Developing a conceptual framework of building maintenance driving factors for effective heritage building maintenance programme in Malaysia

S B H Syed Mohamad[1*], M A A Rahman[2], A Suratkon[3], R Deraman[4] and M N Zakaria[1]

[1] Geo-structure & Rehabilitation Centre (GSRC), Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia.
[2] Konservasi Arkeologi Survei dan Tatacara Pemulihan Warisan (KASTURI), Faculty of Engineering Technology, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Muar, Johor. Malaysia.
[3] Advanced Built Environment Sustainabilty (ADVANCED BESTy), Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia.
[4] Project and Facilities Management (ProFaci), Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Batu Pahat, Johor, Malaysia.
*Corresponding author: burhan@uthm.edu.my

Abstract. The purpose of this research concept paper is to explain the initial development process of a proposed conceptual framework of building maintenance driving factors for an effective heritage building maintenance programme. The maintenance programme is the most important phase in arranging the building maintenance management process. The heritage building value always will decrease within a period of time. If the relevant maintenance procedure fails to detect the root causes of building deterioration, it will have a significant impact on the durability and strength of heritage buildings. This research is initiated in order to search further on the significant effective maintenance driving factors. The maintenance driving factors will be the indicators in filling the gap for improving the heritage building maintenance programme and comprehensive heritage maintenance framework. The aim of this research is to develop a comprehensive framework that depict the significant driving factors of the effective building maintenance programme for a heritage building in Malaysia. The research objectives are to investigate the significant driving factors which are involved in the maintenance programme and to examine the significant connection between the driving factors in developing an effective maintenance programme for heritage buildings in Malaysia. The relevant research data collection has been obtained by conducting expert opinion interviews and findings from literature reviews. Several factors have been identified as the enablers of the effective heritage building maintenance programme, and clustered into 4 main factors (Human Factor; Management Factor; Organisational Factor, and Technology Factor). In conclusion, the research will be able to give significant findings regarding the driving factors involved in the development of a conceptual framework for an effective heritage building maintenance programme.

1. Introduction

The comprehensive and effective maintenance programme is very important to ensure the sustainability and elongation of the existing invaluable Malaysian heritage buildings. The effectiveness maintenance system of the heritage building somehow depends on the fundamental performance aspects, which involve time, costs, quality, scope of work, resources, job specifications, and performance. All these components shall be included in the maintenance programme as a related work schedule driving factor. Hence, the success of the maintenance programme is always depending on the comprehensive and effective implementation of the work schedule during heritage building maintenance implementation.

2. Heritage Building Maintenance Problems Identification

Conservation is a comprehensive process that involves the preservation, repair, restoration, and maintenance of sites and buildings that have significant heritage values. Currently, Malaysia's heritage sites and buildings are facing great challenges from new urban development threats, particularly due to the need to accommodate the growth of population, infrastructure development, and economic growth activities [30]. In maintenance work, "maintain as it is" is the building maintainer's motto, which mentions the way to sustain the original function of the building structures, service system, and appearance. Insufficient systematic maintenance work became one of the national issues and key topics in improving the awareness of maintenance culture in Malaysia. In Abdul Rashid and Ahmad's report, the former Malaysian Prime Minister expressed his concern about the need to raise the culture of prioritizing and protecting the structural quality of a building among Malaysians. In addition, the understanding of the importance of maintaining the buildings also needs to be highlighted and should not be only limited to new buildings, as the heritage buildings also have their own significant value [1].

Despite the Malaysian government's concern about building maintenance, but still, the buildings have not been effectively maintained systematically [2]. The sufficient fund allocations will give an opportunity to the authorised heritage major players to establish better maintenance procedures and progressive restoration plans for heritage buildings [3]. The development of environmental conservation concerns could be crucial, with the emphasis focused on the maintenance of buildings as an alternative in reducing a new development project, especially for government building projects. Good maintenance management practices will be able to extend a building's lifespan, minimize energy and materials resource consumption, and preserve old buildings by making them always suitable for modern use as an alternative to redevelopment [10]. Previous studies stated that the insufficient maintenance approach has a significant effect on structural deterioration, which results in the structures falling into disrepair rapidly [4]. The nature of heritage buildings is the focus of some avoidable degree of degradation and decay and has made maintenance the single most significant approach that can ensure the prolongation of the heritage buildings [1].

