

The Smart City in South Africa: The Conflicts of a Developmental Transformation and Urban Optimisation The Smart City and Urban Optimisation

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The Smart City in South Africa: The Conflicts of a Developmental Transformation and Urban Optimisation

The Smart City and Urban Optimisation

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Abstract

Smart urban transformation is increasingly advanced as a pathway to more efficient, connected and sustainable cities, yet its developmental possibilities are conditioned by the territories in which technological interventions occur (Kitchin, 2014). This paper brings developmental-state scholarship (Mkandawire, 2001) and critical smart urbanism into dialogue to examine this relationship in Matjhabeng, a post-extractive municipality in South Africa's Free State Goldfields. Using longitudinal municipal, fiscal, infrastructural and socio-economic evidence, the study examines four dimensions of territorial capacity: productive employment, fiscal mobilisation, service delivery, and institutional legitimacy and governance. Findings reveal a contracting productive base that constrains broad digital participation; weakened fiscal mobilisation that limits the capacity to sustain developmental obligations while financing technological transformation; deteriorating service infrastructure that disrupts the institutions that reproduce human and digital capabilities; and governance conditions that complicate technological absorption. These relationships show that smart technologies do not encounter territorially neutral

cities. In post-extractive territories, their developmental reach is shaped by capacities already transformed by extractive decline. The paper contributes by locating territorial developmental capacity within smart-urban analysis, showing how the conditions that sustain development also shape technological transformation.

Keywords: Smart cities; Developmental state; Digital inequality; Urban governance; Sustainability; South Africa; Digital transformation

Introduction

Smart urbanism has become increasingly prominent within contemporary development agendas, positioning digital technologies, data infrastructures and technologically mediated governance as instruments for improving urban efficiency, sustainability and service delivery (Kitchin, 2014; OECD, 2020). For developmental states, however, the city carries a wider developmental function. Urban territories are sites where productive activity, infrastructure, public services and institutional capacity contribute to structural transformation and the reproduction of human and territorial capability (Evans, 1995; Mkandawire, 2001). This is particularly significant in South Africa, where the constitutional developmental mandate is exercised across spheres of government and municipalities carry substantial responsibility for services and infrastructure. Smart urban transformation therefore enters an existing developmental project rather than a technologically neutral urban system.

This relationship becomes more complicated in territories constituted through extractive development and subsequently exposed to prolonged economic contraction. Mine decline can reshape employment, household incomes, municipal revenue, infrastructure and institutional

capacity, altering the conditions through which urban development is financed and reproduced. Developmental-state scholarship has examined structural transformation and state capability (Evans, 1995; Mkandawire, 2001), critical smart urbanism the uneven consequences of technologically mediated urban change (Kitchin, 2014; Watson, 2014; Cugurullo, 2018), and post-extractive scholarship the territorial consequences of extractive decline. Less attention has been given to what happens when smart urban ambitions encounter territories whose developmental foundations are themselves being reconfigured through that decline.

This study addresses that gap through Matjhabeng Local Municipality in South Africa's Free State Goldfields. It examines four dimensions through which developmental and technological transformation intersect: productive employment, fiscal mobilisation, service delivery, and institutional legitimacy and governance. The paper asks what Matjhabeng's performance across these dimensions reveals about its capacity to realise a developmental mandate and the territorial conditions encountered by smart urban transformation. It argues that technological transformation is territorially conditioned by the developmental capacities of the places in which it occurs. The paper therefore locates territorial developmental capacity within smart urban analysis, showing why the technological futures of post-extractive cities cannot be separated from the economic and institutional trajectories that produced them.

2. Literature Review

This paper brings together two established bodies of scholarship: critical smart urbanism and developmental-state scholarship. Both have substantially advanced understanding of contemporary urban development. Critical smart urbanism has illuminated the political, economic and spatial implications of technologically mediated urban change, including questions of

sustainability, inequality, corporate power and socio-spatial differentiation. Developmental-state scholarship has established structural transformation and the redress of historically constituted inequalities as central concerns of state intervention. Each field, however, sees the city through the questions and analytical traditions that have shaped it. Considering them alongside the historically produced extractive territory extends this field of vision to urban spaces whose economic and institutional foundations are being reconfigured as the extractive relationships that shaped their development begin to unravel.

2.1 Critical Smart Urbanism and the Uneven City

The smart-city concept emerged through scholarship concerned with the growing role of information and communication technologies in urban organisation and management. Early formulations associated smartness with connectivity, technological infrastructure, innovation and data-driven improvements in urban performance (Caragliu et al., 2011; Batty et al., 2012). Digital monitoring, intelligent transport, energy management and data-assisted resource allocation subsequently connected smart urbanism to sustainability through claims of improved efficiency, environmental monitoring and resource use (Bibri & Krogstie, 2017; Silva et al., 2018; Huang et al., 2021). These approaches positioned technological capability as an increasingly important means of coordinating urban systems and improving urban performance.

Critical smart-city scholarship shifted attention from technological capability to the political, economic and spatial relations through which smart urban development occurs. Hollands (2008) questioned the normative assumptions embedded in smart-city discourse, while Greenfield (2013) and Kitchin (2014) examined the growing influence of technological systems and data-driven governance on urban life. Subsequent work has highlighted corporate power, technocratic

decision making and the capacity of smart-city agendas to privilege particular forms of development and particular populations. From the African urban context, Watson (2014) demonstrates the tensions that arise when globally circulating models of technologically sophisticated development encounter poverty, informality and deeply unequal access to urban resources.

This critical turn also located technological transformation within existing patterns of socio-spatial inequality. Questions of digital access extend to who participates in smart urban systems, who benefits from technological investment and how infrastructure, institutional capacity and economic opportunity shape those benefits (Hollands, 2008; Kitchin, 2014; Cugurullo, 2018). The city cannot therefore be treated as a homogeneous space whose residents encounter technological change from equivalent positions. Smartness is experienced through differentiated material, economic and institutional conditions, while technological investment can itself reinforce particular urban nodes and development trajectories.

For South African cities, this unevenness has a historical as well as contemporary dimension. Differences in access to infrastructure, services, connectivity and economic opportunity are embedded in longer histories of economic organisation, labour, settlement, infrastructure investment and spatial governance. Critical smart urbanism therefore provides an important account of the differentiated terrain on which technological transformation occurs, but also raises the question of how that terrain was produced. This becomes particularly significant in territories whose urban development was organised around extractive economies and whose productive foundations are subsequently altered by their decline.

2.2 The Developmental State and the Urban Expression of Structural Transformation

Developmental-state scholarship has historically centred on the capacity of the state to direct structural economic transformation. Foundational accounts of East Asian development located this capacity in institutions able to coordinate industrial policy, direct investment, discipline and collaborate with capital, and support technological and productive upgrading (Johnson, 1982; Amsden, 1989; Wade, 1990; Evans, 1995). Subsequent scholarship extended the debate beyond East Asia, retaining the importance of state capacity and developmental commitment while emphasising the historical and political conditions under which developmental institutions emerge and operate (Leftwich, 1995; Mkandawire, 2001; Routley, 2014).

