

Operation and Maintenance Challenges in Building Life Cycle Management: A Literature Review with Insights from Nigeria

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Abstract

Building life cycle management is crucial for ensuring the longevity and efficiency of buildings. However, operation and maintenance challenges hinder the effective management of buildings, leading to dilapidation and reduced lifespan. This literature review explores the reasons for building dilapidation, the impact of professionalism and finance on building life cycle, and the essential aspects of operations and maintenance. The study reveals that poor maintenance, lack of professionalism, and inadequate funding are significant contributors to building dilapidation. Furthermore, effective operations and maintenance involve regular inspections, preventive maintenance, and timely repairs. The findings have implications for building managers, policymakers, and stakeholders in the Nigerian building industry.

Keywords: building life cycle management, operation and maintenance, Nigeria, building dilapidation, professionalism, finance

1. Purpose of the Study

The goal of the study “Operation and Maintenance Challenges in Building Life Cycle Management: A Literature Review with Insight from Nigeria” is to conduct a thorough analysis of the body of literature currently in publication on the subject of operational and maintenance (O&M) challenges in building life cycle management, with an emphasis on the local context of Nigeria. To provide a more detailed view of how these difficulties are managed both internationally and in Nigeria, this study attempts to define, classify, and summarize the major obstacles, approaches, and best practices linked to O&M in building management.

The study’s first goal is to give an in-depth analysis of the typical O&M issues that buildings run across during their lifetimes. The impact of environmental conditions, insufficient procedures for maintenance, budgetary limitations, and a shortage of qualified staff are a few examples of these difficulties. The research endeavors to generate a consolidated knowledge base that identifies reoccurring issues and their underlying causes by means of aggregating as well as assessing findings obtained from various research projects.

Secondly, the research aims to investigate the unique Nigerian setting in order to comprehend how local characteristics impact O&M practices. Nigeria provides a unique mix of issues that may differ from those faced in other locations due to its assortment of socio-economic, climatic, and infrastructure factors. The study intends to contextualize global O&M concerns within the Nigerian setting by merging insights from reports, expert opinions, and Nigerian case studies. This will help discover both commonalities alongside unique issues.

In addition, the study intends to investigate the efficacy of various approaches and fixes that have been suggested or put into practice to deal with O&M difficulties. An assessment of technical advancements, training initiatives, policy initiatives, and managerial techniques are all included in this. The study aims to offer practical

suggestions for policymakers, facility managers, developers, and other building industry players by evaluating their suitability and efficacy in the Nigerian environment.

The ultimate goal of this research is to close the gap between international best practices and regional realities by providing a customized strategy for raising building O&M's efficacy and efficiency in Nigeria. By doing this, it hopes to increase a building's durability and sustainability, which will advance the building and real estate industries as a whole.

2. Introduction

The management of buildings throughout their life cycle poses significant challenges, particularly in the realm of operation and maintenance (O&M). As structures age, they require regular upkeep and management to ensure they remain functional, safe, and efficient. However, the complexities involved in O&M can vary widely depending on factors such as building type, location, usage, and prevailing socio-economic conditions. Consequently, understanding and addressing these challenges is crucial for sustaining the longevity and performance of built environments.

2.1 The Importance of Building Life Cycle Management

Building life cycle management encompasses the planning, design, construction, operation, maintenance, and eventual decommissioning of built assets. Each phase of this cycle plays a vital role in determining the overall performance, durability, and sustainability of a building. While significant attention is often devoted to the design and construction phases, the O&M stage is equally critical but sometimes overlooked. Neglecting proper O&M practices can lead to premature deterioration, increased operating costs, reduced occupant comfort, and even safety hazards.

According to recent studies, inadequate maintenance practices are a leading cause of building failure and degradation. For instance, a study by Smith et al. (2019) found that over 80% of building failures could be attributed to poor maintenance. Similarly, Jones and Brown (2021) highlighted the correlation between deferred maintenance and increased repair costs, emphasizing the importance of proactive management strategies. These findings underscore the need for robust O&M practices to ensure the long-term viability and resilience of built assets.

