

AGING MUNICIPAL INFRASTRUCTURE IN SOUTH AFRICA: A CRITICAL REVIEW OF MANAGEMENT STRATEGIES, SYSTEMIC CHALLENGES, AND FUTURE DIRECTIONS

T.L NKOSI¹ and S.H.P. CHIKAFALIMANI²

^{1,2}Construction Management & Quantity Surveying, Durban University of Technology, Durban, RSA.
Email: ¹thalenten@dut.ac.za, ²SamuelC@dut.ac.za

Abstract

The sustainability and reliability of municipal infrastructure are critical for socioeconomic development and quality of life. In South Africa, much of the municipal infrastructure spanning water supply, sanitation, roads, and public facilities is aging, with many systems operating beyond their intended lifespan. This critical review synthesizes current research and policy literature to evaluate existing management strategies, identify systemic challenges, and propose future directions for addressing the issue. The review employs a structured analysis of peer-reviewed articles, government reports, and policy documents, focusing on both historical context and contemporary practices. Key findings reveal a persistent gap between infrastructure maintenance needs and available resources, exacerbated by fiscal constraints, governance shortcomings, and limited technical capacity within local municipalities. While asset management frameworks and preventive maintenance are recognized as essential, their implementation remains inconsistent. Challenges such as fragmented institutional responsibilities, inadequate funding models, and insufficient stakeholder engagement further undermine infrastructure sustainability. Case studies highlight both successful interventions and enduring barriers. Drawing on international best practices, the review outlines innovative solutions, including integrated asset management systems, capacity-building initiatives, and policy reforms aimed at enhancing coordination and accountability. The paper concludes by emphasizing the necessity of holistic, multi-level strategies that integrate technical, financial, and social dimensions. Addressing aging municipal infrastructure in South Africa will require not only increased investment but also systemic reforms and strengthened collaboration among government, communities, and the private sector. The findings provide actionable insights for policymakers, practitioners, and researchers seeking to ensure resilient and sustainable urban infrastructure.

Keywords: Aging Infrastructure; Asset Management; Infrastructure Sustainability; Governance Challenges; Maintenance Strategies; Urban Development Municipal Management; South Africa.

1. INTRODUCTION

Municipal infrastructure forms the backbone of urban and peri-urban communities, directly influencing public health, economic productivity, and social equity (Nel & Denoon-Stevens, 2015). In South Africa, much of this infrastructure encompassing water supply, sanitation, roads, and community facilities was constructed during the late 20th century, often under conditions of rapid urbanization and unequal resource allocation (Van Niekerk et al., 2020). Decades of underinvestment, deferred maintenance, and systemic management challenges have led to accelerated aging and deterioration of critical assets (Amponsah-Dacosta et al., 2015). The implications are severe: frequent service disruptions, escalating repair costs, and growing risks to human and environmental health (Sithole & Mathonsi, 2015). Persistent gaps in technical capacity, financial resources, and institutional accountability further complicate the management of aging infrastructure (Van der Walddt, 2014). Many South African

municipalities struggle to implement proactive asset management strategies, resulting in a reactive approach dominated by crisis repairs rather than preventive maintenance (Van Niekerk et al., 2020). Moreover, governance issues such as fragmented responsibilities between government spheres and insufficient stakeholder engagement undermine the effectiveness of policy and investment interventions (Nel & Denoon-Stevens, 2015). This critical review synthesizes current research and policy perspectives to evaluate management strategies, identify systemic barriers, and propose future directions for safeguarding municipal infrastructure in South Africa. By contextualizing local challenges within broader international trends, the article seeks to inform integrated, sustainable approaches that prioritize resilience, fiscal prudence, and inclusive urban development.

2. LITERATURE REVIEW

2.1 Management of Ageing Municipal Infrastructure in South Africa

Municipal infrastructure management in South Africa is shaped by the interrelated pressures of ageing assets, historical service-delivery backlogs, weak maintenance regimes, fiscal stress, technical-capacity deficits and governance shortcomings. The peer-reviewed literature broadly agrees that infrastructure failure is not simply an engineering problem: it reflects weaknesses across the full asset-management lifecycle, from planning and investment prioritisation to operation, maintenance, monitoring and renewal.