Abdul Rashid and Ahmad suggested that building maintenance is the first important issue that needs to be considered in heritage building management. This is because regular maintenance is ideal, providing value for money and better performance for the heritage building [1]. Some researchers suggested that maintenance is the most significant safeguard in order to conform to the conservation good practice. Heritage conservation works practice in Malaysia is a new practice compared to other developed countries [5-6], and the level of awareness of heritage building among the public is increasing [7]. The involved parties in heritage building maintenance still need to upgrade the standard guidance and fill in the loose gap for the best maintenance management approach for heritage buildings [6],[8],[31]. The guidelines for heritage building conservation in Malaysia only have been published in year 2012 under the Department of National Heritage, Ministry of Tourism, Arts and Culture Malaysia [9].

In addition, the heritage building's physical value will decrease from time to time, and failure to detect the causes of building deterioration will have a significant impact on the durability and strength of heritage buildings. The maintenance of heritage buildings shall take a careful approach in order not to disturb or destroy the historic fabric, damage the character of the building, and alter the features which give the building historic, architectural, and cultural significance [8]. Therefore, a systematic,

specific, and comprehensive framework of the heritage building maintenance programme is required to manage the heritage building more effectively. In summary, all the related literature reviews and expert opinions in this research are arranged and depicted in **Figure 1** as a proposed heritage building organisational structure.

