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Validation of Maintenance Management Core-Elements for Higher Educational Institution Buildings in Developing Countries Education Sector

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ABSTRACT

Maintenance management is a preventive management philosophy that provides a platform to retain assets value, improve life quality, improve risk cost and productivity in maintenance organisations. Given this contextual setting, the study examines whether core elements of maintenance management utilised in developed countries are relevant in developing countries, using Higher educational institutional (HEI) buildings in Nigeria as a case study. In obtaining data for this study, an empirical research design was employed. Precisely, a Delphi study piloted showed eight (8) core elements that influence effective maintenance management of HEI buildings in Nigeria. Of these eight (5) cores elements, five (5) of the elements have a very high influence on maintenance management of HEI buildings (VHI: 9.00 -10.00), and three (3) other elements had a high influence (HI: 7.00-8.99). The key finding from the study reveals that the core elements that influence maintenance management of HEI buildings include organisational maintenance policies, maintenance budget, human resources management, training, monitoring and supervision, maintenance information, communication among stakeholders, and maintenance culture. The study's findings indicated that these core elements are related to those of other countries. Effective maintenance management of HEI buildings is guaranteed when these core elements are integrated into the maintenance processes and operations.

Keywords: Higher educational buildings, Maintenance, Maintenance management, Nigeria

INTRODUCTION

In ensuring building optimal performance over its life cycle, there is a need for an effective maintenance system. Based on the important maintenance aspect, this paper defines maintenance as the essential services and processes carried out to care for a building structure and its attached components.

According to Lateef (2009), maintenance is the required services undertaken after completion, refurbishment, repair, or replacement to current standards of a building to serve its anticipated functions throughout its entire lifespan without affecting its basic features and function. Wahab et al. (2013) postulated that maintenance is required in a building to sustain its value and keep it acceptable. Maintenance is an arrangement that helps the building fulfill its usage and purpose (Ogunbayo et al., 2019). One thing that is common to both definitions is that maintenance is a continuous activity that is important to both in-used and proposed buildings. It shows that maintenance helps a building preserve all its attached components and its auxiliaries' structure and services to their original status as required by the users. However, on the other hand, management is the process of engaging in the four major functions of planning, organising, leading, and controlling in attaining organisational set goals (Martin, 1998). It is also intended to achieve organisational objectives through working with other people to obtain the most from the available resources (Ogunbayo et al., 2021). Maintenance Management is fundamentally a preventive management philosophy that can be considered a function that provides the opportunity to retain quality, life, and value of building and improve risk, cost, and production concern in maintenance organisation (Karia et al., 2014). In concept, effective MM will positively affect maintenance organisations by improving their operations cost and productivity (Spedding 1994). The significance of MM within maintenance organisations in maintaining buildings and other attached components cannot be over-emphasised. The significance of MM in the maintenance process is to support the core business process through workable human resources management (Ogunbayo et al., 2018). The significance of MM in maintaining buildings is to make sure that buildings and their attached components are performing well (Amaratunga, 2000). MM within an organisation should be dynamic, capable, and straightforward of periodic review as the needs arise to technological advancements and users value system (Basari, 2009). It involves the combinations of technical and administrative action and supervision actions anticipated to keep an item (building) in or restore it to a state where it can perform the required function (Arditi, 1999). As shown above, the significance of MM indicates that MM needs people with technical knowledge, a variety of skills, and site experience (Takata et al., 2004). Because of the significance of MM toward running a proper maintenance process, researchers have identified different core elements for an effective maintenance process in their study (Cobbinah, 2010). In identifying core elements for MM appropriate for maintaining buildings and other structures, the researchers have different opinions. The MM model, as developed by Campbell (1995), showed that the MM core elements would include: organisational maintenance policy, human resources management, monitory and supervision, maintenance information system (MIS), maintenance budget, and training. Wireman (2005) model indicates that MM core elements will include: organisational maintenance policy, MIS, provision of spare parts; training; maintenance approach; human resources management; maintenance budget; monitoring and supervision. Takata's life cycle maintenance model (2004) shows that the MM core elements include spare

