

A Predictive Model for Estimating the Service Life of Floor Finishes in Public Office Buildings in Nairobi: Implications for Maintenance Practice and Policy

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Abstract

Service life prediction, a key component of lifecycle-based asset management, remains underdeveloped and underutilized in Kenya's public building sector. The absence of empirical prediction tools has contributed to reactive maintenance leading to inefficient use of resources in public office buildings. The main aim of the study was to develop a predictive model for estimating the service life of floor finishes in public office buildings in Nairobi. The study examined the common types of floor finishes and their service lives, determining the factors influencing service life and examining relevant regulatory frameworks using a mixed-methods approach. Quantitative data was collected from 42 government-owned office buildings through a questionnaire to facility managers as well as observations on the floor conditions. Qualitative insights were obtained from officials at the State Department for Public Works, Kenya Bureau of Standards (KEBS), and the Kenya Association of Manufacturers (KAM). Multiple regression analysis was used to examine the influence of nine determinants on observed service life. The regression model was statistically significant ($F(9,32)=2.313$, $p=0.039$) and explained 39.4% of the variance in service life ($R^2=0.394$). Management practices ($\beta=-0.580$, $p=0.005$), design deficiency ($\beta=0.447$, $p=0.021$), accidents/force majeure ($\beta=0.356$, $p=0.041$), and poor workmanship ($\beta=0.383$, $p=0.043$) were statistically significant predictors. Management-related factors had the strongest influence, highlighting the role of institutional culture in material performance. The study recommended stronger implementation of the existing maintenance policies while standardizing maintenance practices across all public office buildings. The proposed model provides a practical decision-support tool for lifecycle-based procurement and predictive maintenance scheduling for efficient use of public resources.

Keywords: Floor Finishes, Lifecycle Costing, Maintenance Planning, Predictive Modelling, Public Buildings

1. Introduction

Public buildings, according to (Christiaens, 2022) are assets created to disperse government services, making it important to minimize maintenance costs to ensure efficient use of public resources. Despite this, their long-term performance in many developing countries is compromised by inadequate maintenance, poor materials selection, and the absence of evidence-based planning tools (Zeni & Kikwasi, 2023). Floors, one of the most heavily used elements in building interiors, are particularly vulnerable to deterioration due to continuous foot traffic, furniture movement, and environmental exposure.

International standards such as ISO 15686 provide structured approaches for service life planning. Despite this, applying them in Kenya has been limited due to differences in climatic conditions, procurement practices, and installation quality (Ferreira et al., 2021). Current policy instruments in Kenya including the National Building Code (2024) and Sessional Paper No. 2 of 2015, recognize the need for structured maintenance but lack practical tools for predicting service life or guiding material selection based on empirical performance. In the absence of the empirical

models, maintenance managers lack the capacity to forecast replacement cycles, prioritize resource allocation, or justify budgets using objective indicators (Plebankiewicz & Gracki, 2024). This gap results in haphazard maintenance, premature material replacement and inefficient utilization of resources. Existing literature on service life prediction predominantly focuses on building envelopes and structural systems, with limited empirical modelling of interior finishes and especially floor finishes. In addition, most models put emphasis on physical deterioration without taking into consideration the influence of managerial and institutional culture on the service life of finishes.

In response to the identified gaps in service life prediction and maintenance planning for floor finishes in Kenyan public buildings, this study was undertaken to support more evidence-based decision-making in the management of public assets. Through integration of service life prediction with lifecycle costing principles, the study seeks to contribute to more efficient use of public funds, improved building performance, and safer indoor environments for users. The study findings contribute to existing knowledge by bridging the gap between service life planning, maintenance

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management, and lifecycle costing in the context of developing countries. This study is expected to be beneficial to facility and maintenance practitioners, built environment professionals and policy makers by providing practical tools that can aid life-cycle based procurement decisions and maintenance planning.

2. Literature Review

2.1. Performance Requirements for Floor Finishes Relating to Service Life

The service life performance of floor finishes can be defined as the time during which a floor finish fulfills its intended functional, aesthetic and safety requirements without the need for a major repair or replacement (Silva, et al., 2022). Floor finishes play an important role in enhancing the comfort of users, the protection of the substrates and enhancing the overall building functionality. The performance of floor finishes is influenced by several factors including characteristics of materials, quality of installation, maintenance practices and usage patterns as discussed in the subsequent paragraphs. For this study, the service life performance of floor finishes was the dependent variable while the factors influencing service life performance including design quality, quality of workmanship, maintenance practices, management practices and accidental factors were the independent variables.

