Ikuabe, M., Aigbavboa, C., Awuzie, B. and Ogungbe, M., 2025. Towards a computerised maintenance management system for healthcare facilities in South Africa. In: Waidyasekara, K.G.A.S., Jayasena, H.S., Wimalaratne, P.L.I. and Tennakoon, G.A. (eds). *Proceedings of the 13th World Construction Symposium*, 15-16 August 2025, Sri Lanka. pp. 1384-1390. DOI: https://doi.org/10.31705/WCS.2025.103. Available from: https://ciobwcs.com/papers/

TOWARDS A COMPUTERISED MAINTENANCE MANAGEMENT SYSTEM FOR HEALTHCARE FACILITIES IN SOUTH AFRICA

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ABSTRACT

Healthcare facilities constitute one of the essential infrastructures in any community. It plays a critical role in achieving Sustainable Development Goal (SDG) No. 3, which aims to enhance the health and well-being of individuals. Nevertheless, the efficient upkeep of healthcare facilities in South Africa has encountered several obstacles, and one potential solution is the implementation of computerised maintenance management systems (CMMS). This study explored the benefits of the deployment of CMMS for healthcare facilities in South Africa. A quantitative methodology required data collection through a structured questionnaire distributed to professionals within the built environment. The collected data was analysed via exploratory factor analysis, utilising principal component analysis as the extraction method. The study's outcome identified four components as the benefits of the deployment of CMMS for healthcare facilities in South Africa: maintenance efficiency and facilities uptime, asset and resource management, regulatory compliance and safety assurance, and sustainability adherence and strategic insights. In conclusion, the study offered suggestions that could facilitate the effective integration of computational systems like CMMS to maintain healthcare facilities in South Africa.

Keywords: *Benefits; CMMS; Developing Country; Facilities; Healthcare.*

1. INTRODUCTION

Healthcare delivery is a fundamental provision of any decent society. Prowle and Araali (2017) noted that in most developing countries, there is a growing need for healthcare services arising from the surge in population. This also reflects the surge in healthcare facilities needed to attend to the teeming population. The maintenance management of healthcare facilities is critical in delivering healthcare needs (Lavy & Terzioğlu, 2023). In most developing countries, such as South Africa, there has been a strain on utilising healthcare facilities due to increased healthcare needs. According to Yousefli et al.

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(2017), this underscores the need for efficient maintenance management of healthcare facilities. Also, in most developing countries, due to poor maintenance planning and management, most healthcare facilities are attributed with downtime (Arab-Zozani et al., 2021). A major contributor to the non-implementation of maintenance management is the lack of or missing data. Furthermore, Ikuabe et al. (2023) noted that, resulting from outdated systems, there is a significant bottleneck towards the efficient management of facilities. Hence, there is a need to navigate to a system that can deliver efficient maintenance management to deliver the requisite functions of healthcare facilities. Implementing the computerised maintenance management system (CMMS) is one such system.

The computerised maintenance management system (CMMS) is a digital platform that assists in maintenance and asset management of an organisation's facilities (Wienker et al., 2016). Rastegari and Mobin (2016) state that it is an enabling, technology-driven system that helps in functions such as scheduled maintenance, asset management, and production & tracking of issued work orders. Moreover, CMMS is featured as a digital platform used to plan and supply parts of facilities, while also driving the proper keeping of records of facilities (Alemayehu et al., 2023; Stazic et al., 2023). Generally, the system helps gather and collect maintenance records and data to project the effectiveness and efficiency of maintenance management (Alemayehu et al., 2023). The deployment of CMMS for healthcare facilities can help mitigate some of the challenges experienced in the maintenance management of facilities. Furthermore, by employing strategic maintenance management of healthcare facilities, there is a high tendency to reduce medical incidents propagated by faulty facilities and equipment (Li et al., 2023). Also, the Joint Commission on Accreditation of Healthcare Organisations issued a certified revised programme to drive the maintenance of healthcare facilities (Joint Commission, 2014). Moreover, from a South African perspective, no study has explored the benefits of the deployment of CMMS for healthcare facilities. Hence, on this basis, the current study strives to evaluate the benefits of the deployment of CMMS for healthcare facilities in a South African context. The study's outcome will make theoretical and practical contributions towards the upscaling of maintenance management practices of healthcare facilities using innovative solutions.

