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Assessing the Role of Organizational Features in Maintenance Management of Buildings in Higher Education Institutions

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ABSTRACT

This paper presents the results of a study conducted on the importance of organizational features in the maintenance management (MM) of HEI buildings in South Africa. The study was undertaken with the aim of improving the MM of buildings used by HEIs in South Africa. The study adopted a post-positivism philosophical perspective which informed the use of a quantitative research approach using a questionnaire survey. The survey was conducted amongst the users of academic buildings and the head of maintenance departments in six HEIs in Gauteng, South Africa. Data gathered were analysed using mean item score, Kruskal-Wallis H-test, and confirmatory factor analysis. The study's result shows that for HEIs to maintain their buildings effectively, they should prioritise asset management capability, maintenance action plans, and adequate resources. This study offers a theoretical contribution to the existing discourse on the maintenance of educational buildings by exploring the organizational features – an aspect that has gained little attention in HEIs building maintenance studies.

Keywords: HEIs, Maintenance management, Educational buildings, Organizational features

INTRODUCTION

Higher Education Institutions (HEIs) play an important role in the development of any country. They contribute to social and economic growth by developing human capital and expanding the knowledge base (Pouri and Inglesi-Lotz, 2014). They are the hub of knowledge dissemination and production of employable professionals (Adamu and Shakantu, 2016). To achieve this objective of knowledge dissemination, they require appropriate infrastructure, such as buildings. Lateef (2010) considered buildings as the second most important asset of HEIs after human resources. As such, buildings used by HEIs should be properly maintained to provide acceptable safety and comfort to users, as their upkeep impacts teaching and learning (Akinlolu, 2018). Furthermore, regular maintenance contributes to

building sustainability, minimizes lifecycle costs, and slows down the rate of deterioration (Abbas and Shafiee, 2020).

Despite the importance of building maintenance for the effective delivery of HEI objectives, the practice of maintaining buildings, in general, has been largely ignored as the focus has been placed on new construction projects (Tan, Shen, Langston, Lu, and Yam, 2014). The focus on new construction projects has led to buildings that cannot survive their lifespan as maintenance costs needed to bring them to an acceptable standard significantly increase (Olanrewaju and Abdul-Aziz, 2014). While studies appreciate the important role that maintenance has on the sustainability of buildings, maintenance remains a challenge in HEIs particularly in developing countries (Bullen and Love, 2011; Puķite and Geipele, 2017). These buildings deteriorate due to a lack of maintenance budget, plan, and dedicated maintenance departments (Zakiyudin, Fathi, Rambat, Tobi, and Rejab, 2014; Ropi and Tabassi, 2014; Ismail, 2017; Ugwu et al., 2018).

Studies on effective building maintenance strategies have emerged to address building maintenance challenges. For instance, preventive maintenance and corrective maintenance have been proposed (Eti, Ogaji, and Probert, 2006; Tee and Ekpiwhre, 2019; Dzulkifli et al., 2021). Furthermore, models and frameworks on maintenance management have also been developed (Jones and Sharp, 2007; Márquez, De León, Fernndez, Márquez, and Campos, 2009; Barberá, Crespo, Viveros, and Stegmaier, 2012; Macchi and Fumagalli, 2013; Idrus, Khamidi, and Abdul Lateef, 2014). From these developed models and frameworks, organizational features have been noted to be a significant dimension for effective maintenance. These organizational features relate to processes and strategies organizations implement to support maintenance management and are defined and planned by senior management (Lee and Scott, 2009). According to Adenuga, Olufowobi, and Raheem (2010), having organizational features such as maintenance policy in place can help reduce the deterioration of structures.

These organizational features have not been considered adequately in HEI building maintenance management. This is evident in the lack of applicable maintenance management models and frameworks designed for HEI buildings. Furthermore, there is scant literature relating to the maintenance of HEI buildings in South Africa. It is for this reason that this study was designed to assess the significant organizational features required by HEIs in South Africa to effectively manage their buildings. This was done to ensure that HEIs can effectively meet their objectives of knowledge dissemination and production of employable professionals.