African developmental-state scholarship challenged assumptions that developmental states were institutionally or historically confined to East Asian trajectories. Mkandawire (2001) demonstrated both the historical presence of developmental states in Africa and the need to understand developmental capacity in relation to particular political and economic conditions. In South Africa, the developmental-state project has been shaped by the dual challenge of restructuring the economy while addressing inequalities inherited from apartheid. Post-apartheid debates have consequently connected productive restructuring and state capacity with redistribution, employment creation, expanded capabilities and the transformation of inherited inequalities (Edigheji, 2010; Fine, 2010; National Planning Commission, 2012).

This developmental mandate has an explicitly territorial expression. South Africa's constitutional and policy architecture assigns local government a developmental role linking municipal governance to service provision, spatial planning, social and economic development and improvements in communities' material conditions (Republic of South Africa, 1996; Ministry for Provincial Affairs and Constitutional Development, 1998). Urban scholarship similarly locates

housing, infrastructure, mobility, land-use planning and local economic development within the continuing transformation of apartheid spatial structures (Harrison et al., 2008; Parnell & Pieterse, 2010; Turok, 2014; Harrison & Todes, 2015). The city therefore constitutes an important arena through which developmental intervention connects residence, services, mobility and productive opportunity.

These developmental functions are exercised across an uneven territorial geography. South African cities and regions differ in their productive structures, employment trajectories, institutional capacities, demographic patterns and relationships to national and global economies (Harrison & Todes, 2015; Turok & Visagie, 2018). Structural transformation consequently encounters territories whose capacities and constraints have been produced through different economic and spatial histories. This unevenness brings developmental-state scholarship into conversation with critical smart urbanism, while raising a further question where urban territories have themselves been constituted through extractive relationships whose contraction is altering their productive and institutional foundations. This territorial condition is developed through the literature on extractive urbanisation and the post-extractive city in the following section.

2.3 Extractive Urbanisation and the Post-Extractive Territory

Extractive urbanisation refers to how cities, settlements and regional economies are constituted through sustained dependence on mineral and resource extraction. Extractive industries reorganise labour, infrastructure, settlement, mobility, land use and institutional development around the requirements of resource production and export (Bebbington et al., 2008; Arboleda, 2020). In mining-dependent regions, employment, household incomes, local business activity, municipal revenue and infrastructure investment can consequently become closely linked to a

dominant extractive sector. Research on single-industry towns and resource-dependent regions has shown the vulnerability this creates when productive diversification remains limited (Bradbury & St-Martin, 1983; Hayter et al., 2003). More recent work on regional development emphasises the resulting path dependence: capabilities, infrastructures and labour-market structures developed around historically dominant industries can become difficult to reorient when those industries contract (MacKinnon et al., 2019; Boschma, 2022; Grillitsch et al., 2023).

In South Africa, these processes are inseparable from the historical organisation of the mineral economy. Mining shaped urbanisation through migrant labour systems, racially differentiated settlement, infrastructure investment and labour-sending geographies connecting mining centres to distant rural and peri-urban regions (Wolpe, 1972; Crush et al., 1991; Beinart, 2001). Mining centres in the Free State Goldfields developed urban economies whose employment base, commercial activity, property markets, infrastructure and municipal revenues were deeply linked to gold production (Marais, 2013b; Marais & Nel, 2016). Extractive decline therefore unsettles relationships between production, employment, settlement and local governance that were built over decades, while the territory continues to carry the population, infrastructure and institutional obligations produced under the earlier economic regime.

Post-extractive scholarship increasingly examines this longer process of territorial restructuring rather than closure as a discrete event. Regional resilience, evolutionary economic geography and just-transition scholarship show that new development trajectories depend upon the interaction between inherited assets, institutional capacity, labour-market structures and new investment, and that capacities for adaptation vary substantially across territories (MacKinnon et al., 2019; Boschma, 2022; Grillitsch et al., 2023). A territory may therefore be incorporated into

national economic restructuring while simultaneously experiencing declining employment, weakening public finances and reduced local opportunity.

The post-extractive territory introduces this temporal and structural condition into the smart-urbanism and developmental-state conversation. It is an urban space whose contemporary capacity is conditioned by an extractive economic history and by the continuing restructuring that follows its decline. Smart urban interventions introduced into such territories therefore encounter productive, fiscal, infrastructural and institutional conditions that are themselves changing. Their developmental significance cannot be understood independently of the territorial trajectory into which technological transformation is introduced.

3. Theoretical Framework

This study brings developmental-state scholarship and critical smart urbanism into dialogue as theoretical lenses for examining urban transformation. Developmental-state scholarship locates development within structural transformation and the institutional capacity to alter the economic and material conditions that sustain it (Evans, 1995; Mkandawire, 2001), while critical smart urbanism directs attention to technologically mediated urban systems and their differentiated social and spatial effects (Kitchin, 2014; Watson, 2014; Cugurullo, 2018). Bringing the two together allows the same territorial condition to carry different analytical meanings. Institutional weakness may constrain the implementation of technological systems while also signalling diminished capacity to realise developmental obligations; infrastructure may be amenable to technological optimisation while remaining fundamental to access to services, mobility and productive opportunity. Their intersection therefore distinguishes between improving

the operation of urban systems and transforming the structural conditions through which developmental outcomes are produced.

This distinction is particularly consequential in post-extractive territories, where the conditions encountered by technological transformation have been historically produced through economic relationships whose contraction continues to reshape employment, institutional capacity, infrastructure and local development. The post-extractive territory therefore provides the setting in which technological transformation can be examined against the developmental condition of the territory in which it is introduced. The relationship between developmental and technological transformation is examined through four dimensions of territorial capacity: productive employment, fiscal mobilisation, service delivery, and institutional legitimacy and governance. Each carries distinct but connected significance within the two theoretical frames.

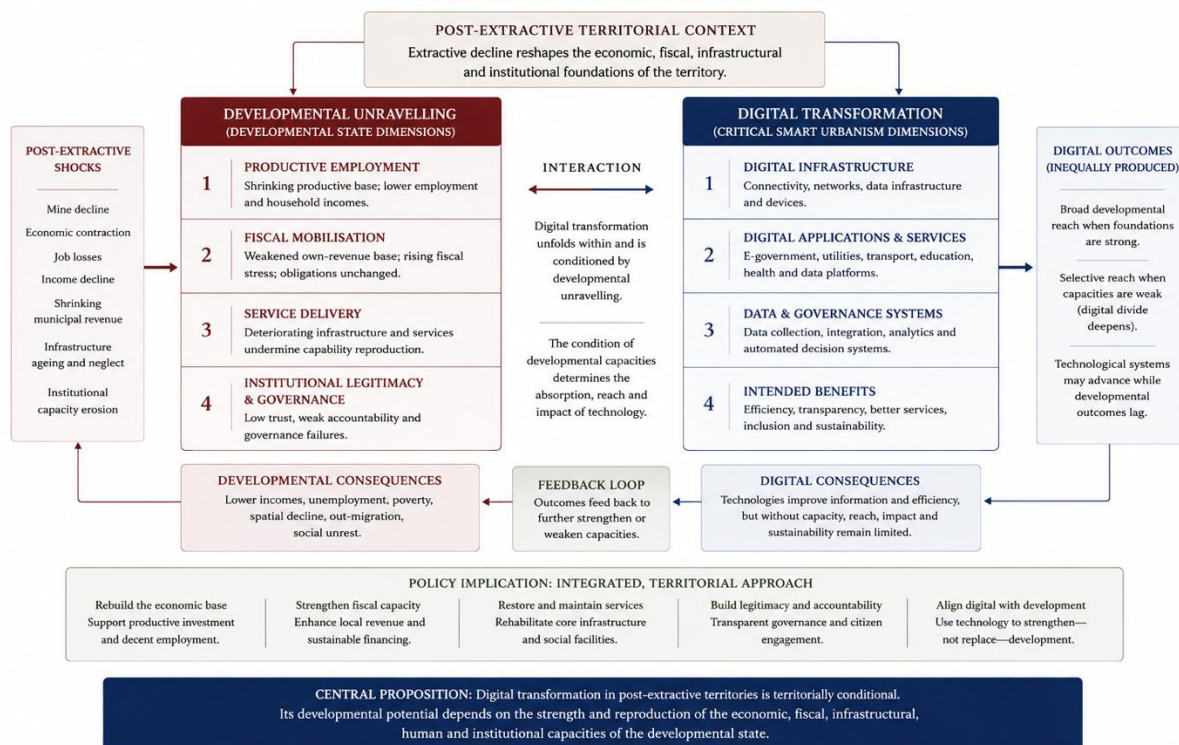
Productive employment provides an economic foundation for developmental and technological transformation. Developmental-state scholarship connects productive expansion and diversification to employment, income formation and structural transformation (Johnson, 1982; Amsden, 1989; Evans, 1995; Mkandawire, 2001). Critical smart urbanism and digital inequality scholarship, however, show that technological participation is conditioned by socio-economic resources: technological availability does not ensure meaningful access where households lack the economic capacity to acquire, maintain and use digital services and technologies (Watson, 2014; van Dijk, 2020). These perspectives locate the territorial productive base both as a foundation of developmental transformation and as a determinant of the social reach of technological transformation..