part management, monitory and supervision, outsource strategy, training, human resources management, and maintenance budget. The supporting structure pillars model by Marques et al. (2006) also specifies that the MM core elements will include MIS, outsource strategy, organisational maintenance policy, human resources management, monitoring and supervision, training, and maintenance budget. However, Faghihinia [29] noted that all these identified MM core elements are more like guidelines or strategies for maintenance decisions with maintenance operation and process. However, the review shows that different MM core elements influence MM's effectiveness (Oke et al., 2006). Nevertheless, there are varying interpretations of the specific core elements that constitute MM of buildings. Hence, this study provides a holistic framework that combines the different models for developing practical MM core elements for maintenance operations, especially for MM of HEI of buildings in developing countries' education sector.

METHODOLOGY

This study employed the Delphi techniques in affirming the core elements of MM for the maintenance of HEI buildings in the Nigerian education sector. The Delphi study applies to both qualitative and quantitative academic research (Ogunbayo et al., 2022). As a research tool, its usage involves using a structured questionnaire to solicit selected expert panellists' opinions, with the consensus built from their responses through rounds of the questionnaire (Fletcher et al., 2014). The Delphi technique is essential for capturing data in qualitative and quantitative studies (Aigbavboa, 2014). The strength of the qualitative and qualitative study is anchored on the scrupulous methodology (Leung, 2001). Hence, quantitative was used in this study and adapted detailed Delphi process as suggested by (Ogunbayo et al., 2022). To ascertain relevant core elements of MM that influence the maintenance of HEI buildings in the developing countries' education sector, the relevant literature on the subject matter was first reviewed. As detailed in Aigbavboa (2014) study, experts were then selected to represent a broad spectrum of opinions on the subject under investigation. In achieving a comprehensive outcome for the Delphi study, the experts were drawn from industry and academia based on their practical experience and adequate theoretical knowledge of building maintenance works and processes (Somiah et al., 2020). In selecting the experts for the study, purposive non –probability sampling was adopted, and the selection was based on the researcher's experience, knowledge, and desirable respondents' characteristics (Leung, 2001). In all, fifteen (15) experts participated in the Delphi survey. The sample size of fifteen (15) experts was considered suitable and used for this study based on the recommendation of the previous studies that 10-15 participant provides adequate coverage in Delphi studies (Loo, 2002). The Delphi survey was structured on a 10-points influence scale: where 1-2 signify no influence; 3-4 signify low influence; 5-6 signify medium impact; 7-8 signify high influence, and 9-10 denote very high impact. The Delphi survey calculated and analyzed an appraised statical view of the experts' panelist using mean, median, standard deviation, and interquartile deviation.

Table 1. Delphi survey results–elements of maintenance management.

MM core-elements	Median (M)	Mean ($\bar{x}$)	Standard deviation (σx)	IQD	Mean scores ranking (R)
Organizational maintenance policies	**9**	9.12	0.50	0.00	1
Maintenance budget	**8**	8.35	0.87	1.00	8
Human resources management	**9**	8.54	0.81	1.00	5
Training factors	**9**	8.68	0.47	1.00	4
Monitoring and supervision	**8**	8.38	0.88	1.00	7
Maintenance information system	**8**	8.47	0.50	1.00	6
Communication among stakeholders	**9**	8.80	0.40	0.05	3
Maintenance culture	**9**	8.86	0.34	0.00	2

RESULT OF THE DELPHI STUDY

As shown in Table 1, the elements of MM in the Delphi survey result were constituted by eight (8) core elements. Among the eight (8) core elements, four (4) elements which are: organisational maintenance policy', maintenance culture, 'communication among stakeholders,' 'training factors,' and 'human resources management and were ranked very high impact (VHI: 9.00-10.00) by the panellists with a median score of nine (9), while three (3) other core-elements which are: 'maintenance information system,' 'monitoring and supervision, and 'maintenance budget' were ranked by the panellists to have a high impact (HI: 7.00-8.99). Besides, consensus levels among the elements varied, while the standard deviation scores among the elements suggest strong consistency levels and little variability in the panellists' responses.