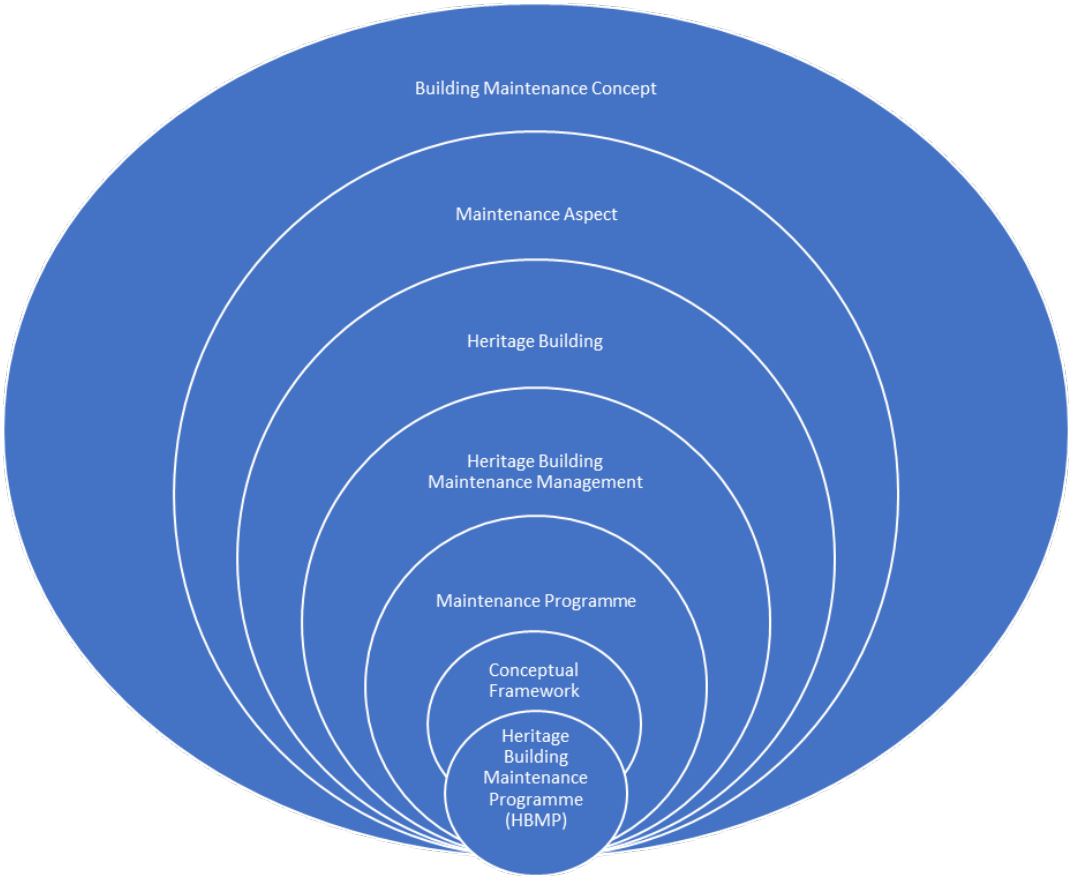

Figure 1. Proposed Heritage Building Organisational Structure

Motivated by previous heritage building maintenance research, the aim of this research is to discover the significant effective maintenance variables that can be used as an indicator in supporting the development of a comprehensive approach in the heritage building maintenance programme framework. It is difficult to ignore the importance of heritage buildings, which are very significant to our current and future social-economy impacts.

3. Research Objectives

The aim of this research is to model the framework of significant driving factors for effective heritage building maintenance programme in Malaysia. In accordance with the research aim, the objectives of this research are to identify the scenario of building maintenance for heritage buildings in Malaysia and to explore the driving factors for an effective maintenance programme of heritage buildings in Malaysia. The potential respondents consist of consultants, heritage conservation professionals, building maintenance professionals, and specialist contractors, who are directly involved and experienced in the maintenance management of heritage buildings in Malaysia.

4. Proposed Effective Heritage Building Maintenance Driving Factors and Sub-Driving Factors

In the initial stage of the process, the framework is clustered into 4 major factors (independent variables - IV), namely, Human Factor; Management Factor; Organisational Factor, and Technology Factor. These major driving factors will be expanded to nineteen (18) sub-driving factors that drive the effective programme implementation of heritage buildings in Malaysia. The involved factors as follows: (1) The Importance of Historical Buildings; (2) Human Behaviour; (3) Maintenance Policy and Organization; (4) Maintenance Effectiveness; (5) Task Planning and Scheduling; (6) Maintenance Approach – Current Practice; (7) Financial Factor; (8) Risk Management; (9) Customer Perspective; (10) Information Management and computerized maintenance management system (CMMS); (11) Environment; (12) Technical Aspects; (13) Institutional and Training Facilities; (14) Continuous Improvement; (15) Human Resources Management; (16) Spare Part Management; (17) Regulations & Guidelines and, (18) Contracting Out Maintenance. **Table 1** shows the relevant driving factors, sub-driving factors, and indicators that are important in developing the effective maintenance programme conceptual framework.

Table 1. Driving Factors and Sub-driving Factors

Driving Factors, Sub-Driving Factors & Indicators
Driving Factor: Human Factor (focus on the related factor which can increase the competent level) **Sub-Driving Factors:** 1. Human Resources Management 2. Institutional and Training Facilities 3. Human Behaviour 4. Customer Perspective **Indicators:** 1. Work Productivity [11] 2. Skilled and expert workers [1] 3. Project personnel competency and project mission [12] 4. Training according to the recommended guidelines [8] 5. Equipped with maintenance knowledge [13]
Driving Factor: Management Factor (focus on management approaches which is reliable in building maintenance) **Sub-Driving Factors:** 1. Importance of Historical Buildings 2. Information Management and CMMS 3. Financial Management 4. Risk Management 5. Continuous Improvement **Indicators:** 1. CSF approach to upgrade MMS practices [4] 2. Cost allocation to carry out maintenance [14] 3. Proper setting up of maintenance department [1] 4. Maintenance operation system [15], [16] 5. Emphasize strategic maintenance management [17], [18] 6. Provide systematic management [19], [5], [20]