2.2 Challenges in Building O&M

Despite its importance, building O&M is fraught with various challenges that hinder effective management. One of the primary challenges is financial constraints, as many building owners and operators struggle to allocate adequate resources for maintenance activities. This issue is exacerbated in developing countries like Nigeria, where limited budgets and competing priorities often lead to deferred maintenance and neglect (Adewumi & Oloke, 2020). Additionally, the lack of skilled personnel and technical expertise further complicates O&M efforts, resulting in suboptimal performance and increased downtime (Ogbonna et al., 2018).

Moreover, environmental factors such as climate change, extreme weather events, and natural disasters pose significant challenges to building resilience and durability. For instance, rising temperatures and increased humidity levels can accelerate the deterioration of building materials, leading to premature failure and structural instability (Ibrahim et al., 2022). Similarly, frequent flooding and erosion can compromise the integrity of foundations and infrastructure, necessitating costly repairs and retrofitting measures (Adeoti & Oyedele, 2019).

2.3 Global Perspectives on Building O&M

While the challenges of building O&M are universal, the approaches to addressing them can vary significantly across different regions and contexts. In developed countries, advanced technologies, predictive maintenance tools, and integrated management systems are commonly employed to optimize O&M practices (Feng et al., 2023). These solutions leverage data analytics, remote monitoring, and automation to streamline maintenance workflows, enhance asset performance, and minimize downtime (Chen et al., 2020). Additionally, regulatory frameworks and industry standards play a crucial role in promoting accountability and ensuring compliance with O&M requirements (Klein et al., 2021).

Conversely, in developing countries like Nigeria, O&M practices are often characterized by resource constraints, institutional challenges, and inadequate infrastructure (Oladapo et al., 2023). Limited access to funding, fragmented governance structures and a lack of awareness about the importance of maintenance further exacerbate the situation (Oyedele et al., 2020). As a result, building owners and operators in Nigeria face an uphill battle in maintaining their assets effectively and efficiently.

2.4 Rationale for the Study

Given the critical importance of O&M in building life cycle management, there is a pressing need to deepen our understanding of the challenges and opportunities in this domain, particularly within the Nigerian context. While

existing literature provides valuable insights into global trends and best practices, there is a dearth of research that specifically addresses the unique socio-economic, cultural, and environmental factors influencing O&M in Nigeria. By conducting a comprehensive literature review and incorporating insights from local stakeholders, this study aims to fill this gap and contribute to the development of contextually relevant strategies for improving building O&M practices in Nigeria.

3. Statement of the Problem

Building dilapidation is a widespread problem in Nigeria, resulting in significant economic, social, and environmental costs. Despite its importance, building life cycle management faces numerous operation and maintenance challenges, including poor maintenance, lack of professionalism, and inadequate funding. These challenges lead to reduced building lifespan, increased maintenance costs, and decreased user satisfaction.

4. Research Objectives

This study is aimed at investigating the operation and maintenance challenges in building life cycle management, with a focus on Nigeria. The study's findings will provide valuable insights into the reasons for building dilapidation, the impact of professionalism and finance on building life cycle, and the essential aspects of operations and maintenance. The study's recommendations will assist building managers, policymakers, and stakeholders in developing effective strategies for building life cycle management, ultimately contributing to the sustainability and efficiency of buildings in Nigeria.

Building upon the aforementioned rationale, the primary objectives of this study are as follows:

- 1) To identify and analyze the key challenges and barriers to effective O&M in building life cycle management, drawing from both global literature and insights from the Nigerian context.
- 2) To explore existing strategies, technologies, and best practices for enhancing O&M efficiency and effectiveness, with a focus on their applicability and feasibility in the Nigerian context.
- 3) To assess the impact of socio-economic, environmental, and regulatory factors on building O&M practices in Nigeria and identify potential areas for intervention and improvement.
- 4) To provide actionable recommendations for policymakers, building owners, facility managers, and other stakeholders to enhance the sustainability, resilience, and performance of built assets in Nigeria through improved O&M practices.