2. REVIEW OF RELATED STUDIES

Healthcare facility maintenance in South Africa faces challenges including aging infrastructure, limited budgets, regulatory compliance demands, and the need for uninterrupted services (Lebea et al., 2024). These constraints often lead to reactive rather than preventive maintenance approaches, compromising safety, hygiene, and operational efficiency, while also increasing long-term costs and affecting patient care quality and staff productivity. Due to the purpose of use, maintaining healthcare facilities is very important. This is reinforced by the sustainable and life expectancy attainments, characterised by well-maintained facilities. Beniacoub et al. (2021) noted that CMMS seeks to help deliver the mandates as mentioned earlier, aided by its computational capabilities. CMMS are automated in that they provide predictive maintenance, which therefore plays a vital role in ensuring that adequate and quick maintenance is easily achieved (Gorski et al, 2022). When a fully detailed maintenance strategy (e.g. scheduled inspection) for all equipment is pre-loaded in the CMMS, maintenance is executed, which reduces possible breakdowns on such equipment. CMMS also facilitates the collection and storage of data. Aliyu et al. (2023) noted that the system is not only deployed for storing data but can also store large amounts of data. Thus, enhancing maintenance planning of healthcare facilities. Moreover, a critical use of the CMMS in a healthcare set-up is the drive for preventive maintenance strategies (Wienker et al., 2016). Due to the reliance of healthcare facilities on high-value and complex equipment, the use of CMMS can foster optimised preventive maintenance techniques that can serve in the long term. The system enables maintenance personnel to set up and automate maintenance functions using facilities' historical data or manufacturer recommendations (Besiktepe et al., 2020). A fundamental derivation from the deployment of the CMMS is the optimisation of asset management (Jonassen, 2024). Also, due to the limited resources and tight budgets operated by most healthcare institutions, the use of CMMS tends to make facilities very efficient. This is actualised through centralised databases that assist in tracking and conducting a comprehensive assessment of the facilities lifecycle (Ismail, 2019). This covers maintenance history, performance metrics, warranty periods, and purchase dates. Besiktepe et al. (2020) stated that well-maintained equipment provides a high probability of such equipment operating and performing to its full capacity without failure, and becomes a dependable tool in times of need, and can offer service delivery to patients (improving health and safety). Healthcare facilities are subject to stringent regulations from health authorities and accreditation bodies, and CMMS aids in actualising regulatory compliance (Wienker et al., 2016). The regulation covers maintenance process documentation, enforced routine inspections, and traceable maintenance actions.

3. METHODOLOGY

The study aims to evaluate the benefits of the deployment of CMMS for healthcare facilities in South Africa. A questionnaire survey was employed for data collection using a quantitative research approach. The ability to reach out to a large number of respondents while also considering the quantifiability of the data is the reason for the choice of the data collection instrument (Nardi, 2018). Using a Likert scale of 1 to 5, the questionnaire captured fourteen benefits identified from literature and presented to the study's respondents for rating based on their significance. These respondents were facilities managers, construction managers, quantity surveyors, and architects. The research area is Gauteng province in South Africa. The choice of the study area is driven by its characteristics of having a large pool of professionals and having a significant number of healthcare facilities in the country. The sampling techniques deployed for the study are purposive and snowball sampling techniques. Professionals with knowledge and experience in healthcare facilities management were identified and participated in the survey; thereafter, referrals were given to professionals with similar expertise and experience. Sixty-five questionnaires were filled out and deemed appropriate for analysis after collection. Cronbach's alpha was used to assess the validity and reliability of the research instrument. An alpha value of 0.896 was given, which gives a good validity and reliability of the study's instrument as it is above the threshold of 0.7 and closer to 1.00 (Tavakol & Dennick, 2011). The method of data analysis used for the study is exploratory factor analysis (EFA) employing the principal component analysis as the technique for data extraction, as employed by Ikuabe et al. (2021) and Maphongwane et al. (2024). This technique helped in clustering variables with similar attributes, thereby leading to a reduction in the number of variables.