Table 1. Driving Factors and Sub-driving Factors

Indicators
Driving Factor: Organisational Factor (focus on the related to common maintenance practices) **Sub-Driving Factors:** 1. Maintenance Policy and Organization 2. Task Planning and Scheduling 3. Maintenance Effectiveness 4. Environment **Indicators:** 1. Operation and maintenance optimization [21] 2. Agreed condition and organization expectations [22] 3. Good preventive measures avoid high cost of maintenance [3] 4. Proper maintenance programme [23], [29] 5. Enforcement of scheduled inspection [1] 6. Planned maintenance approach [10]
Driving Factor: Technology Factor (focus on the item which is concerned during the building maintenance process) **Sub-Driving Factors:** 1. Regulations and Guidelines 2. Contracting Out Maintenance 3. Spare Part Management 4. Technical Aspects 5. Maintenance Approach – Current Practice **Indicators:** 1. Sitting and structure design efficiency [25] 2. Material efficiency [26] 3. Indoor Environmental Quality enhancement [21] 4. Satisfactory of requirements by user [10] 5. Building performance monitoring [22] 6. Historic preservation technology [24]

5. Effective Maintenance Programme Implementation Conceptual Framework

Maintenance work is one of the conservation activities as the safeguarding aspect of heritage buildings. Maintenance work is different from other activities in conservation in that it must be done in a continuous way and not just depending on needed time [27-28]. The success of the maintenance programme depends on the comprehensive and effective implementation of the work schedule during maintenance implementation. Accordingly, in order to improve the maintenance work procedure for heritage buildings, it is decisive to understand the fundamental root problems and improve the maintenance work process for heritage buildings. [27].

It is important to really understand the relationship of the listing factors between the Independent Variable (IV) and Dependant Variable (DV) in any factoring research accordingly. This is why we need to define the research IV and DV in detail. For this research, **Figure 2** shows the heritage

building maintenance conceptual framework, which is the best-illustrated technique to display the relationship between determined significant factors.

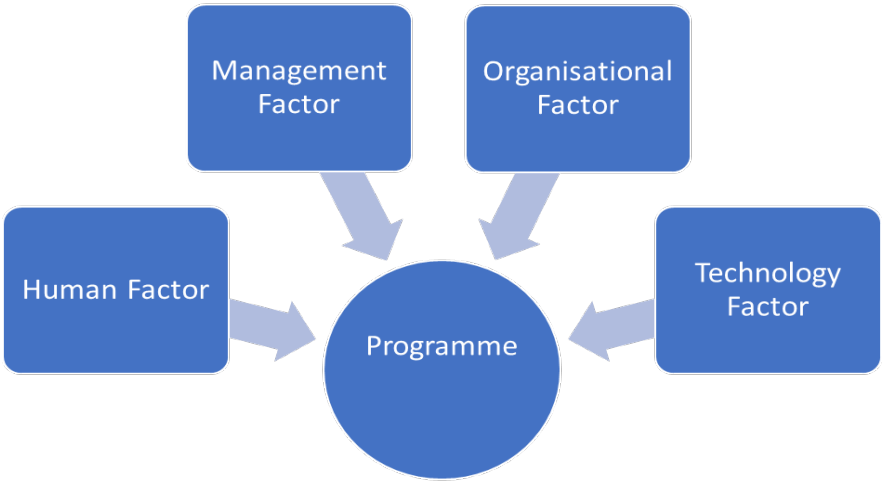

Figure 2. Heritage Building Maintenance Programme Conceptual Framework

6. Conclusion

An effective maintenance programme is essential to ensure the sustainability and elongation of the existing invaluable Malaysian heritage museum building. The effectiveness of the heritage building somehow depends on the fundamental performance components, which involve time, costs, quality, scope, and resources. All these components shall be included in the maintenance programme as a work schedule. The success of the heritage building maintenance programme depends on the level of comprehensiveness and effectiveness of the work schedule during maintenance implementation. Finally, the recommended and improved solutions will be concluded and could be used further as a useful reference and added to the existing guidelines of the Malaysia Department of National Heritage. The results of this study are expected to be an important reference to improve existing master policies and procedures in relation to the driving factors for heritage building maintenance.