According to (Harris and Fitzgerald, 2017) the selection of floor finishes is primarily driven by durability, safety, resistance to wear, and ease of maintenance. However, for finishes to achieve their intended design life, they must be applied to sound, dry substrates. Poor installation or moisture control drastically shortens their longevity (Folorunso, 2021). Environmental factors including high humidity, temperature changes and use of harsh chemicals have also been shown to reduce the service life performance of floor finishes (Folorunso, 2021). Similarly, the intensity of usage is also another factor that heavily affects the performance of floor finishes. Heavy foot traffic, rolling chairs, carts and equipment all abrade the surface. High-traffic areas such as lobbies and corridors see constant abrasion impacting the performance (Dixit et al., 2019). Heavily used spaces are also more prone to accumulated dirt, sand, and grit which cause abrasion and accelerate wear and tear, shortening the service life.

In addition to physical factors, management and maintenance decisions also play a role in service life performance. Management decisions influence maintenance practices, repair routines and lifecycle planning all of which can extend or minimize the service life (West et al., 2024). Therefore, the service life performance of floor finishes should be viewed as a function of technical design quality, workmanship,

usage conditions, environmental exposure, and institutional management practices.

2.2. The case for Service Life Prediction and the Degradation Theory

Service life prediction is dependent on a systematic approach for estimating the period within which building materials and components can satisfactorily meet their performance requirements. De Brito and Silva, (2020) assert that service life prediction is generally addressed by the determination of mechanical and chemical loads (such as in laboratory tests in-service) where the building materials are most likely to be subjected; features of the materials and components; computerized knowledge of the materials and their components; articulating performance requirements and criteria for evaluating the materials' performance; and figuring out the mechanism of degradation of the materials and systems. Such predictive approaches support proactive maintenance planning and informed decision-making regarding repair and replacement interventions.

The degradation theory provides the foundation for this study, positing that material deterioration is driven by the interaction between an object's internal energy and its external environment (Varlamov et al., 2018). In the case of floor finishes, factors such as moisture exposure, temperature fluctuations, mechanical abrasion, and use of harsh chemicals contribute to the deterioration process and ultimately affect service life performance. While critics such as (Lacasse et al., 2020) argue that degradation models can be overly theoretical, empirical evidence by (Shao et al., 2013; Varlamov et al., 2018) shows that targeted maintenance can substantially mitigate these effects and extend service life. This theory provides a framework for examining how design quality, workmanship, environmental conditions, usage intensity, and institutional management practices influence the service life performance of floor finishes. It further supports the argument that effective maintenance and management interventions can modify deterioration rates and improve long-term performance.

3. Research Methodology

The study used a mixed methods approach that combined quantitative performance data with qualitative insights from facility managers and maintenance personnel. This approach allowed for an in-depth analysis of statistical evidence with institutional factors that influence service life. The study covered public office buildings in Nairobi City County. Census sampling was preferred in this study since due to the relatively small overall number of buildings made it feasible to conduct a full census. A preliminary audit identified 77 government-owned buildings with the final sample size reducing to 49

buildings after excluding demolished structures, small buildings (with a plinth area of less than 4000 sq. ft.), and inaccessible sites. Data was received from 42 buildings, indicating an 86% response rate, using structured questionnaires, observation checklists and key informant interviews with representatives from The State Department for Public Works, The Kenya Bureau of Standards (KEBS) and the Kenya Association of Manufacturers (KAM). The variables captured reflected the conceptual framework of service life performance, including Design deficiency, Quality of workmanship, Type and Frequency of maintenance, Management Practices, Accidental/force majeure impacts and the Observed service life in years. The qualitative component was primarily used to support the interpretation and validation of quantitative findings. The detailed interview and observation results are not presented separately in this paper but are reflected in the discussion of the quantitative findings.