Fiscal mobilisation similarly provides the resources through which public institutions translate developmental objectives into material intervention. Developmental-state scholarship connects fiscal and institutional capacity to the state's ability to finance infrastructure, services and productive investment (Evans, 1995; Mkandawire, 2001; Edigheji, 2010). At the municipal scale, this capacity is shaped by the local economic base and the ability to mobilise revenue to sustain developmental obligations. Smart urban transformation adds further fiscal demands because digital infrastructures require not only acquisition but integration, operation, maintenance, security, upgrading and replacement (Kitchin, 2014; OECD, 2020). The two perspectives locate fiscal mobilisation as the capacity to reproduce existing developmental systems while financing and sustaining additional technological systems without displacing those obligations.

Service delivery connects institutional capacity to human and territorial capability. Developmental-state scholarship treats public services and infrastructure as mechanisms through which state capacity is translated into material conditions that support welfare, productive participation and development (Evans, 1995; Mkandawire, 2001; Edigheji, 2010). Water, sanitation and other basic services sustain health, education, household reproduction and economic activity, while digital inequality scholarship shows that meaningful technological participation depends on capabilities and conditions extending beyond physical access to technology (van Dijk, 2020). Critical smart urbanism similarly locates digital systems within existing material and infrastructural environments rather than outside them (Kitchin, 2014; Watson, 2014). These perspectives position service delivery both as a means of reproducing developmental capability and as part of the material and institutional foundation on which digital capability depends.

Institutional legitimacy and governance shape the relationships through which public authority coordinates development, implements policy and sustains cooperation around developmental objectives. Developmental-state scholarship locates effective state capacity not only in administrative resources but in institutions capable of maintaining credible relationships with social and economic actors (Evans, 1995; Mkandawire, 2001; Edigheji, 2010). Critical smart urbanism extends this concern to digitally mediated governance, where data, platforms, monitoring and automated administrative systems reshape interactions between citizens and public institutions (Kitchin, 2014; Morozov & Bria, 2018). These perspectives position legitimacy and governance as conditions both for exercising developmental authority and for the institutional absorption and sustained operation of technological transformation.

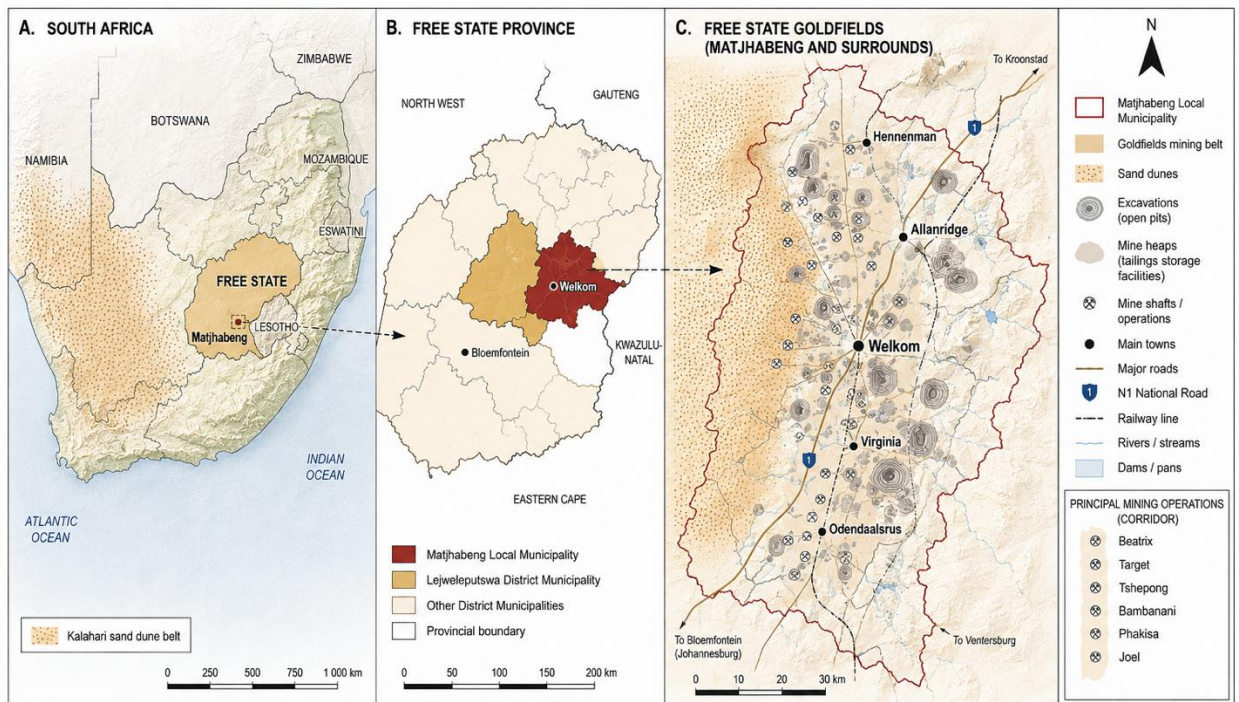
Figure 1. Digital Transformation and the Developmental Unravelling of the Developmental State at the Territorial Post-Extractive Level



4. Methodology

This study uses a theory-informed territorial approach to examine Matjhabeng Local Municipality in South Africa's Free State Goldfields through developmental-state scholarship and critical smart urbanism (Masnavi, 2007). Theory-informed urban analysis uses conceptual frameworks to derive analytically relevant dimensions and indicators rather than selecting evidence on availability alone (Niemeijer & de Groot, 2008; Falah et al., 2025; Calafiore, 2026). Matjhabeng's location within the Free State Goldfields and the wider South African territorial context is shown in **Figure 1**.