2.2 Ageing Infrastructure and Service Delivery

Municipal infrastructure including water and sanitation systems, roads, stormwater networks, electricity distribution assets and public facilities is essential to local economic activity, public health and equitable urban development. However, researchers emphasise that infrastructure delivers value only when it is properly operated, maintained and renewed. Wall (2024) observes that the operational and maintenance condition of public infrastructure is a decisive determinant of its capacity to provide services, yet a substantial share of South Africa's public fixed infrastructure is not maintained in good condition. This highlights the importance of shifting municipal attention from asset creation alone to the sustained management of existing infrastructure assets across their lifecycle. The consequences of neglect are multidimensional. In a review of the right to functioning urban infrastructure, Wall (2021) argues that inadequate maintenance contributes directly to infrastructure failure, disrupts the daily lives of residents, constrains economic activity and can undermine citizens' access to constitutionally significant services. The study frames functioning infrastructure not merely as a technical output, but as a condition for the practical enjoyment of basic rights and sustainable local development.

The ageing of municipal assets is compounded by the legacy of apartheid-era spatial inequality and uneven infrastructure provision. Municipalities must simultaneously address historical backlogs in under-served communities and renew infrastructure that has reached, or exceeded, its useful life. This dual obligation creates a persistent tension between extending access through new capital projects and protecting the value and reliability of existing infrastructure through maintenance and rehabilitation. Bester (2024) notes that post-apartheid local-

government reform required municipalities to address inherited infrastructure and service deficits while building administrative capability, financial systems and participatory governance arrangements.

2.3 Maintenance and Asset-Management Shortcomings

A central finding in the literature is that municipalities often operate reactively. Rather than using condition information, risk analysis and lifecycle planning to schedule preventive interventions, many respond only after failure has occurred. This approach tends to increase long-term costs, reduce reliability and expose communities to avoidable interruptions in water, sanitation, electricity, roads and refuse services. Patience and Nel's (2021) mixed-method study of the City of Ekurhuleni illustrate this problem. Although the municipality performed comparatively well on selected service-delivery measures, the study found continuing infrastructure-management weaknesses that constrained sustainable service provision. The authors recommend that municipalities strengthen managerial capability, avoid prioritising new infrastructure at the expense of maintaining existing assets, and adopt an integrated approach to infrastructure programming.

The Literature Identifies Several Practical Deficiencies In Municipal Asset Management:

- Incomplete or unreliable asset information, including weak asset registers, inadequate condition assessments and limited maintenance histories.
- Insufficient use of lifecycle costing when deciding whether to maintain, rehabilitate, replace or expand infrastructure.
- Weak links between infrastructure plans, municipal budgets, service-delivery priorities and performance-management systems.
- Inadequate monitoring of asset condition, service reliability and the impact of maintenance interventions.
- A bias toward visible capital projects rather than routine maintenance and timely renewal.

Wall (2024) similarly identifies recurring causes of poor infrastructure condition: skills shortages, budget constraints, weak institutional systems, and poor data and governance weaknesses. Importantly, the study argues that these apparent causes are themselves shaped by deeper issues of leadership, institutional capacity, socioeconomic context and organisational culture. Thus, technical asset-management tools alone are unlikely to succeed unless municipalities also address the institutional conditions that determine whether such tools are implemented consistently.

2.4 Financial, Institutional and Governance Barriers

Financial constraints are widely cited as a major obstacle to infrastructure renewal and maintenance. Municipalities facing weak revenue collection, consumer debt, constrained operating budgets and financial mismanagement may defer maintenance to fund immediate operational demands. Yet deferred maintenance produces a cycle of deterioration: minor defects become major failures, emergency repairs displace planned work, and future

rehabilitation or replacement costs increase. Bester (2024) found that poor financial management, inadequate funding, leadership deficiencies, corruption and weak community engagement were all identified by municipal managers as contributors to service-delivery challenges. The study further reports that infrastructure management should be assessed alongside governance, financial management, service delivery and stakeholder communication rather than treated as a separate technical function. Governance is equally significant. Political-administrative instability, unclear accountability, procurement irregularities, limited oversight and political interference can weaken technical decision-making and undermine the continuity required for long-term asset management. Bester (2024) notes that municipal dysfunction is associated with inadequate governance, deficient resource management and poor service delivery, while the blurring of political and administrative roles may compromise professional management and accountability.