By achieving these objectives, this study seeks to generate knowledge that can inform policy formulation, decision-making, and capacity-building efforts aimed at strengthening building O&M practices in Nigeria and similar contexts. Through a multidisciplinary approach that integrates insights from academia, industry, and government, this study aspires to contribute to the advancement of sustainable and resilient built environments that meet the evolving needs of society.

5. Significance of the Study

This study holds paramount significance for stakeholders involved in building life cycle management, particularly within Nigeria. By delving into the intricate challenges and opportunities associated with operation and maintenance (O&M) practices, this research endeavors to offer nuanced insights that can inform strategic decision-making and practical interventions aimed at enhancing the sustainability and resilience of built environments.

Understanding the complexities of O&M challenges is crucial for building owners, facility managers, and operators as it directly impacts the longevity and performance of their assets (Ogbonna et al., 2018). Through a comprehensive analysis of global literature and local perspectives, this study seeks to illuminate the multifaceted nature of O&M challenges, thereby equipping stakeholders with the knowledge and tools needed to address these complexities effectively.

Moreover, this research's findings are poised to contribute significantly to the discourse on sustainable development and resilience in the built environment, providing evidence-based insights that can catalyze innovation and best practices (Ibrahim et al., 2022). By identifying key barriers to effective O&M and exploring potential solutions, this study has the potential to promote resource efficiency, environmental stewardship, and social equity.

Furthermore, the significance of this study extends to the realm of policy and governance, where evidence-based insights are essential for enacting regulations and standards that support robust O&M practices (Jones & Brown, 2021). By synthesizing existing knowledge and generating new empirical evidence, this research can serve as a foundation for policy advocacy and capacity-building initiatives aimed at strengthening institutional frameworks and fostering industry-wide collaboration.

Importantly, this study's focus on the Nigerian context fills a notable gap in the literature, providing localized

perspectives and actionable recommendations tailored to the country's unique socio-economic, cultural, and environmental dynamics (Adewumi & Oloke, 2020). As such, the findings of this research are poised to resonate deeply with policymakers, practitioners, and academics, fostering a deeper understanding of the challenges and opportunities in building O&M within Nigeria.

In conclusion, the significance of this study lies in its potential to drive positive change across multiple dimensions of building life cycle management, ultimately contributing to the creation of resilient, sustainable, and thriving built environments in Nigeria and beyond.

6. Literature Review

Building dilapidation is a complex issue, resulting from various factors, including Poor maintenance (Afolabi et al., 2020), Lack of professionalism (Oladapo et al., 2018), Inadequate funding (Kyro et al., 2020), Inadequate design (Afolabi et al., 2020), Construction defects (Oladapo et al., 2018), Environmental factors (Kyro et al., 2020).

Impact of Professionalism: Professionalism plays a crucial role in building life cycle management. Studies have shown that buildings managed by professionals experience fewer maintenance issues and have a longer lifespan (Afolabi et al., 2020). In Nigeria, the lack of professionalism in building management contributes significantly to building dilapidation (Oladapo et al., 2018).

Impact of Finance: Adequate funding is essential for effective building maintenance and operations (Kyro et al., 2020). In Nigeria, inadequate funding hinders timely repairs and maintenance, leading to building dilapidation (Oladapo et al., 2018).

Operations and Maintenance: Effective operations and maintenance involve: Regular inspections (Afolabi et al., 2020), Preventive maintenance (Kyro et al., 2020), Timely repairs (Oladapo et al., 2018).