DISCUSSION

This study aims to establish whether MM's core elements (found in other countries) that influence MM are relevant to the MM of HEI buildings in the Nigerian education sector. Eight elements (8) of MM were identified. Among the eight (8) elements, five (5) elements have a very high impact with a median score range (VHI: 9:00-10.00), while three (3) other elements had a high impact (HI: 7.00-8.99). Although the level of consensus varied among the elements, the IQD scores indicate consensus, with the IQD being ≤ 1 for all the eight (8) core-elements elements. Similarly, the elements' respective standard deviation (σx) indicates consistency in the experts' responses as their respective σx values were at most (1). Out of the eight (8) core-elements, the five elements (5) that recorded (VHI: 9.00-10.00) were: 'organisational maintenance policy' with mean value ($\bar{x}$) value of (+9.12) ranked first, maintenance culture with $\bar{x}$ of (8.86) ranked second, 'communication among stakeholders' with $\bar{x}$ of (8.80) ranked third, 'training factors' with $\bar{x}$ of (8.68) ranked

fourth, and 'human resources management with $\bar{x}$ of (8.54) ranked fifth as core-elements that influence the MM of HEI buildings in the Nigeria education sector. This finding is similar to findings of the studies by (Campbell, 1995; Takata et al., 2004; Wireman, 2005). Relatively, three (3) other core-elements that recorded (HI: 7.00-8.99) were: 'MIS' with $\bar{x}$ of (8.47) ranked sixth, monitoring and supervision with $\bar{x}$ of (8.38) ranked seventh, and maintenance budget with $\bar{x}$ (8.35) ranked eighth as core-elements that influence MM of HEI buildings in the Nigeria education sector. This finding is consistent with those presented by (Campbell, 1995; Wireman, 2005; Marquez et al., 2006). Subsequently, finding from the study shows that all the eight (8) core elements validated by the panellists' recorded good consensus with five (5) of the core-element had very high influence score (VHI: 9.00-10.00) with RII value of 0.80-1.00 and IQD value of $\leq$1. While the other three (3) core elements had a high influence score (HI: 7.00-8.99) with an RII value of 0.60-0.79 and IQD of $\geq$1, 1$\leq$ 2. Consequently, these eight core elements influence MM of HEI buildings within the developing countries' education sector.

CONCLUSION

This study was carried out to validate MM core elements for MM of HEI of buildings in the education sector of developing countries. The expert panelists appraised the eight (8) core elements of MM that were perceived to have influenced MM. All the core elements evaluated were found to have influenced the MM of HEI buildings in the developing countries' education sector. Moreover, these elements were coherent with MM core elements that have been identified in earlier studies and some national contexts. Hence, the study recommends that the following elements are significant in developing MM to maintain HEI buildings in the developing countries' education sector. Namely: organisational maintenance policies; maintenance budget; human resources management; training factors; monitoring and supervision; maintenance information system; communication among stakeholders and maintenance culture. The study concluded that the MM core elements that determine MM of HEI building in the developing countries' education sector are largely similar to other geographical contexts. Additionally, based on the findings of this study, an effective MM of HEI buildings is guaranteed if there is a serious consideration of these core elements in the development of MM for the maintenance of the HEI buildings in the developing countries' education sector.

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REFERENCES

Ab Wahab, Y., Basari, A. S. H., and Samad, A. (2013). Building maintenance management preliminary finding of a case study in Icym. Middle-East Journal of Science Research, 1260–1268.

Aigbavboa, C. O. (2014). An integrated beneficiary-centered satisfaction model for publicly funded housing schemes in South Africa. Published doctoral dissertation, University of Johannesburg.

Amaratunga, D. and Baldry, D (2000). Assessment of facilities management performance in higher education properties, Facilities, 18 (7/8), 293–301.

Arditi, D., and Nawakorawit, M. (1999). Designing buildings for maintenance: designers' perspective. Journal of Architectural Engineering, 5(4), 107–116.

Basari, A. S. H. (2009). Maintenance modeling tools with special to incomplete data, published doctoral dissertation, Universiti Teknikal Malaysia Melaka (UTeM), Malaysia).