4. FINDINGS

The use of EFA in this study is driven by the need to identify clusters of measurement variables with similar dimensions. This clustering process resulted in a more streamlined and comprehensible framework by reducing the number of variables. The initial phase involved evaluating the appropriateness of the gathered data from the study participants. The outcome indicated an inter-item correlation ranging from 0.20 to 0.50, which is deemed suitable (Phelan & Wren, 2007). The data's factorability was assessed using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. According to Pallant (2005), a dataset is considered suitable for EFA if it is significant ($p < 0.05$). The results displayed in Table 1 reveal a KMO value of 0.826, while Bartlett's test shows significance with a p-value of 0.000. This result exceeds the 0.6 threshold recommended by earlier studies (Ikuabe & Oke, 2019; Ibrahim et al., 2024). This finding confirms that the retrieved data is suitable for conducting EFA.

Table 1: KMO and Bartlett's Test

KMO and Bartlett's Test Results		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.826
Bartlett's Test of Sphericity	Approx. Chi-Square	1207.496
	Df	115
	Sig.	0.000

The rotated component matrix results and the percentage of variance accounted for by the analysed variables are shown in Table 2. The measurement variables converged through six iterations by applying principal component analysis (PCA) as the extraction method with varimax rotation. The results revealed four components with an eigenvalue ≥ 1.00, explaining a cumulative variance of 72.97%. The initial component is linked to four variables with factor loadings between 0.885 and 0.635, accounting for 53.72% of the variance and is referred to as Maintenance Efficiency and Facilities Uptime. The second component comprises four variables with factor loadings that range from 0.777 to 0.581, representing 11.36% of the variance and is labelled Asset and Resource Management. The third component includes three variables with factor loadings from 0.679 to 0.518, contributing to 4.64% of the variance and is identified as Regulatory Compliance and Safety Assurance. The fourth component comprises three variables, with factor loadings between 0.622 and 0.508, accounting for 3.25% of the variance and is named Sustainability Adherence and Strategic Insights.

Table 2: Rotated component matrix

Benefits	**Component**				**Extracted Communalities**	**% of Variance**
	1	**2**	**3**	**4**		
Maintenance Efficiency and Facilities Uptime						
Automated Work Order Scheduling	0.885				0.533	53.72
Reduced Equipment Downtime	0.814				0.628	
Preventive Maintenance Optimisation	0.722				0.615	
Real-time updates	0.635				0.507	

Benefits	Component				Extracted Communalities	% of Variance
	1	2	3	4		
Asset and Resource Management						
Lifecycle Asset Tracking		0.777			0.738	11.36
Inventory Management		0.716			0.777	
Minimised Emergency Repairs		0.649			0.829	
Capital Planning		0.581			0.715	
Regulatory Compliance and Safety Assurance						
Regulatory and Standards Compliance			0.679		0.661	4.64
Improved Safety			0.542		0.593	
Support for Quality Assurance			0.518		0.724	
Sustainability Adherence and Strategic Insights						
Environmental Sustainability				0.622	0.566	3.25
Enhanced Decision-Making				0.547	0.599	
Analytical Reporting and KPIs				0.508	0.682	

Extraction Method: Principal Component Analysis
a.4 components extracted

5. DISCUSSION

The results of the study affirm that the implementation of CMMS in healthcare facilities provides notable advantages. The system increases the scheduling and execution rates of preventive and corrective maintenance activities. This is corroborated by Beniacoub et al. (2021), who noted that CMMS improves facility reliability by minimising unplanned downtime. Also, the system's automated work order generation and monitoring in real-time systems markedly reduced response times, thus improving overall efficiency. For asset and resource management, CMMS enables enterprises to track asset lifecycles effectively, supporting equipment replacement and budgeting decision-making. CMMS also improves resource planning based on performance data and maintenance costs, as Jonassen (2024) asserted. The system's ability to create audit-ready regulatory compliance and safety assurance documentation was highly appreciated. This is corroborated by the study of Wienker et al. (2016), who noted that CMMS facilitates compliance by capturing all maintenance activities in logs, documents, and records. Furthermore, regarding sustainability adherence and strategic insights, the study found that CMMS promotes environmental sustainability by reducing paper use and conserving energy. Moreover, the system's analytics and reporting capabilities helped develop more effective strategies, which Wienker et al. (2016) also noted regarding the role of CMMS in performance evaluation and ongoing enhancement.