Figure 2. Location of Matjhabeng within South Africa, the Free State Province and the Free State Goldfields



Matjhabeng Local Municipality is situated in the historical core of the Free State Goldfields, one of South Africa's most important gold-mining regions. The area is characterized by extensive sand dune landscapes to the west and a long history of gold extraction, leaving behind mine excavations and tailings storage facilities that continue to shape the territory.

4.1 Research Design

The study uses a longitudinal, theory-informed territorial research design to examine changes in Matjhabeng between 1996 and 2026, with the temporal coverage of individual indicators determined by data availability. Theory-informed territorial approaches enable empirical conditions to be examined through conceptually derived dimensions rather than as discrete measures of municipal performance (Masnavi, 2007; Alrowais et al., 2026; Flacke & Köckler, 2015; Calafiore, 2026). The longitudinal dimension distinguishes **condition from trajectory**, allowing contemporary observations to establish the state of particular territorial dimensions while observations across time identify the direction and persistence of change (Masnavi, 2007). This design therefore situates Matjhabeng's contemporary developmental conditions within the longer restructuring of its productive, fiscal, infrastructural and institutional systems, while allowing relationships among these dimensions to be examined across the period of mining decline (Ragheb et al., 2022).

4.2 Data Sources and Construction of the Territorial Profile

The territorial profile is constructed from longitudinal secondary data drawn from Statistics South Africa, Matjhabeng Local Municipality, National Treasury, the Auditor-General of South Africa, the Electoral Commission of South Africa, court records, municipal planning and financial recovery documents, and relevant provincial and national government reports. These sources provide indicators of productive employment, fiscal mobilisation, service delivery and infrastructural functionality, and institutional legitimacy and governance, corresponding to the analytical dimensions established in the theoretical framework. Historical and contemporary evidence is combined to construct a territorial profile spanning 1996–2025, although individual

indicators cover different periods according to data availability. Quantitative indicators are read alongside documentary and administrative evidence to capture institutional and infrastructural conditions not consistently represented in statistical series, while cross-source comparison is used where possible to verify reported trends and events

4.3 Analytical Approach

The analysis proceeds in two stages. First, indicators within the territorial profile are examined longitudinally to distinguish condition from trajectory, with contemporary observations establishing territorial conditions and observations across time identifying the direction and persistence of change (Niemeijer & de Groot, 2008). The evidence is then interpreted separately through developmental-state scholarship and critical smart urbanism to identify what the same territorial conditions reveal about developmental capacity and the conditions encountered by technological transformation (Masnavi, 2007). Preserving these distinct analytical perspectives makes different relationships visible before cross-frame interpretation (Sarkar & Pujara, 2025; Brelsford et al., 2024).

In the second stage, the two perspectives are brought together to identify convergence, divergence and differential significance across the same territorial conditions, consistent with theoretically derived, framework-based approaches to urban analysis (Ragheb et al., 2022). These relationships are situated within Matjhabeng's post-extractive trajectory by examining quantitative trends alongside municipal planning and reporting documents and historical evidence of changes in the territory's productive structure. Temporal correspondence between indicators is treated as evidence of association and changing territorial configuration rather than, by itself, causation (Alrowais et al., 2026; Masnavi, 2007). The analysis therefore moves from individual indicators,

through their theoretical interpretation to the territorial relationships through which developmental capacity conditions smart urban transformation.

5. Findings

The findings examine Matjhabeng through the four dimensions established in the theoretical framework: productive employment, fiscal mobilisation, service delivery, and institutional legitimacy and governance. Each is examined for what the territorial evidence reveals about Matjhabeng's developmental capacity and the conditions encountered by technological transformation.

5.1 Productive Employment

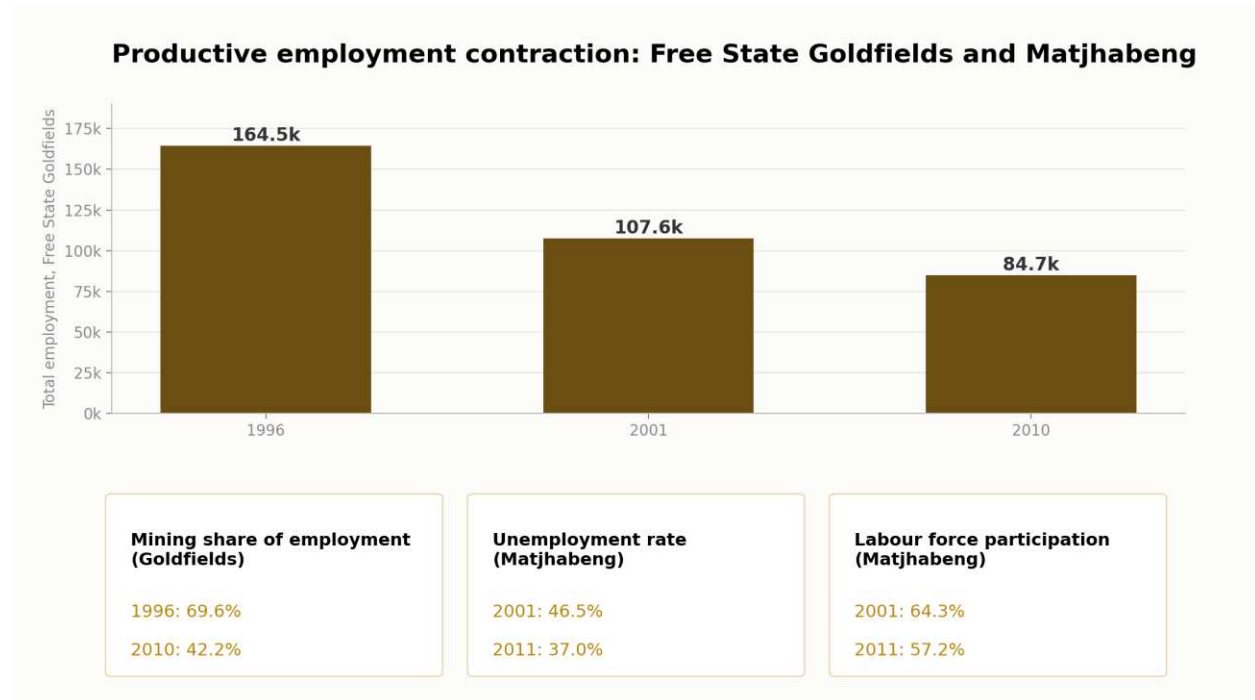
The employment trajectory shows substantial weakening of Matjhabeng's productive base. Total employment in the Free State Goldfields declined from approximately 164,500 in 1996 to 84,700 in 2010, while mining employment fell from approximately 114,400 to 35,700 over the same period (Marais, 2013a). In Matjhabeng, labour-force participation declined from 64.3% in 2001 to 57.2% in 2011, while economic inactivity increased from 35.7% to 42.8% (Matjhabeng Local Municipality, 2020). The contraction extended beyond the initial employment rupture, with the Matjhabeng economy contracting at an average annual rate of 1.45% between 2011 and 2021.

These trends indicate productive employment contraction without sufficient replacement elsewhere in the economy, weakening the economic base supporting household livelihoods, local demand, municipal revenue and developmental activity.