7. References

[1] Rashid R A and Ahmad A G 2011 Overview of Maintenance Approaches of Historical Buildings in Kuala Lumpur – A Current Practice *Procedia Engineering*. **20(0)** p 425-434 doi: 10.1016/j.proeng.2011.11.185

[2] Ramli A, Akasah Z A and Masirin M I M 2013 Factors Contributing Building Safety and Health Performance of Low Cost Housing in *Malaysia Journal of Safety Engineering.* **2(1)** p 1-9

[3] Murad D 2013 October 23 Budget 2014: Environment, wildlife, heritage conservation efforts need boost in funds. The Star Online. Retrieved August 22 2015 from http://www.thestar.com.my/news/nation/2013/10/23/budget-2014-conservation-efforts/

[4] Zulkarnain S H, Zawawi E M A, Rahman, M Y A and Mustafa N K F 2011 A Review of Critical Success Factor in Building Maintenance Management Practice for University Sector *World Academy of Science, Engineering and Technology*. **59** p 195

[5] Akasah A Z A and Alias M 2009 Analysis and Development of the Generic Maintenance Management Process Modeling for the Preservation of Heritage School Buildings *International Journal of Integrated Engineering (Issue on Civil and Environmental Engineering).* **1(2)** p 43-53

[6] Mohd-Isa A F, Zainal-Abidin Z and Hashim A E 2011 Built Heritage Maintenance: A Malaysian Perspectives *Procedia Engineering* **20(0)** 213-221 doi: 10.1016/j.proeng.2011.11.158
[7] Azhari N F N and Mohamed E 2012 Public Perception: Heritage Building Conservation in Kuala Lumpur *Procedia - Social and Behavioral Sciences* **50(0)** 271-279
[8] Sodangi M, Khamidi M F, Idrus A, Hammad D B and Ahmedumar A 2014 Best practice criteria for sustainable maintenance management of heritage buildings in Malaysia *Procedia Engineering.* **77** p 11-19 10.1016/j.proeng.2014.07.017
[9] Jabatan Warisan Negara (2017). Garis Panduan Pemuliharaan Bangunan Warisan. Kuala Lumpur: Jabatan Warisan Negara.
[10] Wordsworth P 2001 Lee's Building Maintenance Management 4th Edition Oxford: Blackwell Science Ltd
[11] Panas A and Pantouvakis J P 2010 Evaluating Research Methodology in Construction Productivity Studies *the Built & Human Environment Review* **3(1)** p 63-85
[12] Kuen, C. W., Zailani, S. and Fernando, Y. (2009). Critical factors influencing the project success amongst manufacturing companies in Malaysia. *Afr. J. Bus. Manag.* **3(1)**, pp.16-27.
[13] Briffett C 1995 Building maintenance technology in tropical climates Singapore: Singapore University Press
[14] Rahman M A A, Akasah Z A & Zuraidi S N F 2012 The importance of on-going maintenance in preserving the heritage listed buildings *International Journal on Advanced Science Engineering Information Technology*. **2(2)** 83-85
[15] Ahmad B R, Nur Azfahani A and Nor Haniza I 2006 Part 1 - The Effects of Design on the Maintenance of Public Housing Buildings in Malaysia *Building Engineer Journal*. UK **81(4)** p 30-33
[16] Alias A and Ali A S 2011 Pengurusan Penyenggaraan dan Pengubahsuaian Bangunan. Batu Pahat Johor: Penerbit UTHM
[17] Kerr J S 2013 The Seventh Edition Conservation Plan 2013: Guide to the Preparation of Conservation Plans for Places of European Cultural Significance New South Wales: Australia ICOMOS Inc Retrieved from http://australia.icomos.org/wp-content/uploads/The-Conservation-Plan-7th-Edition.pdf.
