducive educational environment, all facilities must be underpinned by an effective maintenance system. Implementing a robust maintenance management system within the KAED building is vital for protecting the assets from defects and failures. The teaching and learning facilities must be underpinned by an effective maintenance system to ensure the facilities can be complemented with the continuous education development goals in serving the communities to advance the technical and social transformation (Fadhila & Komariah, 2020).

3.2 Semi-Structured Interview Method

For this study, a semi-structured interview question set is designed with a combination of open-ended and closed-ended questions developed from the outcome of a comprehensive literature review. A semi-structured interview methodology was employed to identify the key users of KAED for active participation in assessing the operational performance and maintenance status of the teaching and learning facilities within KAED. This qualitative study is structured around semi-structured interviews, which allow for flexible yet targeted responses, with questions tailored to the specific instruments used in the research, thereby aligning with the overarching objectives of the study. Table 1 briefly presents the two types of questions, i.e., open-ended and closed-ended. The questions are designed based on a specified objective to obtain data and feedback from academic and non-academic staff, and students who have more than three (3) years of experience in using, operating, administrating, or maintaining the teaching and learning facilities in the chosen case study, i.e., the KAED education building. To improve the questionnaire's quality and answerability before the interview, the pilot questionnaire is carried out with a small group of people who

have established knowledge in the subject of study (Bidi & Ayob, 2015; Bidi et al., 2020). The close-ended questions are developed with a Likert-type scale to evaluate the responses provided using a descriptive statistical analysis method, i.e., mean and standard deviation. The mean is calculated to determine respondents' opinions' average or central tendency, and the cut-off mean is 3.75. It is used to identify the critical item response to be included in the answer set of questions. The standard deviation is calculated to determine the variation of the response distribution amongst the respondents, where a small score of less than 1.00 indicates a high consensus achieved from the group of respondents (Ayob, 2014; Mansor et al., 2017).

Table 2: Types of interview questions (Bidi, 2018)

Types of questions	Descriptions
Open-ended question	It comprises exploratory questions that allow the respondent to express their opinion freely without selecting an answer from the list of options.
Close-ended question	It comprises a wide variety of questions that require the respondents to choose from a list of pre-selected options, such as multiple-choice, drop-down, checkboxes, ranking, and more.

3.3 Building Condition Assessment (BCA) Method

Building condition assessment (BCA) is a visualisation assessment technique that is performed to evaluate the condition performance of the building, and to identify any inadequacies, defects, and potential problems within a building's structure, systems, and components. Building Condition Assessment (BCA) entails a comprehensive physical inspection and diagnostic evaluation of a building's structural integrity and overall condition. The primary objective of such an assessment is to ascertain the current state of the structure, including the extent of any deterioration or degradation it may have experienced over time (Faqih & Zayed, 2021). In Malaysia, two BCA rating systems are implemented: the CP BS101 Code of Practice for Building Inspection Report with Building Assessment Rating System (BARIS) (RISM, 2010), and the JKR 21602-0004-13 Building Examination and Evaluation Guideline for BCA (PWD, 2013) using the Building Assessment Rating System (BARS) (Awang et al., 2017). The JKR 21602-0004-13 standard guideline was selected as the foundational framework for this study due to its comprehensive rating system, which encompasses key aspects such as defects, condition, and functionality. The guideline clearly delineates the distinctions between various rating categories, streamlining the rating process and enhancing its interpretability (Mohd & Deraman, 2013). The outcome of the BCA can prioritise the maintenance needs and plan for immediate remedy repair based on the severity of faults or defects found to prevent greater structural difficulties and extend the building's overall durability, functionality, safety and value over time. Hence, maintenance resources can be efficiently directed to vital areas first, which can help reduce the likelihood of costly repairs or safety issues.

Based on the outcome of review of the JKR 21602-0004-13 Building Examination and Evaluation Guideline for BCA using the Building Assessment Rating System (BARS) a new revision form of BCA is prepared as the second approach in the methodology of study to assess physical state of the building portfolio and to identify any defects and faults in the existing building frameworks of

the chosen case study, i.e., KAED education building. In addition, the revised BCA is designed to assess the operational performance and maintenance conditions of the teaching and learning systems, subsystems, and components in the building, civil, mechanical, electrical, and ICT. The outcome of BCA also provides useful input for the remedy planning and strategies that can be prioritised according to the maintenance needs and optimum life cycle cost.

3.4 Quick Response Code (QR Code) Method

A QR code is a two-dimensional barcode that can be scanned with a smartphone or a QR code reader to obtain information or execute numerous actions quickly. The QR code comprises black square dots on a white background and can hold various data, including text, URLs, contact information, and even directions for a particular action. According to Hung et al. (2020), the QR code is a form of matrix barcode (or two-dimensional barcode) invented in 1994 by the Japanese automotive firm, i.e., Denso Wave, to track vehicles during manufacturing. QR codes have been utilised significantly in various consumer industry applications. The basic goal of QR codes is to give a quick and effortless way to transmit information. When scanned, the QR code can trigger operations like opening a website, displaying text or messages, starting a phone call, sending an email, or prompting consumers to download an application. The QR codes serve as a bridge between the physical and digital worlds, enabling users to access information or perform actions by simply scanning the code with a compatible device.

The QR code is chosen as the third approach in the methodology of study to allow building users, i.e., students, staff, and visitors to make immediate maintenance complaint or report in a digitalised form using the digital platform on any defects or issues that arise in the operation of teaching and learning facilities in the chosen case study, i.e., KAED education building. The building users who intend to make defect complaints using the digital platform of QR code will be required to provide basic information like contact info, defect location, dates of the new and previous reports, and photos taken as proof to support the submission of the complaint report.

4.0 CONCLUSION

This paper has presented the methodology proposed for the study to investigate the university building maintenance condition and operational performance as inputs for developing the life cycle cost of maintenance of the university building. The literature study has established that very limited studies have been reported on the methodology to investigate the university building maintenance condition and operational performance with specific reference to maintenance life cycle cost (LCC). Hence, the qualitative research strategy has been proposed as the methodology designed for the study to procure subjective, profound, and limited data of LCC. The qualitative research strategy incorporates three fieldwork approaches, i.e., semi-structured interviews, building condition assessment (BCA), and quick response (QR) codes. The study has recommended the QR code as a useful technique to be integrated with the BCA technique to collect comprehensive firsthand data that can facilitate the facilities management practitioners to produce a thorough and trustworthy LCC analysis of maintenance in achieving cost-effectiveness and value for money maintenance management decision making based on the Key Performance Indicators (KPIs) to protect the assets from defects and failures, and prolong their service life span.

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