For data analysis, descriptive and inferential statistics including frequencies, correlation analysis, ANOVA and Multiple Regression Analysis were used to quantify the influence of these independent variables on the observed service life of floor finishes. Multiple Regression Analysis was selected as the primary technique because it allowed for the simultaneous examination of multiple factors. It also offered a practical, interpretable tool for asset managers, while alternative probabilistic models were deemed unsuitable due to local data constraints.

4. Findings and Discussion

4.1. Model Summary

The model summary was used to assess the overall fit of the regression model and to evaluate how well the set of nine predictors namely; normal wear and tear, vandalism, design deficiency, negligence/misuse, accidents/force majeure, infestations, management issues, poor workmanship, and client preference, which collectively explains variations in the service life of floor finishes (SLFF). This analysis provided key indicators of the strength of the relationship between the predictors and the dependent variable, as well as the proportion of variance in SLFF accounted for by the model (Table 1).

The regression model produced an R value of 0.628, indicating a moderate relationship between the combined predictors and the service life of floor finishes (SLFF). The coefficient of determination ($R^2 = 0.394$) revealed that approximately 39.4% of the variance in SLFF was accounted for by the nine independent variables included in the model.

Although the level of explanatory power indicated that additional unobserved factors may influence service life outcomes, it is consistent with studies examining institutional and behavioural determinants of building performance. The adjusted R^2 value of 0.224 accounted for the number of predictors. The statistically significant F-change ($p = 0.039$) confirmed that the model contributed meaningfully to explaining variation in SLFF. These results justified further examination of the individual regression coefficients (Table 2) to

Table 1: Model Summary for Regression Predicting Service Life of Floor Finishes (SLFF)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.628 ^a	.394	.224	.136	.394	2.313	9	32	.039

a. Predictors: (Constant), Normal wear and tear, Vandalism, Design deficiency, Negligence/misuse, Accidents/force majeure, Infestations, Management issues, Poor workmanship, Client preference

Source: (Field study, 2025)

Table 2: Regression Co-efficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
		B	Std. Error	Beta			Zero-order	Partial	Part
1	(Constant)	-.161	.068		-2.354	.025			
	Normal wear and tear	.127	.065	.356	1.947	.060	.087	.325	.268
	Vandalism	.094	.085	.199	1.101	.279	-.057	.191	.151
	Design deficiency	.195	.080	.447	2.428	.021	.383	.394	.334
	Negligence/misuse	.045	.049	.145	.920	.365	.189	.160	.127
	Accidents/force majeure	.120	.056	.356	2.135	.041	.247	.353	.294
	Infestations	-.009	.107	-.012	-.083	.934	-.035	-.015	-.011
	Management issues	-.237	.079	-.580	-3.014	.005	-.070	-.470	-.415
	Poor workmanship	.118	.056	.383	2.106	.043	.180	.349	.290
	Client preference	-.036	.059	-.115	-.607	.548	.189	-.107	-.084

a. Dependent Variable: Service Life of Floor Finishes (SLFF)

Source: (Field study, 2025)

identify which predictors have the strongest influence on SLFF.

4.2. Regression Co-efficients

The multiple regression analysis identified four statistically significant predictors of SLFF: management issues ($\beta = -0.580$, $p = 0.005$), design deficiency ($\beta = 0.447$, $p = 0.021$), accidents/force majeure ($\beta = 0.356$, $p = 0.041$), and poor workmanship ($\beta = 0.383$, $p = 0.043$). Management issues had the strongest standardized effect and the only negative coefficient. This indicates that decision making in regards to maintenance planning can contribute to a shorter service life of finishes. This finding thus suggests that institutional practices also have a great influence on service life and durability of materials.

Design deficiency and poor workmanship both had a positive and statistically significant relationship to the service life of floor finishes. This highlights the importance of technical quality both during the design and construction phases. Accidents and force majeure events also had a significant contribution, indicating the important role of risk preparedness and mitigation strategies in extending service life. Statistically non-significant variables included vandalism, infestations, negligence/misuse and client preference. This suggested that their influence may be indirect or context-dependent when controlling for other factors. Thus, the model demonstrated that the deterioration of floor finishes in Nairobi's public buildings is driven more by institutional behavior and management culture than by material properties alone

4.3. Discussion

The regression model established that the selected determinants collectively explained 39.4% of the variation in the service life of floor finishes in public office buildings in Nairobi. This indicated that service life performance is influenced by a combination of technical, operational and institutional factors and not just by material characteristics alone. The finding supports the service life prediction approach advanced by ISO 15686, which recognizes that the performance of building components is influenced by design conditions, workmanship, use conditions, maintenance practices and management decisions.