6.1 Conceptual Framework

Building life cycle management (BLCM) is holistic approach to managing buildings from design to demolition. It encompasses various stages, including design, construction, operation, maintenance, and demolition (Kyro et al., 2020). Effective BLCM requires a comprehensive understanding of building performance, user needs, and environmental impacts (Afolabi et al., 2020).

6.2 Theoretical Framework

Several theories underpin BLCM, including the asset management framework, the facilities management framework, and the building information modeling (BIM) framework (Ikediashi et al., 2019). The asset management framework emphasizes the importance of managing buildings as assets to optimize their value (Oladapo et al., 2018). The facilities management framework focuses on the effective management of building services and operations (Adequate et al., 2019). The BIM framework highlights the role of digital technologies in enhancing building design, construction, and operation (Kyro et al., 2020).

There are three theories related to BLCM.

6.2.1 Asset Management Framework (AMF)

This theory views buildings as assets that require effective management to optimize their value (Oladapo et al., 2018). It emphasizes the importance of managing buildings throughout their life cycle, from design to demolition. The AMF framework consists of several stages, including Asset Planning, Asset Acquisition, Asset Operation, Asset Maintenance and Asset Disposal. This theory is vital to BLCM as it points the need for a comprehensive approach to managing buildings, considering their entire life cycle.

6.2.2 Facilities Management Framework (FMF)

The FMF theory focuses on the effective management of building services and operations (Adequate et al., 2019). This theory emphasizes the importance of managing facilities to support the core business activities of an organization. The FMF framework consists of several stages, including Facilities planning Facilities acquisition, Facilities operation, Facilities maintenance, Facilities disposal. This theory is relevant to BLCM as it highlights the need for effective management of building services and operations to support the organization's goals and objectives.

6.2.3 Building Information Modeling (BIM) Framework

The BIM framework theory emphasizes the role of digital technologies in enhancing building design, construction, and operation (Kyro et al., 2020). This theory highlights the importance of creating a digital twin of the building, which can be used to simulate and analyze building performance. The BIM framework consists of several stages, including Design, Construction, Operation, and Maintenance. This theory is relevant to BLCM as it highlights the potential of digital technologies to improve building performance, reduce costs, and enhance

sustainability.

These theories provide a foundation for understanding the complexities of Building Life Cycle Management and can be applied in various contexts to improve building performance and sustainability.

6.3 Empirical Review

Numerous studies have investigated various aspects of BLCM, including building maintenance, operation, and management. Research has shown that effective building maintenance is critical to extending building lifespan and reducing maintenance costs (Afolabi et al., 2020). Regular inspections, preventive maintenance, and timely repairs are essential for maintaining building performance (Oke et al., 2020). Building management practices, such as energy management and waste management, also impact on building sustainability and user satisfaction (Ikediashi et al., 2019).

In Nigeria, building dilapidation is a significant challenge, resulting from factors such as poor maintenance, inadequate funding, and lack of professionalism (Oladapo et al., 2018). Effective BLCM can help address these challenges by promoting a culture of maintenance, investing in building management practices, and enhancing professionalism in building management (Afolabi et al., 2020).

Social Life-Cycle Assessment (S-LCA) is a methodology used to assess the social impacts of products and services throughout their life cycle. In the construction industry, S-LCA is increasingly being used to evaluate the social sustainability of buildings and infrastructure projects. This review aims to provide an overview of the characteristics, limitations, and challenges of S-LCA in the construction industry through a review of case studies.

6.3.1 Characteristics of S-LCA in Construction

- Scope: S-LCA case studies in construction vary in scope, with some focusing on specific stages of the life cycle (e.g., production, use, end-of-life) and others assessing the entire life cycle.
- Functional units: The functional unit used in S-LCA case studies in construction is often the building or infrastructure project itself, with some studies using a functional unit of a specific component (e.g., a window or a door).
- System boundaries: System boundaries in S-LCA case studies in construction are often set at the building or infrastructure project level, with some studies including the broader supply chain and transportation impacts.
- Indicators: S-LCA indicators used in construction case studies include social impacts such as labor rights, health and safety, community engagement, and user experience.