The literature also shows that public participation is not peripheral to infrastructure management. Communities experience infrastructure failures directly and possess locally relevant knowledge about service reliability, access constraints and priority needs. However, Bester (2024) found that many municipalities lacked robust processes for monitoring service-delivery performance, evaluating service impacts or incorporating community perspectives into evaluation systems. In the study sample, 80.6% of respondents reported service-delivery backlogs, while 75% indicated that service-delivery performance was not adequately monitored and evaluated.

2.5 Towards Proactive and Integrated Management

The reviewed literature suggests that a sustainable response to municipal infrastructure deterioration requires a transition from fragmented and reactive maintenance to integrated, risk-based asset management. Such an approach should combine technical, financial, institutional and participatory dimensions.

Key Strategies Emerging From The Literature Include:

- Developing credible, regularly updated infrastructure asset registers that record location, condition, age, criticality, and maintenance history and replacement value.
- Undertaking periodic condition assessments and using them to prioritise maintenance, rehabilitation and replacement according to service risk and social impact.
- Ring-fencing adequate maintenance and renewal budgets rather than relying predominantly on emergency repairs.
- Applying lifecycle costing so that infrastructure decisions consider whole-of-life operating, maintenance, rehabilitation and replacement costs.
- Integrating asset-management plans with Integrated Development Plans, service-delivery and budget implementation plans, procurement programmes and long-term financial strategies.

- Strengthening the capacity of engineers, technicians, planners, finance personnel and senior managers responsible for infrastructure governance.
- Establishing performance indicators that measure asset condition, service interruptions, response times, maintenance backlog, non-revenue losses and customer experience.
- Creating meaningful community-feedback mechanisms to improve priority setting, accountability and responsiveness.

Patience and Nel (2021) particularly stress the need for an integrated municipal infrastructure programme and greater managerial competence in maintaining infrastructure assets. Bester (2024) likewise supports a comprehensive municipal-performance framework that connects governance, finance, infrastructure planning, maintenance, service outcomes and community engagement. eprints.lib.uts.edu.au/1

2.6 Synthesis and Research Gap

The literature demonstrates that ageing municipal infrastructure in South Africa is the outcome of cumulative maintenance backlogs, uneven historical development, limited financial resources, and shortages of technical expertise, weak data systems and governance failures. While asset-management principles are well established, implementation remains uneven, especially in municipalities with limited institutional capacity. A useful research gap therefore concerns how municipalities can operationalise integrated asset-management systems under resource-constrained conditions. Future research could examine which combinations of condition-based maintenance, digital asset records, lifecycle budgeting, technical-capacity development and participatory monitoring are most feasible and effective across metropolitan, secondary-city, rural and financially distressed municipalities. Such work would move beyond diagnosing infrastructure decline toward identifying context-sensitive mechanisms for improving infrastructure resilience, service reliability and local developmental outcomes.

3. METHODOLOGY

This study employed a critical narrative literature review to examine the management of ageing municipal infrastructure in South Africa. The review synthesised peer-reviewed journal literature on municipal asset management, infrastructure maintenance, service delivery, governance, financial capacity and technical skills shortages. Relevant literature was identified through searches of Google Scholar, Scopus, Web of Science, Sabinet and African Journals Online (AJOL). Search terms included “municipal infrastructure management”, “ageing infrastructure”, “municipal asset management”, “infrastructure maintenance”, “service delivery”, “local government”, and “South Africa”. Only English-language peer-reviewed journal articles with direct relevance to South African municipal infrastructure and local-government management were considered. The selected studies were analysed thematically. Findings were grouped into recurring themes relating to infrastructure deterioration, maintenance backlogs, lifecycle asset management, municipal finance, institutional and technical capacity, governance, accountability and community participation. The review adopted a critical approach by comparing areas of agreement and divergence across the

literature, identifying persistent knowledge gaps, and drawing implications for policy and municipal practice.