The same contraction conditions the economic reach of technological transformation. Smart urban infrastructures encounter populations with differentiated material capacities to access

and use them (Watson, 2014; Kitchin, 2014). In Matjhabeng, technologies requiring household expenditure on electricity, connectivity, devices and digitally mediated services therefore encounter a weakened income-generating base, making employment and purchasing capacity relevant to the distribution of technological uptake. **Figure 3** situates these conditions within the longer employment trajectory, showing the contraction of the productive base against which both developmental and technological transformation must be considered.

Figure 3. Productive employment trajectory, Free State Goldfields, 1996 to 2011. Sources: Marais (2013a); Matjhabeng Local Municipality (2020).



The contraction of productive employment is simultaneously a developmental and digital constraint: it weakens the productive base of the territory while narrowing the household economic capacity through which technological participation can acquire broad social reach.

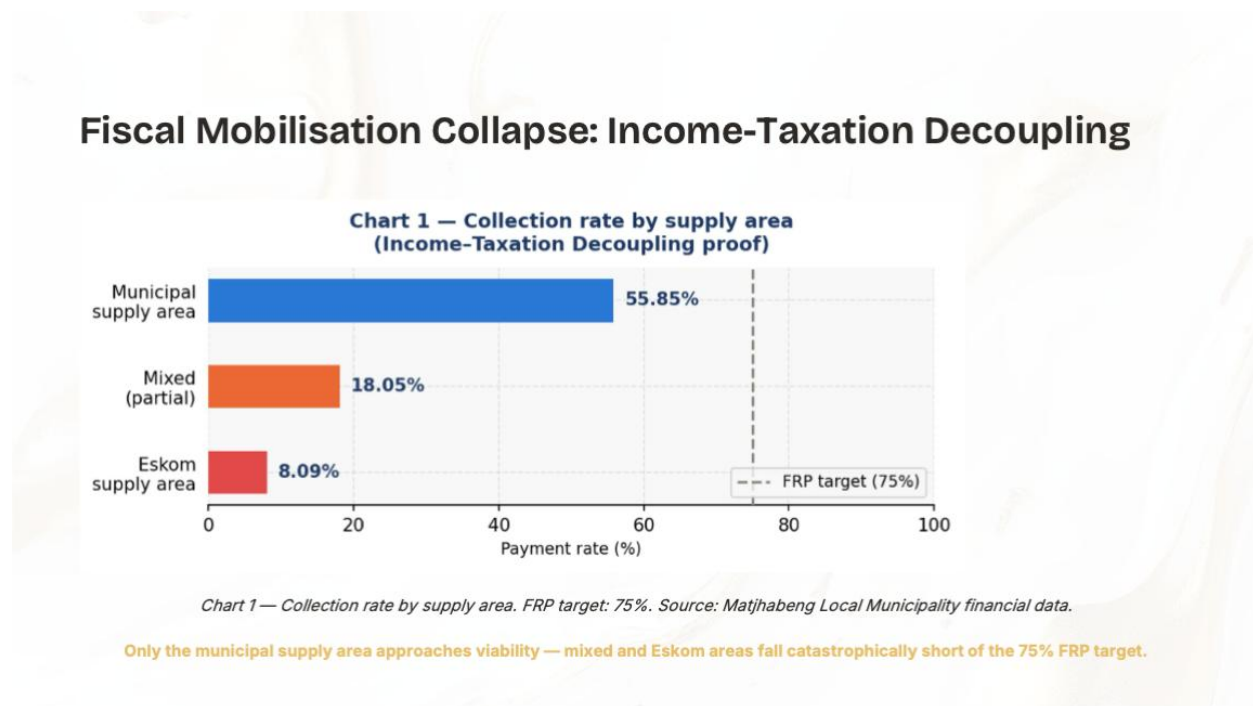
5.2 Fiscal Mobilisation

Matjhabeng's fiscal profile shows a substantial gap between municipal obligations and the resources available to finance them. The municipality records an overall collection rate of 49.5%

(Matjhabeng Local Municipality, 2024), substantially below the Financial Recovery Plan target of 75–85%, while cash coverage is below 15 days against a norm of 30–90 days (Matjhabeng Local Municipality, 2025). The debtor book further illustrates the constraint: of R7.54 billion in outstanding debtors, R5.91 billion, or 78%, was assessed as impaired and unlikely to be recovered, while trade payables stood at R12.57 billion (Auditor-General South Africa, 2024; Matjhabeng Local Municipality, 2024). These figures establish a widening gap between developmental responsibilities and the fiscal resources available to discharge them.

For smart urban transformation, the same figures establish the financial conditions within which new technological infrastructure would have to be procured, operated, secured, maintained, and eventually replaced. This also affects the revenue model by which some smart technologies are expected to improve municipal management. In a territory where only 49.5% of billed revenue is collected, technologies intended to improve metering, billing or system management enter an already weakened relationship between service consumption and municipal revenue mobilisation. **Figure 4** traces this fiscal deterioration over time, locating declining revenue collection alongside the accumulation of municipal debt and financial obligations.

Figure 4. Matjhabeng municipal revenue and expenditure profile. Sources: Matjhabeng Local Municipality (2024, 2025).



The fiscal constraint reflects declining revenue collection: it reflects a widening gap between the resources the municipality can mobilise and the developmental obligations it must continue to finance.