ORGANIZATIONAL FEATURES FOR MAINTENANCE MANAGEMENT IN HIGHER EDUCATIONAL INSTITUTIONS

Maintenance is an activity applied to assets to preserve or restore them to their intended function after failure so they can continue to serve their purpose (Yiu, 2008). Their lifecycle is optimized by continuously maintaining assets, thereby ensuring continued reliability and availability (Velmurugan and Dhingra, 2015). Maintenance management assists in effectively planning,

organizing, monitoring, and evaluating all activities related to the maintenance of buildings using available resources (Mukelas et al., 2012; Idrus et al., 2014). In HEIs, maintenance management of buildings becomes essential, and studies have shown that the organisational features will play a crucial role in ensuring effective maintenance. Organizational features are critical in ensuring that maintenance management of buildings used by HEIs is supported. In this study, organizational features are viewed as core functions that top management drives to support and improve the performance of the maintenance department. Various models and frameworks such as the house of maintenance (Barberá et al., 2012), the maintenance management framework (Márquez et al. (2009), a new performance-based process model for built assets (Jones and Sharp, 2007), and sports facilities maintenance management model (Harun et al., 2013) have identified the importance of organizational features in maintenance management. Several variables were identified to measure this feature. For instance, Olanrewaju and Abdul-Aziz, (2015) identified the development of a maintenance strategy as a key organizational variable. This strategy should be based on corporate objectives aligned with the organization's strategies (Márquez et al., 2009; Al-Turki, 2011). Also, the issue of developing and agreeing on a maintenance policy is important. Maintenance policy will determine the strategic direction of maintenance management and the resource requirements (Yahya and Ibrahim, 2011).

Furthermore, Adamu and Shakantu (2016) identified the need for a proper maintenance plan to drive the maintenance strategies put in place by organizations. In the same vein, other studies have shown the need for the maintenance department to be adequately resourced to execute its function effectively (Mohd-Noor et al., 2011; Velmurugan and Dhingra, 2015). More so, fundamental to executing a maintenance plan is the determination of the most appropriate maintenance delivery model. Where organizations lack the in-house technical expertise or need to reduce costs associated with carrying a fully resourced maintenance department, a decision to outsource all or some maintenance functions can be made at a strategic level. Although many factors influence the decision to outsource, outsourcing some of the maintenance functions can afford HEIs the ability to focus on core activities (Mcivor, Humphreys, and Mcaleer, 1997; Bertolini and Bevilacqua, 2006; Chanter and Swallow, 2008). Hence most HEIs opt for a combination of both insourcing and outsourcing. This approach is also a result of the diverse nature and wide range of university buildings (Olanrewaju and Abdul-Aziz, 2015).

Another organizational feature that has been given considerable attention is the need for risk assessment (Hassanain et al., 2003; Márquez et al., 2009; Puķite and Geipele, 2017). To ensure effective maintenance actions that will reduce indirect costs associated with maintenance, it is necessary to undertake an evaluation of the risks of various assets while aligning maintenance actions with overall organizational goals (Márquez et al., 2009). According to Puķite and Geipele (2017), it is important to regularly undertake an inventory of buildings and their components to reduce maintenance-associated risks. This will ensure that the maintenance prioritization of these buildings is undertaken, and their maintenance plan is scheduled accordingly

(Hassanain et al., 2003). Other organizational features, such as the availability of a maintenance management budget, maintenance culture in the organization, top management support, and asset management capability, have been noted in past studies (Fernández and Márquez, 2012; Ding and Kamaruddin, 2014; Lateef and Abdul-Aziz, 2015 and Velmurugan and Dhingra, 2015). These variables identified from the literature were used in this study to assess the significant organizational features needed for improving the maintenance management of HEIs in South Africa.

METHODOLOGY

This study adopted a postpositivist philosophical view which informed the use of a quantitative research approach. Data collection was undertaken using a questionnaire developed from the extensive review of existing literature on maintenance management. The sample population for this study includes 783 users of academic buildings and maintenance managers in the six HEIs in Gauteng, South Africa. This is because the majority of HEIs are located in Gauteng. The sample population was drawn from a total target population of 19691 academic and non-academic staff in HEIs in Gauteng, as indicated by the Department of higher education and training (DHET) (2021). This sample size was done using Cochran's sample size calculation formula with a confidence level of 90% and a margin of error of $\pm 7\%$. The questionnaire comprised two sections. Section A sought to obtain background information of respondents, such as their role in the institution, the number of years in the institution, the faculty, and commonly used facilities. This information was critical as it informed their suitability to answer the questions in the other section. Section B assessed the significance of 16 identified organizational features to the effective maintenance management of HEIs buildings. This section was assessed using a five-point Likert scale, with one being 'not important', and five being 'very important'.