Campbell, J.D. (1995), "Outsourcing in maintenance management: A valid alternative to self-provision," Journal of Quality in Maintenance Engineering, Vol. 1 No. 3, pp. 18–24.

Cobbinah, P. J. (2010). Maintenance of Buildings of Public Institutions in Ghana. Case Study of Selected Institutions in the Ashanti Region of Ghana. Published doctoral dissertation, Kwame Nkrumah University of Science and Technology.

Faghihinia, E., and Mollaverdi, N. (2012). Building a maintenance policy through a multi-criterion decision-making model. Journal of Industrial Engineering International, 8(1), 1–15.

Fletcher, A. J., and Marchildon, G. P. (2014). Using the Delphi method for qualitative, participatory action research in health leadership. International Journal of Qualitative Methods, 13(1), 1–18.

Karia, N., Asaari, M. H. A. H., and Saleh, H.: Exploring Maintenance Management in Service Sector: a Case Study. In Proceedings of International Conference on Industrial Engineering and Operation Management, 7–9 January, Bali, Indonesia, pp. 3119–3128.

Lateef, O. A. (2009). Building maintenance management in Malaysia. Journal of Building Appraisal, 4(3), 207–214.

Leung, W. C. (2001). How to design a questionnaire, University of East Anglia: BMJ, 322: 1-9 (Suppl S6).

Loo, R. (2002). The Delphi method: a powerful tool for strategic management. Policing: An International Journal of Police Strategies & Management.., 25 (4), 762–769.

Marquez, A. C., and Gupta, J. N. (2006). Contemporary maintenance management: process, framework, and supporting pillars. Omega, 34(3), 313–326.

Martin, D. C., & Bartol, K. M. (1998). Performance appraisal: Maintaining system effectiveness. Public Personnel Management, 27(2), 223–230.

Ogunbayo, B. F., Aigbavboa, C. O., Amusan, L. M., Ogundipe, K. E., and Akinradewo, O. I. (2021). Appraisal of facility provisions in public-private partnership housing delivery in southwest Nigeria. African Journal of Reproductive Health, 25.

Ogunbayo, B. F., Ajao, A. M., ALAGBE, O. T., Ogundipe, K. E., Tunji-Olayeni, P. F., & Ogunde, A. (2018). Residents'facilities Satisfaction In Housing Project Delivered By Public-Private Partnership (Ppp) In Ogun State, Nigeria. International Journal of Civil Engineering and Technology (IJCIET), 9(1), 562–577.

Ogunbayo, B. F., & Aigbavboa, O. C. (2019). Maintenance requirements of students' residential facility in higher educational institution (HEI) in Nigeria. In IOP Conference Series: Materials Science and Engineering (Vol. 640, No. 1, p. 012014). IOP Publishing.

Ogunbayo, B.F., Ohis Aigbavboa, C., Thwala, W.D. and Akinradewo, O.I. (2022), "Assessing maintenance budget elements for building maintenance management in Nigerian built environment: a Delphi study," Built Environment Project and Asset Management, Vol. ahead-of-print No. ahead-of-print.

Oke, S. A., & Charles-Owaba, O. E. (2006). An approach for evaluating preventive maintenance scheduling cost. International Journal of Quality & Reliability Management. 23 (7), 847–879.

Somiah, M. K., Aigbavboa, C. O., & Thwala, W. D. (2021). Validating elements of competitive intelligence for competitive advantage of construction firms in Ghana: A Delphi study. African Journal of Science, Technology, Innovation and Development, 13(3), 377–386.

Spedding, A., & Holmes, R. Facilities management (1994). CIOB Book of Facilities Management, London: Longman Scientific & Technical.

Takata, S., Kirnura, F., van Houten, F. J., Westkamper, E., Shpitalni, M., Ceglarek, D., and Lee, J. (2004). Maintenance: changing role in life cycle management. CIRP annuals, 53 (2), 643–655.

Wireman, T. (2005). Developing performance indicators for managing maintenance. New York: Industrial Press Inc.