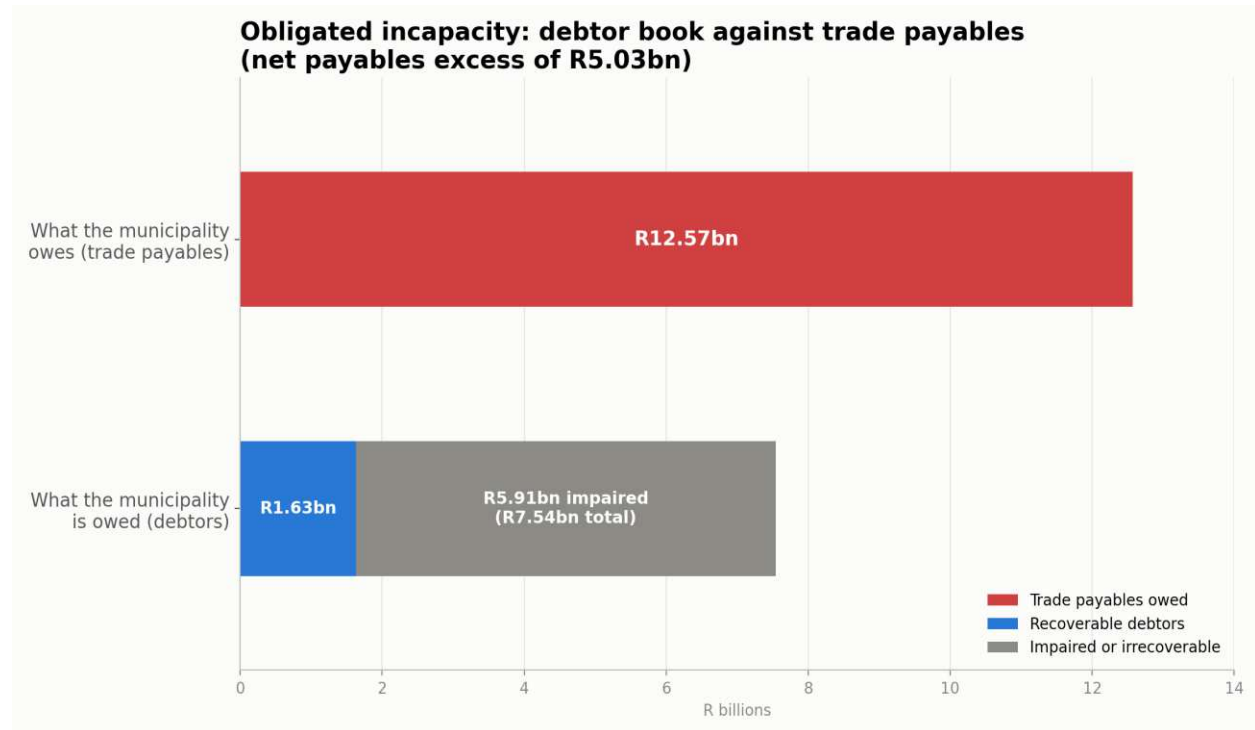
5.2.1. Obligated Incapacity

Figure 5 shows a severe imbalance between Matjhabeng's financial obligations and realistically recoverable resources. Trade payables stand at R12.57 billion, while the municipality's debtor book totals R7.54 billion, of which approximately R5.91 billion is impaired or considered irrecoverable. The recoverable portion of the debtor book is therefore substantially smaller than

the municipality's outstanding obligations, establishing the condition identified here as obligated incapacity.

The same fiscal condition constrains the landing of smart urban technologies. New technological systems require not only initial capital investment but continuing expenditure on operation, energy, connectivity, maintenance, security, upgrading and replacement, embedding smart systems within existing municipal infrastructural and institutional capacities (Kitchin, 2014; Marvin et al., 2016). Smart metering is particularly revealing because such technologies are commonly associated with improved measurement, demand management and the administration of utility consumption (Sovacool et al., 2017). In Matjhabeng, however, the figure shows that the underlying fiscal problem also concerns revenue recovery: approximately R5.91 billion of the existing debtor book is already classified as impaired or unlikely to be recovered. Technological improvement in revenue administration therefore encounters a fiscal base in which a substantial proportion of billed consumption cannot realistically be converted into municipal revenue.

Figure 5. Matjhabeng fiscal obligations and recoverable revenue. Sources: Matjhabeng Local Municipality (2024); Auditor-General South Africa (2024).



Obligated incapacity describes the fiscal condition in which institutional obligations persist while the resources available to discharge them become increasingly inadequate.

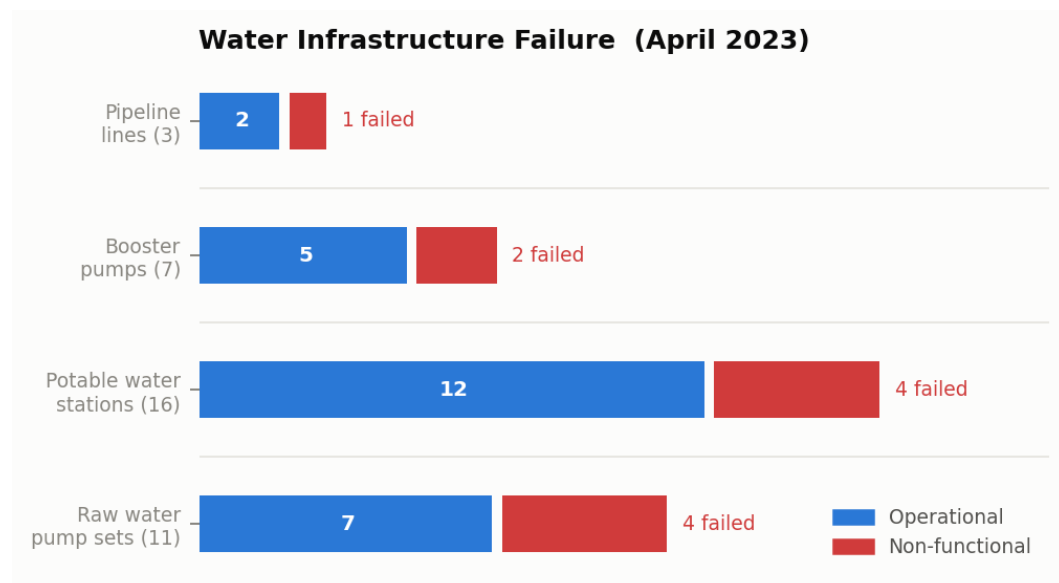
5.3 Service Delivery, Infrastructural Functionality and Digital Transition

The deterioration in service delivery is reflected in the functionality of Matjhabeng's underlying infrastructure. By 2025, 52 of 57 sewage pump stations were non-operational, nine of eleven water treatment plants required urgent refurbishment, and more than 80% of streetlights were non-functional (OFM, 2024, 2025). At the time of parliamentary oversight in May 2025, eight of the municipality's eleven wastewater treatment works were not working, and constant sewer spillages were polluting local water resources (Select Committee on Cooperative Governance and Public Administration, 2025; Matjhabeng Local Municipality, 2025). These indicators establish the operational condition of the physical systems through which municipal services are delivered.

5.3.1. Infrastructure Functionality -Water Infrastructure Failure

The system-wide infrastructure failures identified above are reflected in recurring disruptions to water provision across Matjhabeng. Pump failures, low reservoir levels and failures within the distribution system have resulted in intermittent supply, restrictions and emergency water provision across parts of the municipality (NovaNews, 2026a). These disruptions show that the infrastructure condition recorded in **Figure 6** translates into instability in the delivery of water itself

Figure 6. Water infrastructure failure, Matjhabeng, April 2023. Source: DA Free State (2023a).



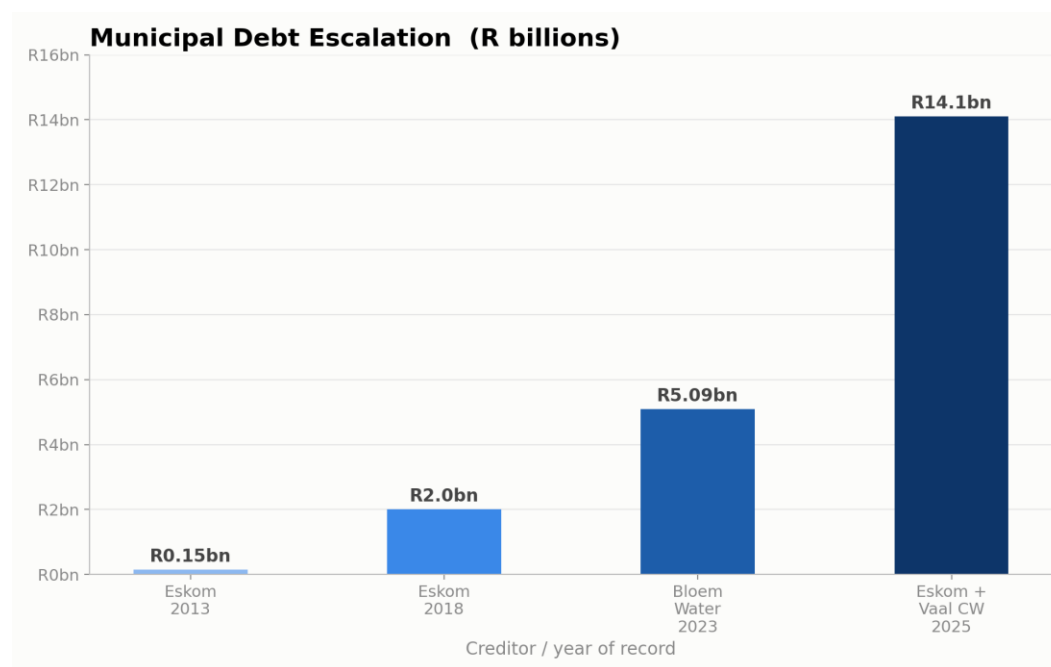
The evidence shifts attention from nominal infrastructure provision to functionality: the developmental significance of a network depends upon the capacity of its underlying systems to remain operational.