Data collection for this study adopted a combination of purposive and snowball sampling approaches. Purposive sampling was used to identify the initial set of study respondents as it allows for direct generalization of the study population (Malhotra and Birks, 2007). Once the respondents were identified, snowball sampling was used to distribute the questionnaire to their networks, creating a chain of referrals. Data collection took a period of 6 months and yielded 203 responses. Data analysis included the use of various statistical analyses. Percentage (%) and frequency (f) were used to analyse the background information of study respondents. To measure the questionnaire's internal reliability, Cronbach's alpha (α) was used. A cut-off of ≥ 0.7 was set as a threshold based on past studies (Schumacker and Lomax, 2010), while 0.971 was derived, thus confirming the reliability of the questionnaire. The mean item score ($\overline{X}$) was used to rank the significance of each variable for the organizational feature as rated by the respondents. The respondents for this study were grouped into four categories (academics, administrative support, head of maintenance, and management), and the significant difference in their rating was assessed using Kruskal-Wallis H-test (K-W).

FINDINGS AND DISCUSSIONS

Background Information of Respondents

Analysis of the background information of the respondents shows that the majority of respondents were academics ($f = 124$, 61%), administrative support ($f = 32$, 15.8%), head of maintenance unit ($f = 4$, 2%), management ($f = 17$, 8.4%), and others ($f = 26$, 12.8%) such as post-doctoral fellows, laboratory technicians, interns, and librarians. In terms of working experience with the relevant institution, 6.4% ($f = 13$) have less than one year, 40.9 % ($f = 83$) have 1–5 years, 25.6% ($f = 52$) have 6–10 years, 14.8% ($f = 30$) have 11–15 years, while12.3% ($f = 25$) have been with the institution for more than 15 years. This feedback suggests that the respondents are knowledgeable about the various facilities that they frequently use.

Organizational Features Influencing Maintenance Management of HEI Buildings in South Africa

In assessing the influence of organizational features on the maintenance management of HEI buildings in South Africa, 16 features were identified from the review of extant literature, models, and frameworks. Table 1 reveals the overall ranking of these organizational features by the respondents. The table also gives the K-W test conducted to ascertain the significant difference in the views of these different groups. The table shows that all the assessed organizational features were considered important, as they all have a value of the above average of 3.0. Top among them is top management support ($\overline{X} = 4.11$, p-value $= 0.735$), adequate resources in the maintenance department ($\overline{X} = 4.10$, p-value $= 0.901$), maintenance management budget

Table 1. Ranking of organizational features.

Organizational features	Overall		K-W	
	$\overline{X}$	Rank	χ^2	Sig.
Top management support	4.11	1	1.274	0.735
Adequate resources in the maintenance department	4.10	2	0.580	0.901
Maintenance management budget	4.09	3	3.761	0.288
Appropriate maintenance procedures and process	4.06	4	1.532	0.675
Building condition assessment	4.03	5	0.074	0.995
Risk assessment related to maintenance aspects	3.96	6	1.463	0.691
Asset management capability	3.96	6	1.650	0.648
Availability of maintenance management plan	3.93	8	3.826	0.281
Availability of maintenance strategy	3.89	9	2.575	0.462
Availability of maintenance management policy	3.88	10	1.267	0.737
Maintenance culture in the organization	3.85	11	1.086	0.780
Organizational staff awareness of the policy	3.82	12	5.852	0.119
Inventory of building components	3.82	12	0.389	0.943
Prioritization of the maintenance action plan	3.81	14	1.254	0.740
Structure of the maintenance department	3.73	15	3.177	0.365
Optimization of the maintenance action plan	3.73	15	0.971	0.808

Note: $\overline{X}$= Mean Score, *K-W* = Kruskal-Wallis H-test, χ^2= Chi-square

($\overline{X} = 4.09$, p-value = 0.288), appropriate maintenance procedures ($\overline{X}$= 4.06, p-value = 0.675), and process and building condition assessment ($\overline{X} = 4.03$, p-value = 0.0995). The structure of the maintenance department and optimisation of the maintenance action plane were ranked least with $\overline{X}$ values of 3.73 each. Despite being ranked the least, both variables are deemed important as they have a $\overline{X}$ of well above average and should be given adequate attention in the quest for improved maintenance management of HEI buildings. Also, the result from the K-W test conducted revealed that there is no statistically significant difference in the rating of the variables in this construct by the four groups of respondents as a p-value of above 0.05 (95% confidence interval) was derived for all the variables.