6. CONCLUSION AND RECOMMENDATIONS

The research revealed the outcomes of evaluating the benefits of deploying CMMS in healthcare facilities in South Africa. A review of existing literature was done, which facilitated the identification of these benefits. The identified benefits were then rated by the study's respondents according to their significance using a Likert scale. The gathered data underwent analysis through exploratory factor analysis, employing principal component analysis as the method for extraction. The results from this analysis identified four components as the benefits of using CMMS in South African healthcare facilities.

These are maintenance efficiency and facilities uptime, asset and resource management, regulatory compliance and safety assurance, sustainability adherence and strategic insights. The enhancement of maintenance management systems within healthcare facilities is crucial for improving the delivery of healthcare services. Implementing CMMS can help mitigate some challenges associated with traditional maintenance management systems, especially as facilities aim to upscale maintenance practices. Consequently, based on the study's findings, it is recommended that healthcare organisations develop the necessary technical skills to utilise CMMS effectively. Additionally, government financial assistance in the form of subsidy regimes could help address the costs involved in implementing the system. Furthermore, fostering a cultural shift among stakeholders is essential to encourage the adoption of advanced computational systems for more efficient maintenance management.

7. REFERENCES

Alemayehu, G., Avvari, M., Alemu, B., & Gebrekidan, A. (2023). Performance Evaluation of Faffa Food Share Company through Computerized Maintenance Management System (CMMS). *Journal of Engineering*, *2023* (1), 4856457 https://doi.org/10.1155/2023/4856457

Aliyu, A., Baglee, D., & Dixon, D. (2023). *Computerised maintenance management system (CMMS) role in small and medium enterprise (SME)*. In Proceedings of the International Conference on Condition Monitoring and Asset Management, 2023, (No. 1, pp. 1-7). The British Institute of Non-Destructive Testing.

Arab-Zozani, M., Imani, A., Doshmangir, L., Dalal, K., & Bahreini, R. (2021). Assessment of medical equipment maintenance management: proposed checklist using Iranian experience. *Biomedical Engineering Online*, *20*(1), 49. https://doi.org/10.1186/s12938-021-00885-5

Beniacoub, F., Ntwari, F., Niyonkuru, J., & Nyssen, M. (2021). 'Health and Technology'. Evaluating a computerized maintenance management system in a low resource setting. *Health and Technology*, *11*, 655–661 https://doi.org/10.1007/s12553-021-00524-y

Beşiktepe, D., Özbek, M. E., & Atadero, R. A. (2020). Computerized maintenance management system data utilization in facility management. In *Proceedings of the 6th International Project and Construction Management Conference (IPCMC2020)* (pp. 12–14). Istanbul Technical University.

Gorski, E., Loures, E., Santos, E., & Kondo, R., (2022). Towards a smart workflow in CMMS/EAM systems: An approach based on ML and MCDM, *Journal of Industrial Information Integration*, *26*. 100278, https://doi.org/10.1016/j.jii.2021.100278

Ibrahim, K., Agidani, J., Oke, A., Ikuabe, M., & Kajimo-Shakantu, K. (2024). Assessing work-life balance strategies employed by Nigerian Builders. *International Journal of Construction Management*, ahead-of-print. https://doi.org/10.1080/15623599.2024.2384215

Ikuabe, M. and Oke, A, E (2019). Contractors' opportunism: construction professionals' awareness of influencing factors. *Journal of Engineering, Design and Technology*, *17*(1), 102-114. https://doi.org/10.1108/JEDT-03-2018-0054

Ikuabe, M., Aigbavboa, C., Anumba, C., & Oke, A. (2023). Business Environment Factors Influencing the Use of Cyber-Physical Systems for Facilities Management – A Confirmatory Factor Analysis Approach. *Journal of Green Building*, *18*(1), 169-188 https://doi.org/10.3992/jgb.18.1.169