Figure 6 shows that infrastructure failure is distributed across several components of the water and sanitation system rather than confined to a single facility or function. The concentration of non-

operational pump stations, treatment plants requiring refurbishment, and collapsed wastewater works indicates constraints across the treatment, movement, and management of water and wastewater.

The system-wide dysfunction also affects the continuity and fiscal sustainability of water provision, as shown in Figure 7.

Figure 7. Matjhabeng bulk water supply disruptions and creditor debt. Sources: *The Journalist* (2018); *DA Free State* (2023a); *IOL* (2025).



Water provision is constrained on two fronts: operational failures disrupt the physical systems through which water is delivered, while substantial bulk-water debt constrains the fiscal conditions through which that provision must be sustained.

The interaction between operational failure and fiscal constraint is expressed territorially through recurring disruptions to water provision. Pump and distribution failures, low reservoir levels, restrictions and emergency water provision indicate instability in the continuity and reliability of water supply. It is at this point that infrastructure failure becomes water insecurity, with consequences extending into institutions and activities dependent upon continuous provision. Matjhabeng's schools make these wider effects particularly visible.

5.3.3 Water Insecurity, School Disruption and Digital Capability

Water insecurity affects the everyday functioning of Matjhabeng's educational institutions. The problem is not confined to household inconvenience or intermittent municipal provision. Schools require continuous water and functioning sanitation to remain operational, making the reliability of municipal infrastructure part of the material conditions that sustain education. Parliamentary oversight in October 2025 documented raw sewage flowing through the entrances of Welkom Secondary School and Lenakeng Technical High School, requiring learners to negotiate sewage-contaminated areas to enter school premises (Parliament of the Republic of South Africa, 2025). Infrastructure and sanitation failures have also affected Goudveld-Hoërskool, Unitas Secondary, Welkom Technical High, St Helena Primary and Golden Park (NovaNews, 2026b). The developmental consequence is therefore visible within institutions responsible for producing the knowledge and capabilities on which subsequent economic transformation depends. **Figure 8** locates this disruption within Matjhabeng's educational infrastructure, showing the schools in which failures in water, sanitation and related municipal infrastructure have compromised the conditions required for their continued functioning.

The available evidence documents infrastructure-related disruption across eight schools in Matjhabeng. These cases include failures associated with water supply, sanitation and sewage infrastructure, demonstrating that disruption has affected multiple educational sites rather than a single institution. The recorded number is, however, incomplete. Comparable school-level records were not available for schools in the township areas of Kutlwanong and Meloding, where service disruptions are also experienced, and these schools could therefore not be included in the documented count. Figure 8 consequently represents the number of schools for which disruption

could be verified from available records rather than the full territorial incidence of school disruption.

Figure 8. Eight schools across Matjhabeng affected by sewage, structural collapse, or safety failures between December 2023 and April 2026. Parliament alarmed October 2025. Hostel closure threat April 2026. Sources: DA Free State (2023b); Parliament of the Republic of South Africa (2025); NovaNews (2026b).

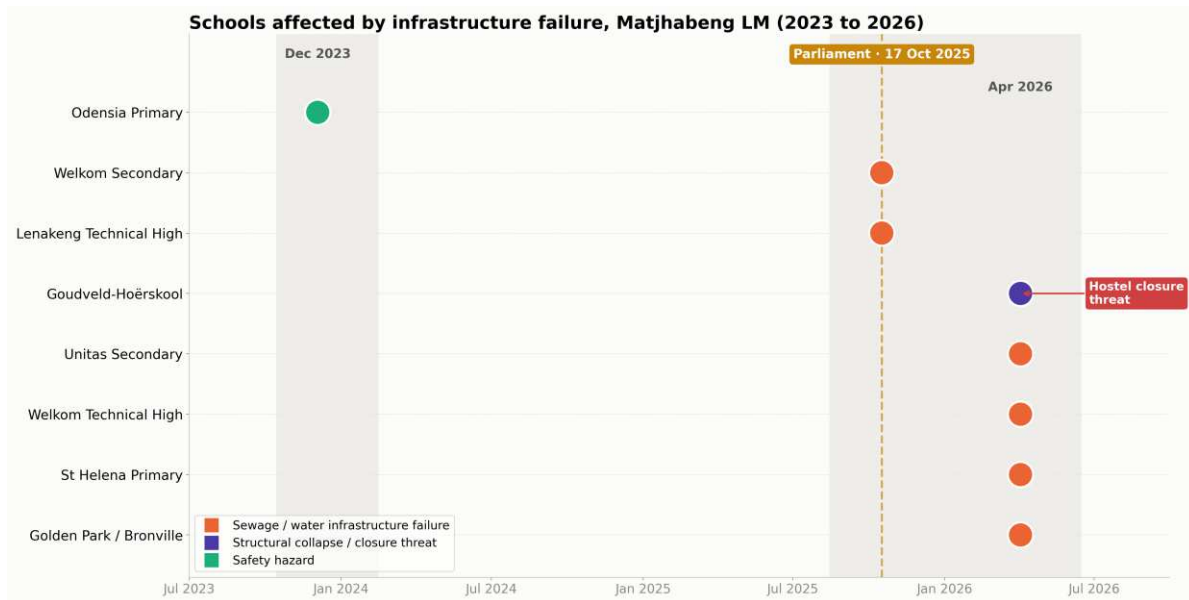


Figure 8 Infrastructure failure disrupts the conditions required for schooling

The documented cases do not represent the full territorial extent of school disruption. Available school-level records are concentrated in the urban areas represented in Figure 8, while comparable records were not available for township schools in Kutlwanong and Meloding. The number of schools shown should therefore be read as the documented extent of disruption rather than its total incidence across Matjhabeng

5.3.3.1 School Disruption as a Site of Digital Capability Loss

The relationship between infrastructural failure and digital transition is captured in the causal pathway presented below. It traces the movement from municipal infrastructure collapse,

through a disrupted school environment and interrupted educational continuity, to the risk posed to the reproduction of digital capability. The pathway locates the school between municipal service provision and digital participation: water, sewage and structural infrastructure affect the conditions under which schooling occurs; disruption of those conditions affects attendance, learning and safety; and educational instability reaches the processes that reproduce the skills and literacy required for digital participation. **Figure 9** traces the pathway through which infrastructure failure translates into educational disruption and, subsequently, constraints on digital capability.