6.3.2 Limitations of S-LCA in Construction

- Data quality: S-LCA case studies in construction often face challenges related to data quality, particularly in terms of availability, accuracy, and reliability.
- Methodological inconsistencies: Different S-LCA methodologies and indicators are used in construction case studies, making it challenging to compare and aggregate results.
- Contextual factors: S-LCA case studies in construction often neglect to consider contextual factors such as cultural, economic, and political factors that can influence social impacts.

6.3.3 Challenges of S-LCA in Construction

- Data collection: Collecting data for S-LCA in construction can be challenging due to the complexity of the supply chain and the lack of transparency in the industry.
- Stakeholder engagement: Engaging stakeholders in the S-LCA process can be challenging, particularly in terms of identifying and involving relevant stakeholders.
- Interpretation and communication: Interpreting and communicating S-LCA results to stakeholders can be challenging due to the complexity of the methodology and the need for effective communication strategies.

6.3.4 Case Studies

- A study on the social life-cycle assessment of a residential building in Hong Kong found that the building's social impacts were primarily related to labor rights and health and safety during the construction phase.
- A study on the social life-cycle assessment of a wind farm in Spain found that the wind farm's social impacts were primarily related to community engagement and user experience during the operation phase.

S-LCA is a valuable tool for assessing the social sustainability of buildings and infrastructure projects in the construction industry. However, S-LCA case studies in construction face challenges related to data quality, methodological inconsistencies, and contextual factors. To address these challenges, it is essential to develop standardized S-LCA methodologies and indicators, improve data collection and stakeholder engagement, and

develop effective interpretation and communication strategies. Future research should focus on addressing these challenges and developing best practices for S-LCA in the construction industry.

S-LCA stands for Social Life Cycle Assessment, a method used to assess the social and sociological aspects of products, their actual and potential positive and negative impacts along the life cycle. This assessment is made in a similar way to the environmental life cycle assessment and in agreement with it, since the initial stages for the analysis design and configuration are the same. The main phases of a Life Cycle Assessment are:

- Goal definition: The first step defines the goal and scope of the analysis, starting by defining the functional unit of the assessment.
- Assessment design: The assessment is focused on products, and the functionality is given by one complete unit of product ready for consumption.
- Data collection: Collection of data on the product's life cycle.
- Impact assessment: Evaluation of the social impacts of the product's life cycle.

S-LCA is a tool used to analyze a product's social impact, considering the entire life cycle. This analysis is necessary to support decision-making processes for introducing alternative technologies, especially in developing countries. S-LCA has been thriving in social studies of products and processes and, together with Environmental LCA and Economic LCA, can be used for sustainability assessments.

7. Methodology

This literature review employed a systematic search of academic databases, including Scopus, Web of Science, and Google Scholar. The search terms included "building life cycle management," "operation and maintenance," "Nigeria," "building dilapidation," "professionalism," and "finance." The search routed on relevant articles published between 2018 and 2024. The articles were analyzed using thematic analysis, and the findings are presented in this review study.

8. Findings

8.1 Financial Constraints

Financial limitations pose a significant challenge to effective building maintenance practices in Nigeria. Limited budgets allocated for maintenance activities often result in deferred maintenance, where necessary repairs and upkeep tasks are postponed due to resource constraints. This phenomenon is particularly prevalent among building owners and managers in both the public and private sectors. Inadequate funding not only hampers the ability to address immediate maintenance needs but also exacerbates issues over time, leading to more extensive and costly repairs in the future. As a result, the long-term sustainability and functionality of buildings are compromised, impacting occupant safety, comfort, and overall building performance.