[18] Worthing D and Bond S 2008 Managing Built Heritage The Role of Cultural SignificanceOxford: Blackwell Publishing.
[19] Hamilton B and Wan Salleh W I 2001, June 20 Maintenance of Building Important. New Straits Times Retrieved Jun 26 2016 from http://www.hba.org.my/news/2001/601/maintenance.htm.
[20] Mohd-Noor N, Hamid M Y, Abdul-Ghani A A and Haron S N 2011 Building maintenance budget determination: An exploration study in the Malaysia government practice In *Procedia Engineering*. **Vol. 20** p 435–444
[21] Sharif S, Kamaruzzaman S and Pitt M 2017 Implementation Framework of Green Building for Government Building: Menara Kerja Raya, Malaysia *Journal of Design and Built Environment* **17(2)** 27-36 Retrieved from https://ejournal.um.edu.my/index.php/jdbe/article/view/10190
[22] Cholasuke C, Bhardwa R and Antony J 2004 The status of maintenance management in UK manufacturing organisations: results from a pilot survey *Journal of Quality in Maintenance Engineering.* **10(1)** p 5-15 doi: 10.1108/13552510410526820
[23] Chanter B and Swallow P 2007 Building Maintenance Management Second edition Oxford: Blackwell Publishing.
[24] Robert A Young 2008 Historic Preservation Technology New Jersey: John Wiley & Sons
[25] Poul Beckmann and Robert Bowles 2004 Structural Aspects of Building Conservation Second Edition Oxford: Elsevier Butterworth-Heinemann
[26] Wood B 2009 Building Maintenance Oxford: Blackwell Publishing Ltd
[27] Zolkafli U K, Zakaria N, Mazlan A M and Ali A S 2018 Maintenance work for heritage buildings in Malaysia: owners' perspectives *International Journal of Building Pathology and Adaptation.* **Vol. 31** No. 1, pp. 186-195. https://doi.org/10.1108/IJBPA-07-2018-0062

[28] Keromo P 2006 *Konservasi Secara Umum, Bengkel Konservasi Monumen dan Tapak Tanah Bersejarah* Hotel Mahkota Malacca November 27–29
[29] Syed Mohamad S B H, Akasah Z A and Rahman M A A 2014 Factors Contributing to Building Maintenance Performance of Heritage Buildings in InCIEC 2013: *Proceedings of the International Civil and Infrastructure Engineering Conference 2013.* Hassan R, Yusoff M, Ismail Z, Amin N M and Fadzil M A (Eds) Singapore: Springer-Verlag Singapur p 851-860.
[30] Rani W N M W M, Tamjes M S and Wahab M H 2018 Governance of Heritage Conservation: Overview on Malaysian practice. *The Journal of Social Sciences Research,* SPI6, 847–851. https://doi.org/10.32861/jssr.spi6.847.851
[31] Bavani M 2017 Broken pieces of history. The Star Online: Available: http://www.thestar.com.my/metro/community/2017/07/11/broken-pieces-of-history-dozens-of-heritage-buildings-in-the-capital-are-at-risk-of-irreversible-dam/#Xx7vUOcrOSJHYE6D.01

Acknowledgments

The authors wish to thank the Geo-structure & Rehabilitation Centre (GSRC) fellow researchers and the management of the Faculty of Civil Engineering and Built Environment, Universiti Tun Hussein Onn Malaysia, for giving great support and encouragement during the research process. This research was supported by Universiti Tun Hussein Onn Malaysia (UTHM) under a Tier 1 grant (H750).