Past studies also highlighted organizational features as critical in achieving effective maintenance management in various sectors (Márquez et al., 2009; Lee and Scott, 2009; Yahya and Ibrahim, 2011). Key organizational features such as support from top management are important as senior management is responsible for developing a maintenance strategy that will influence the maintenance management direction of the organization (Olanrewaju and Abdul-Aziz, 2015). In order to strengthen the maintenance management department, Au-Yong, Ali, Ahmad, and Chua (2017) highlighted the importance of allocating the necessary resources toward maintenance. This strategic function requires top management's input in planning resource allocation (Al-Turki, 2011). Maintenance activities are budget driven and without sufficient budget allocated, buildings and their components can be negatively affected. Raposo, De Brito, and Fonseca (2013) reported that the lack of resources to support maintenance management could result in a less effective maintenance department that cannot optimally function, which can eventually lead to the degradation of buildings and negatively impact user satisfaction. According to Matos, Rodrigues, Rodrigues, and Costa, 2021), building condition assessment is important as it can detect early signs of failure in buildings, thereby prompting maintenance schedules. HEIs can benefit from regularly undertaking building condition assessments for all buildings to reduce deferred maintenance costs. This is because building condition changes with time due to physical and operational impacts (Matos et al., 2021).

CONCLUSION AND RECOMMENDATIONS

Based on the review of existing literature and the survey results from users of various HEI buildings, the study concludes that organizational features are important in supporting maintenance. The key variables identified include the need to have top management support as far as maintenance is concerned. The importance of having adequate resources in the maintenance department and an adequate maintenance management budget can contribute to the achievement of well-maintained HEI buildings. This is because management plays a significant role in developing a maintenance strategy, approving the budget, and ensuring that maintenance departments are well-resourced. Undertaking an inventory of buildings and their components is also important as it will inform the maintenance strategy adopted. Having organizational features

in place will result in improved building sustainability, buildings' that perform better, an improved image of the institution and better satisfaction of building users.

The findings of this study offer practical insight into how HEIs in south Africa can improve the maintenance of their buildings to achieve better performance of buildings. Theoretically, this study contributes to the existing discourse on the maintenance of educational buildings by exploring the organizational features which have gained little attention in HEIs building maintenance studies. Within this contribution, care must be taken in generalizing the study's result as it was conducted in one province in the country. There is a possibility of getting a different perspective when other provinces are assessed. Future studies can be conducted in other provinces that were not included in the study.

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REFERENCES

Abbas, M., and Shafiee, M. (2020). An overview of maintenance management strategies for corroded steel structures in extreme marine environments. *Marine Structures*, 71, pp. 102718.

Abbott, G. R., McDuling, J. J., Parsons, S. A. and Schoeman, J. C. (2007). Building condition assessment: a performance evaluation tool towards sustainable asset management. *CIB World Building Congress*, 2007

Adamu, A. D., and Shakantu, W. (2016). A concept: Strategic maintenance management for built facilities of universities. *Proceedings of the 9th cidb Post-Graduate Conference: Emerging Trends in Construction Organisational Practices and Project Management Knowledge Areas*. 1st – 4th February, 2016, Held at River Club /University of Capetown

Adenuga, O., Olufowobi, M. B, and Raheem, A. A. (2010). Effective maintenance policy as a tool for sustaining housing stock in downturn economy. Journal of Building Performance, 1(1), pp. 93–109.

Akinlolu, M., Ndihokubwayo, R. and Simpeh, F. (2017). The extent of practice of Total Quality Management (TQM) in the maintenance of university buildings in South Africa. ASOCSA 11th Built Environment Conference, Durban, South Africa, 6–8 August.

Akinola, M. T. (2018). *Framework for the effective implementation of total quality management in the maintenance of tertiary institution buildings in South Africa* (Masters dissertation, Cape Peninsula University of Technology).

Al-Turki, U. (2011). A framework for strategic planning in maintenance. *Journal of Quality in Maintenance Engineering*, 17(2), 150–162.