Management issues had the strongest influence on service life. The negative relationship suggests that ineffective maintenance planning, delayed interventions and weak asset management practices contribute to reduced service life of floor finishes. This finding agrees with Plebankiewicz and Gracki (2024), who emphasized that inadequate maintenance strategies contribute to accelerated deterioration and increased lifecycle costs of buildings. Similarly, Ferreira *et al.* (2021) found that inappropriate maintenance actions or delayed maintenance

interventions increase degradation rates of building components.

Design deficiency was also a significant predictor of service life. This highlights the importance of appropriate design decisions in determining long-term performance of floor finishes. The finding supports Harris and Fitzgerald (2017), who noted that flooring selection should consider durability, anticipated traffic levels, maintenance requirements and lifecycle costs rather than initial cost considerations alone. Similarly, Dixit *et al.* (2019) established that inappropriate floor finish selection for particular usage conditions contributes to premature failure.

Another significant predictor was poor workmanship. This confirmed the importance of installation quality in achieving the expected performance of floor finishes. The finding is consistent with Folorunso (2021), who demonstrated that poor installation practices reduce the effectiveness and durability of floor finishes. Observation assessments in this study identified workmanship-related defects such as uneven installation, poor finishing details and premature deterioration in some buildings, further supporting the regression results.

Accidents and force majeure factors were also significant predictors. Although these events are not always predictable, their influence indicates the importance of risk preparedness and resilience considerations in maintenance planning. This aligns with the degradation theory perspective, which explains that deterioration occurs through interaction between materials and external stressors (Varlamov *et al.*, 2018). The finding suggests that effective inspection and timely corrective actions following unexpected events can reduce long-term damage and enhance the performance of floor finishes.

5. Conclusion, Recommendation and Further Research

This study revealed that service life prediction for floor finishes can be locally modelled using empirical data on the performance of floor finishes. The study also discovered that organizational practices and managerial decision making play a huge role in the service life performance of floor finishes, alongside technical processes and material properties. The study established that facility managers in public buildings lack structured tools for estimating replacement timelines and rely heavily on experience or reactive decision-making. The model addresses this gap by offering an evidence-based basis for predicting the service life performance of floor finishes.

The findings of this study have several implications for maintenance management, construction practice and policy recommendations. For maintenance

management, the strong influence of management issues indicates the need for a shift from reactive maintenance towards preventive and predictive maintenance approaches. Facility managers can use service life prediction models to prioritize inspections, estimate replacement cycles and allocate resources more effectively. For construction practice, the findings emphasize the need for improved design coordination, material selection and workmanship standards. Public procurement processes should consider lifecycle performance rather than only initial acquisition costs.

At a policy level, the study contributes empirical evidence that can inform the implementation of Kenya's maintenance and building regulatory frameworks. While existing policies recognize the importance of systematic maintenance, they do not provide tools for estimating component service life or prioritizing interventions. The study demonstrates that service life modelling is both feasible and relevant within the Kenyan context. Integrating such models into public asset management systems would enhance planning accuracy, budget predictability, and long-term building performance.

In conclusion, this research has proven that service life prediction is not merely a technical exercise but it is also a policy and management tool. By developing a local service life prediction model, the study reinforces the need for locally sensitive approaches to building

maintenance especially in the public sector. The study and the model provides a foundation for future work on predictive maintenance, digital asset management, and lifecycle-informed procurement, that can be extended to other building components and public infrastructure systems.

6. Contribution to knowledge

This study provides empirical evidence on the actual service life performance of floor finishes in public buildings. The study will thus serve as a basis for other researchers seeking to study service life performance of not only floor finishes, but others as well in the Kenyan context. The study also provides valuable information to policy makers and built environment professionals that can support data driven material choice and maintenance planning decision making for a more efficient and sustainable built environment. Future studies can conduct a longitudinal study to observe the service life performance of floor finishes, over time and under controlled monitoring. This study was cross sectional in nature and a longitudinal study would make it possible to study and track service life performance over different lifecycle stages. This would strengthen service life prediction models and better inform decision making.

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