4. FINDINGS AND DISCUSSION

The literature identifies asset-management weaknesses, financial constraints, institutional limitations and inadequate stakeholder engagement as interconnected causes of municipal infrastructure deterioration in South Africa. Rather than operating as separate challenges, these factors reinforce one another: weak infrastructure information constrains financial planning; financial stress encourages deferred maintenance; inadequate technical capacity weakens implementation; and limited accountability reduces the responsiveness of municipal systems to service-delivery failures (Patience & Nel, 2021; Rulashe & Ijeoma, 2022).

4.1 Asset Management and Lifecycle-Based Strategies

Asset management is central to sustaining municipal infrastructure because it supports decisions across the lifecycle of an asset, including planning, acquisition, operation, routine maintenance, rehabilitation, renewal and replacement.

Lifecycle-based management requires municipalities to maintain reliable asset information, undertake periodic condition assessments, and determine asset criticality, plan maintenance interventions and budget for future rehabilitation or replacement needs.

Kaiser and Smallwood (2014) argue that systems thinking can improve infrastructure-budget allocation by enabling municipalities to understand the interrelationships among infrastructure assets, operational requirements, available resources and service-delivery outcomes. The literature suggests that many municipalities continue to adopt reactive rather than preventive approaches to maintenance.

In this model, municipalities respond to asset failures after breakdowns or service interruptions occur, rather than undertaking planned maintenance to reduce the probability of failure. Such practices can shorten the useful life of municipal assets, increase emergency-repair costs and weaken the reliability of basic services. Patience and Nel (2021) found that the quality of infrastructure management in the City of Ekurhuleni influenced the municipality's ability to provide sustainable services and support social and economic development.

A lifecycle approach requires municipal decision-makers to distinguish clearly between maintenance, rehabilitation and replacement. Routine and preventive maintenance can preserve an asset's functionality and delay deterioration, while rehabilitation may restore an asset that has materially declined. Replacement is required when an asset can no longer be restored cost-effectively or safely. The effectiveness of these decisions depends on accurate asset registers, condition data, maintenance histories and integrated planning systems.

Where infrastructure information is unreliable or disconnected from budgets, municipalities are less able to prioritise interventions according to infrastructure risk and expected service-delivery impact (Kaiser & Smallwood, 2014). The literature therefore supports risk-based prioritisation of maintenance and renewal. Municipalities should assign priority to assets whose

failure poses the greatest risk to public health, environmental safety, economic activity and continuity of water, sanitation, electricity and transport services.

However, asset-management systems must be incorporated into municipal strategy, budgeting and performance management; asset registers alone cannot prevent deterioration if municipalities do not allocate resources and technical capacity to implement maintenance plans (Patience & Nel, 2021; Kaiser & Smallwood, 2014). Table 1 presents a thematic synthesis of the peer-reviewed literature reviewed in this study. It summarises the main infrastructure-management themes, the challenges identified, their service-delivery implications and the strategic responses proposed in the literature.

Table 1: Thematic Synthesis of Ageing Municipal Infrastructure Management in South Africa

Theme	Key challenge identified	Effect on municipal infrastructure and service delivery	Recommended strategic response	Supporting peer-reviewed sources
Asset management and lifecycle strategies	Reactive maintenance, incomplete asset information, limited condition assessments and poor maintenance planning	Accelerated asset deterioration, frequent infrastructure failures, increased emergency-repair costs and unreliable services	Develop updated asset registers, conduct routine condition assessments, apply risk-based maintenance and use lifecycle costing	Kaiser & Smallwood (2014); Patience & Nel (2021)
Financial constraints and infrastructure investment	Inadequate maintenance budgets, weak revenue collection, deferred renewal expenditure and prioritisation of new capital projects	Growing maintenance backlogs, costly emergency interventions and inability to sustain infrastructure assets	Protect maintenance budgets, integrate maintenance with capital planning and assess operating and lifecycle costs before approving new projects	Kaiser & Smallwood (2014); Patience & Nel (2021)
Institutional capacity, governance and accountability	Shortages of technical personnel, fragmented responsibilities, procurement delays and weak performance monitoring	Poor planning, delayed repairs, ineffective contractor management and reduced accountability for infrastructure outcomes	Strengthen technical and managerial capacity, improve interdepartmental coordination and establish transparent performance reporting	Patience & Nel (2021); Rulashe & Ijeoma (2022)
Stakeholder participation and service-delivery outcomes	Limited meaningful public participation, weak communication and inadequate municipal feedback systems	Poor identification of local priorities, reduced public trust and slow reporting of infrastructure failures	Establish accessible reporting channels, involve communities in priority setting and provide feedback on municipal responses	Rulashe & Ijeoma (2022); Matlala (2024)

Source: Author's compilation from the reviewed literature.