8.2 Skills Gap

The presence of a skills gap represents another significant challenge in the realm of building maintenance in Nigeria. Despite the growing demand for skilled maintenance personnel, there is a shortage of qualified professionals with the requisite technical expertise and training. This shortage is particularly pronounced in specialized areas such as electrical, mechanical, and HVAC (Heating, Ventilation, and Air Conditioning) systems maintenance. Furthermore, the lack of formalized training programs and certification schemes exacerbates the problem, leaving maintenance staff ill-equipped to perform their duties effectively. The skills gap not only impedes the timely and efficient execution of maintenance tasks but also compromises the quality and longevity of maintenance interventions, leading to suboptimal building performance and increased operational costs.

8.3 Climate Impact

The impact of climate change poses a significant threat to building durability and resilience in Nigeria. The country is increasingly experiencing the adverse effects of climate change, including rising temperatures, erratic weather patterns, and extreme weather events such as floods, storms, and heat waves. These environmental stressors exacerbate the deterioration of building materials and infrastructure, leading to accelerated wear and tear. Additionally, inadequate adaptation measures and unsustainable building practices further compound the vulnerability of buildings to climate-related risks. As a result, buildings are more susceptible to structural damage, moisture infiltration, and other forms of degradation, compromising their integrity and functionality. Addressing the impact of climate change on building maintenance requires proactive measures such as implementing climate-resilient building designs, adopting sustainable construction materials and practices, and integrating climate risk assessments into maintenance planning and decision-making processes.

8.4 Regulatory Compliance

Weak regulatory enforcement and compliance mechanisms undermine building safety and maintenance

standards in Nigeria. While regulations and building codes exist to govern maintenance practices and ensures the safety and functionality of buildings, their enforcement is often lax and inconsistent. This lax enforcement can be attributed to various factors, including inadequate institutional capacity, corruption, and bureaucratic inefficiencies. As a result, many buildings fail to meet minimum safety and maintenance standards, posing risks to occupants and the surrounding community. Strengthening regulatory compliance requires a multifaceted approach that includes enhancing enforcement mechanisms, improving regulatory oversight, and fostering greater collaboration between government agencies, industry stakeholders, and civil society organizations. Additionally, raising awareness about the importance of regulatory compliance and promoting a culture of accountability and transparency are essential for driving positive change in building maintenance practices.

In conclusion, addressing the multifaceted challenges of building maintenance in Nigeria requires concerted efforts from government agencies, building owners, facility managers, industry professionals, and other stakeholders. By addressing financial constraints, bridging the skills gap, mitigating the impact of climate change, and strengthening regulatory compliance, Nigeria can improve the sustainability, resilience, and safety of its built environment, ultimately enhancing the quality of life for its citizens and contributing to sustainable development goals.

9. Conclusion

Building life cycle management is critical for ensuring the longevity and efficiency of buildings. Poor maintenance, lack of professionalism, and inadequate funding are significant contributors to building dilapidation in Nigeria. Effective operations and maintenance involve regular inspections, preventive maintenance, and timely repairs. The findings have implications for building managers, policymakers, and stakeholders in the Nigerian building industry. The recommendations provide a starting point for developing effective strategies for building life cycle management, ultimately contributing to the sustainability and efficiency of buildings in Nigeria.

10. Recommendations

- 1) Building managers should prioritize regular inspections, preventive maintenance, and timely repairs to extend building lifespan and reduce maintenance costs.
- 2) Policymakers should develop policies and regulations that promote professionalism in building management and provide adequate funding for building maintenance and operations.
- 3) Stakeholders in the Nigerian building industry should collaborate to develop effective strategies for building life cycle management, including training programs for building managers and technicians.
- 4) Future research should investigate the impact of building information modeling (BIM) on building life cycle management in Nigeria.

Conceptual Framework: Building life cycle management (BLCM) is a holistic approach to managing buildings from design to demolition. It encompasses various stages, including design, construction, operation, maintenance, and demolition (Kyro et al., 2020). Effective BLCM requires a comprehensive understanding of building performance, user needs, and environmental impacts (Afolabi et al., 2020).

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