Ikuabe, M., Oke, A.E., & Aigbavboa, C.O. (2021). Evaluating the influencing factors responsible for construction contractors' opportunism in a developing economy. *African Journal of Science, Technology, Innovation and Development*, *13*(3), 387-393 https://doi.org/10.1080/20421338.2020.1746044

Ismail, Z. A. (2019). An integrated computerised maintenance management system (I-CMMS) for IBS building maintenance. *International Journal of Building Pathology and Adaptation*, *37*(3), 326-343. https://doi.org/10.1108/IJBPA-10-2017-0049

Joint Commission (2014). Standards revisions and clarifications related to medical equipment and utility system maintenance. https://www.jointcommission.org/what-we-offer/accreditation/health-care-settings/hospital/ (Accessed March 20, 2024).

Jonassen, G. S. (2024). *Value of Computerized maintenance management system (CMMS) in smart Maintenance and Asset management decisions–cases and best practices* (Unpublished Master's thesis) University of Stavanger, Norway.

Lavy, S., & Terzioğlu, S. (2023). *Delivery of healthcare facility management services: A literature review*. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1176, No. 1, p. 012017). IOP Publishing. https://doi.org/10.1088/1755-1315/1176/1/012017

Lebea, M.J., Agumba, J.N. & Adebowale, O.J. (2024). Critical success factors in the maintenance strategies of public healthcare facilities. *International Journal of Building Pathology and Adaptation*, 42(7), 55-75 https://doi.org/10.1108/IJBPA-02-2024-0038

Li, J. Mao, Y. & Zhang, J. (2023). Construction of medical equipment maintenance network management platform based on big data. *Frontiers in Physics*, *11*,1105906 https://doi.org/10.3389/fphy.2023.1105906

Maphongwane, N., Aigbavboa, C., & Ikuabe, M. (2024). Key Indoor Environmental Quality Indicators for Students' Satisfaction in Residences Built from ISBU. In: Rotimi, J.O.B., Shahzad, W.M., Sutrisna, M., Ka-handawa, R. (eds) *Advances in Engineering Management, Innovation, and Sustainability. EPPM 2023. Lecture Notes in Civil Engineering*, vol 480. Springer, Cham. https://doi.org/10.1007/978-3-031-56544-1_49

Nardi, P. M. (2018*). Doing survey research: A guide to quantitative methods*. Routledge.

Pallant, J. (2005). *SPSS survival manual: A step-by-step guide to data analysis using SPSS for Windows (version 12).* Crow's Nest: Allen & Unwin.

Phelan, C., & Wren, J. (2007). *Exploring reliability in academic assessment*. Retrieved from https://chfasoa.uni.edu/reliabilityandvalidity.htm [Accessed 18 October 2024], 2007.

Prowle, M. J., & Araali, N. A. (2017). Meeting the escalating demands for health and social care services of elderly populations in developing countries: a strategic perspective. *American Journal of Medical Research*, *4*(2), 127-146. https://doi.org/10.22381/AJMR4220175

Rastegari, A., & Mobin, M. (2016). Maintenance decision making is supported by a computerised maintenance management system. In *2016 Annual Reliability and Maintainability Symposium (RAMS)* (pp. 1–8). IEEE. https://doi.org/10.1109/RAM.2016.7448041

Stazic, L., Racic, N., Stanivuk, T. & Dobrota, D. (2023). Determination of benefits of the application of CMMS database improvement proposals. *Applied Science*, *13*(4), 2731 https://doi.org/10.3390/app13042731

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's Alpha. *International Journal of Medical Education 2*, 53-55. https://doi.org/10.5116/ijme.4dfb.8dfd

Wienker, M., Henderson, K. & Volkerts, J. (2016). The computerized maintenance management system: An essential tool for world-class maintenance. *Procedia Engineering*, *138*, 413 – 420 https://doi.org/10.1016/j.proeng.2016.02.100

Yousefli, Z., Nasiri, F. & Moselhi, O. (2017). Healthcare facilities maintenance management: A literature review. *Journal of Facilities Management*, *15*(4), 352-375 http://dx.doi.org/10.1108/JFM-10-2016-0040