Au-Yong, C. P., Ali, A. S., Ahmad, F. and Chua, S. J. L., 2017. Influences of key stakeholders' involvement in maintenance management. *Property Management*.

Barberá, L., Crespo, A., Viveros, P., and Stegmaier, R. (2012). Advanced model for maintenance management in a continuous improvement cycle: Integration into the business strategy. *International Journal of Systems Assurance Engineering and Management*, 3(1), 47–63.

Bertolini, M., and Bevilacqua, M. (2006). A combined goal programming - AHP approach to maintenance selection problem. Reliability Engineering and System Safety, 91(7), 839–848.

Bullen, P. S., and Love, P. E. (2011). Adaptive reuse of heritage buildings, *Structural Survey*, 29(5), 411–421.

Chanter, B., and Swallow, P. (2008). *Building maintenance management*. John Wiley & Sons.

Department of Higher Education and Training, South Africa (DHET) (2021). *Post-School Education and Training Monitor: Macro-Indicator Trends*. Available from: https://www.dhet.gov.za/Planning%20Monitoring%20and%20Evaluation%20Coordination/Post-School%20Education%20and%20Training%20Monitor%20-%20Macro-Indicator%20Trends%20-%20March%202021.pdf.

Ding, S. H., and Kamaruddin, S. (2014). Maintenance policy optimization—literature review and directions. *International Journal of Advanced Manufacturing Technology*, 76(5–8), 1263–1283.

Dzulkifli, N., Sarbini, N., Ibrahim, I., Abidin, N., Yahaya, F., and Azizan, N. (2021). Review on maintenance issues toward building maintenance management best practices. *Journal of Building Engineering*, (89), 40.

Eti, M. C., Ogaji, S. O. T., and Probert, S. D. (2006). Strategic maintenance-management in Nigerian industries. Applied Energy, 83(3), pp.211–227.

Fernández, J. F. G., and Márquez, A. C. (2012). Defining maintenance management framework. In *Springer Series in Reliability Engineering*, 49, 127–147.

Harun, M. T., Salamudin, N., and Hushin, H. F. (2013). Appraisal of the sport facilities maintenance management practices of Malaysian stadium corporations. Asian Social Science, 9(12), 93–98.

Hassanain, M. A., Froese, T. M., and Vanier, D. J. (2003). A framework model for facilities maintenance management. NRCC-46395. *Framework*, 3828(1), 51–64.

Idrus, A., Khamidi, F., and Sodangi, M. (2010). Maintenance management framework for conservation of heritage buildings in Malaysia. *Modern Applied Science*, 4(11).

Ismail, Z. A. (2017). Maintenance management system (MMS) to support facilities management at Malaysian polytechnic. *Smart and Sustainable Built Environment*, 6(1), 19–33.

Jones, K., and Sharp, M. (2007). A new performance-based process model for built asset maintenance. *Facilities*, 25(13–14), 525–535.

Lateef, O. A. (2010). Case for alternative approach to building maintenance management of public universities. *Journal of Building Appraisal*, 5(3), 201–212.

Lau, L. C., Lee, K. T., Mohamed, A. R. (2012). Global warming mitigation and renewable energy policy development from the Kyoto Protocol to the Copenhagen Accord—A comment. *Renewable and Sustainable Energy Reviews*, 16(7), 5280–5284 (2012).

Lee, H. H. Y. and Scott, D. (2009). Overview of maintenance strategy, acceptable maintenance standard and resources from a building maintenance operation perspective. *Journal of Building Appraisal*, 4(4), 269–278.

Márquez, A. C., de León, P. M., Fernández, J. G., Márquez, C. P. and Campos, M. L. (2009). The maintenance management framework: A practical view to maintenance management. *Journal of Quality in Maintenance Engineering*.

Macchi, M., and Fumagalli, L. (2013). A maintenance maturity assessment method for the manufacturing industry. *Journal of Quality in Maintenance Engineering*, 19(3), 295–315.

Malhotra, N., and Birks, D. (2007). *Marketing research: An applied approach*. Pearson.
Matos, R., Rodrigues, F., Rodrigues, H. and Costa, A. (2021). Building condition assessment supported by Building Information Modelling. *Journal of Building Engineering*, 38, p.102186.
Mcivor, R. T., Humphreys, P. K., and Mcaleer, W. E. (1997). A strategic model for the formulation of an effective make or buy decision. *Management Decision*.