4.2 Stakeholder Participation and Service-Delivery Outcomes

Stakeholder participation is important because municipal infrastructure directly affects residents, businesses, civil-society organisations, ward committees, contractors and other government institutions. Meaningful engagement can assist municipalities to identify service-delivery priorities, understand local infrastructure conditions, communicate maintenance programmes and monitor whether interventions improve service reliability. Rulashe and Ijeoma (2022) argue that accountability and service delivery are strengthened when municipalities are responsive to community needs. This suggests that participation should extend beyond formal consultation processes and enable residents to report failures, receive feedback and influence infrastructure priorities. Figure 1 illustrates the interrelationship between infrastructure-management practices, financial and institutional conditions, stakeholder participation, and municipal service-delivery outcomes.



Figure 1: Conceptual Framework for Sustainable Management of Ageing Municipal Infrastructure

Source: Author's compilation based on Kaiser and Smallwood (2014), Patience and Nel (2021), Rulashe and Ijeoma (2022), and Matlala (2024)

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This critical narrative review examined the management of ageing municipal infrastructure in South Africa, focusing on asset management, lifecycle planning, financial capacity, institutional governance, accountability and stakeholder participation.

The review demonstrates that the deterioration of municipal infrastructure cannot be attributed to the age of physical assets alone. Rather, it reflects the cumulative effects of deferred maintenance, reactive management practices, inadequate financial planning, technical-capacity shortages, fragmented institutional systems and weak accountability.

The literature indicates that many municipalities continue to prioritise failure-driven repairs over preventive maintenance, rehabilitation and planned renewal. While emergency interventions may restore services in the short term, they are often more costly and less sustainable than planned maintenance.

A lifecycle-based asset-management approach is therefore necessary to enable municipalities to monitor infrastructure condition, prioritise critical assets, plan maintenance and renewal activities, and allocate resources more efficiently over the useful life of infrastructure assets.

Financial constraints remain a major barrier to effective municipal infrastructure management. However, the challenge is not limited to the availability of funds; it also concerns how municipalities plan, allocate, spend and monitor infrastructure resources.

Capital investments in new infrastructure should be accompanied by realistic provision for future operation, maintenance, rehabilitation and replacement. Without this, municipalities may increase their infrastructure stock without developing the financial and technical capacity required to sustain it over time (Kaiser & Smallwood, 2014).

The review further shows that governance and institutional capacity are central to sustainable infrastructure outcomes. Municipalities require competent engineers, technicians, planners, financial officials and contract-management personnel, supported by accurate asset information, coordinated planning systems and transparent procurement processes. Accountability mechanisms are equally necessary to ensure that infrastructure budgets are used effectively, maintenance programmes are implemented, and service-delivery failures are addressed in a timely manner.

Stakeholder participation also contributes to improved infrastructure management by enabling communities to communicate local priorities, report service disruptions and monitor municipal responsiveness. However, participation is most effective where it is supported by accessible information, functioning reporting systems and clear feedback from municipalities. Communities can strengthen monitoring and accountability, but they cannot substitute for the municipality's statutory responsibility to plan, finance, operate, and maintain infrastructure.

5.2 Recommendations

Based on the reviewed literature, the following recommendations are proposed:

- Municipalities should implement lifecycle-based asset-management systems that include accurate asset registers, periodic condition assessments, maintenance histories, risk classifications and multiyear renewal plans.
- Maintenance and rehabilitation budgets should be protected to reduce dependence on costly emergency repairs. Funding decisions should be guided by infrastructure condition, asset criticality, and service-delivery risk and lifecycle costs.
- Municipalities should integrate asset-management plans with Integrated Development Plans, capital budgets, procurement plans, service-delivery and budget implementation plans, and performance-management systems.
- Municipalities should strengthen technical and managerial capacity through the recruitment, retention and continuous professional development of engineers, technicians, asset managers, infrastructure planners, financial officials and contract-management personnel.
- Municipal councils and senior municipal management should establish transparent accountability mechanisms for infrastructure performance, including regular reporting on asset condition, maintenance backlogs, service interruptions, expenditure, project delays and contractor performance.
- Infrastructure investment decisions should include lifecycle costing to ensure that the long-term operating, maintenance, rehabilitation and replacement requirements of new infrastructure are financially sustainable.
- Municipalities should improve stakeholder engagement through accessible reporting channels, public feedback mechanisms, ward-level communication and the meaningful inclusion of communities in infrastructure-priority setting.
- National and provincial government should provide differentiated technical and financial support to municipalities with limited capacity, particularly rural and financially distressed municipalities.

5.3 Future Research

Future research should examine how municipalities with limited financial and technical capacity can practically implement lifecycle asset-management systems. Comparative studies across metropolitan municipalities, secondary cities, rural municipalities and financially distressed municipalities would assist in identifying context-specific strategies for reducing infrastructure-maintenance backlogs. Research is also needed on the potential of digital asset registers, geographic information systems, remote monitoring, predictive maintenance and citizen-reporting platforms to improve infrastructure-condition data, maintenance planning and service-delivery responsiveness.

References

- 1) Amponsah-Dacosta, F., Mathu, K., & Afful-Dadzie, A. (2015). Infrastructure asset management: Towards sustainable municipalities in South Africa. *Journal of the South African Institution of Civil Engineering*, 57(4), 27.
- 2) Bester, J. 2024. Making dysfunctional municipalities functional: Towards a framework for improving municipal service delivery performance in South African municipalities. *Commonwealth Journal of Local Governance*, 29, pp. 59–78. <https://doi.org/10.5130/cjlg.vi29.8702>
- 3) Patience, J.J. & Nel, D. 2021. Municipal infrastructure management and its impact on service delivery in the City of Ekurhuleni. *Africa's Public Service Delivery and Performance Review*.
- 4) Kaiser, G.N. & Smallwood, J.J., 2014. Towards a systems thinking approach in allocating infrastructure budgets in local government. *Journal of the South African Institution of Civil Engineering*, 56(1), pp. 93–99.
- 5) Matlala, L.S., 2024. Factors affecting effective citizen-based monitoring of frontline service delivery in South Africa. *Africa's Public Service Delivery and Performance Review*, 12(1), a851. <https://doi.org/10.4102/apsdpr.v12i1.851apsdpr+1>
- 6) Nel, V., & Denoon-Stevens, S. (2015). Addressing infrastructure backlogs and maintenance in South African cities. *Urban Forum*, 26(3), 275–293.
- 7) Patience, J.J. & Nel, D., 2021. Municipal infrastructure management and its impact on service delivery in the City of Ekurhuleni. *Africa's Public Service Delivery and Performance Review*, 9(1), a508. <https://doi.org/10.4102/apsdpr.v9i1.508apsdpr+1>
- 8) Rulashe, T. & Ijeoma, E.O.C., 2022. An exploration of public accountability and service delivery at the Buffalo City Metropolitan Municipality in the Eastern Cape province, South Africa. *Africa's Public Service Delivery and Performance Review*, 10(1), a535. <https://doi.org/10.4102/apsdpr.v10i1.535>
- 9) Wall, K., 2021. The right to functioning urban infrastructure – A review. *Town and Regional Planning*, 79, pp. 55–66. <https://doi.org/10.18820/2415-0495/trp79i1.7>
- 10) Wall, K., 2024. Monitoring the condition of public sector fixed infrastructure in South Africa. *Acta Structilia*, 31(2).
- 11) Sithole, N., & Mathonsi, N. (2015). Municipal infrastructure delivery in South Africa: A case study of eThekweni Municipality. *Journal of Public Administration*, 50(1), 106–120.
- 12) Van der Walddt, G. (2014). Infrastructure asset management: A South African local government perspective. *Administratio Publica*, 22(2), 30–47.
- 13) Van Niekerk, D., Nemakonde, L. D., Kruger, L., & Forbes-Biggs, K. (2020). Addressing the challenges of municipal infrastructure management in South Africa. *International Journal of Disaster Risk Reduction*, 51, 101848.