Matjhabeng Local Municipality, Free State Goldfields | 2023–2026

Figure 9. Causal Pathway: Infrastructure Failure to Digital Capability Gap

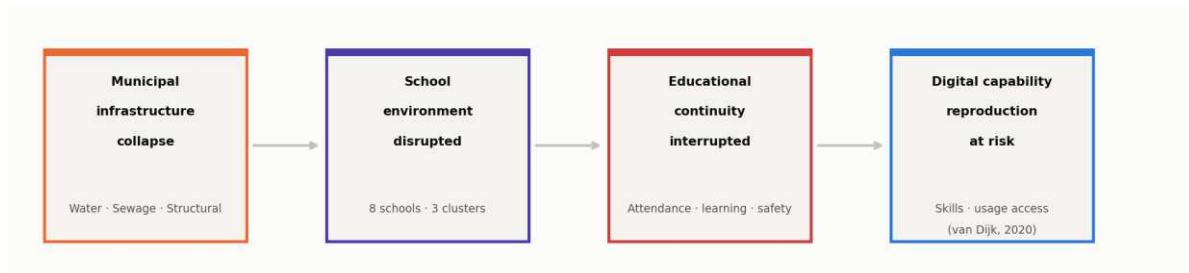


Figure 9. Infrastructure collapse in Matjhabeng disrupts schooling, which interrupts the reproduction of the skills and literacy required for digital participation.

The pathway identifies school disruption as the intermediate mechanism through which municipal infrastructure failure can reach digital capability. Infrastructure failure does not produce a digital capability gap directly; it disrupts the institutional environment in which educational continuity, skills formation and digital literacy are reproduced.

The empirical evidence across Matjhabeng’s schools supports this pathway. Between December 2023 and April 2026, eight schools were documented as affected by sewage, structural deterioration or infrastructure-related safety failures. The chronology shows that these were neither confined to one institution nor to one moment. Odensia Primary was exposed to an unfilled road trench and non-functional streetlights in December 2023 (DA Free State, 2023b). In October 2025, raw sewage affected Welkom Secondary and Lenakeng Technical High, with learners having to

navigate sewage streams to enter classrooms (Parliament of the Republic of South Africa, 2025). By April 2026, sewage and structural failures were documented at Goudveld-Hoërskool, Unitas Secondary, Welkom Technical High, St Helena Primary and Golden Park/Bronville. At Goudveld-Hoërskool, nine overflowing manholes, emerging sinkholes and structural erosion threatened closure of the school hostel (NovaNews, 2026b).

The pathway is significant because the effects of infrastructure failure extend into an institution through which digital capability is expected to be reproduced. Van Dijk's (2020) distinction between motivational, physical, skills and usage access identifies skills access and usage access as particularly exposed where schooling is repeatedly disrupted. This relationship also accords with South Africa's developmental policy architecture. The National Development Plan (National Planning Commission, 2012) locates education and skills formation within the development of human capabilities required for economic and social participation, while the White Paper on e-Education (DoE, 2004) and the DBE's Digital Education Strategy (DBE, 2025) position schools as sites through which digital competencies, access and technology-enabled learning are to be expanded. Infrastructure failure that disrupts educational continuity therefore intersects with both the individual capability dimensions identified by van Dijk and the institutional mechanisms through which South Africa intends those capabilities to be developed and extended. **Figure 10** applies van Dijk's (2020) four dimensions of digital access to this evidence, identifying where school disruption most directly exposes the conditions required for digital participation.

Figure 10. Digital Capability Dimensions at Risk

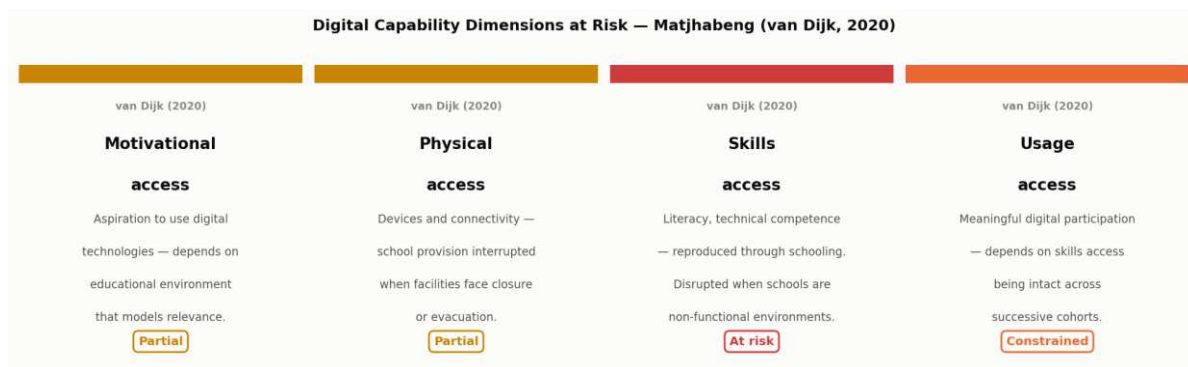


Figure 10. Digital access may remain technologically available while disruption to schooling weakens the institutional processes through which the capabilities required to use it are reproduced. Van Dijk's (2020) four-dimensional capability framework applied to the Matjhabeng educational disruption context. Skills access and usage access are most directly exposed to school infrastructure failure.

Figure 10 shows that school disruption does not affect all dimensions of digital access equally. Within van Dijk's (2020) framework, the most direct exposure occurs in skills access and usage access, both of which depend upon sustained opportunities to acquire, practise and apply digital capabilities. Physical access may remain available through devices and connectivity, while the institutional conditions required to convert that access into meaningful digital participation are disrupted. This distinction is significant in the South African policy context, where the National Development Plan positions education and skills formation as central to the development of human capabilities (National Planning Commission, 2012), and national education policy assigns schools a role in extending digital learning and capability. School disruption therefore affects not only educational continuity but an institutional site through which wider digital participation is intended to be developed.

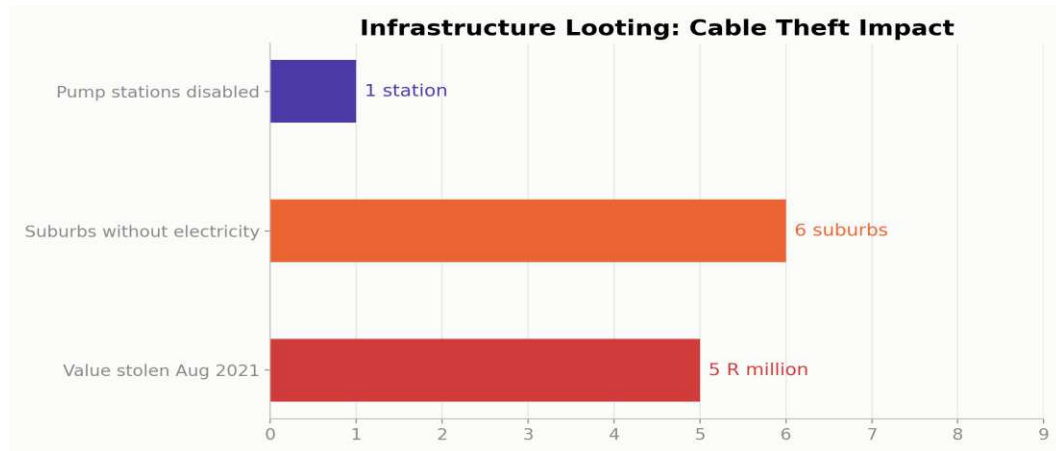
The three figures trace a progression from infrastructural failure, through school disruption and interrupted educational continuity, to constraints on the formation and use of digital capability. The finding therefore extends the assessment of digital transition beyond whether Matjhabeng possesses or can acquire technological infrastructure to the condition of the institutions where residents acquire the capabilities required for that transition

5.4. Institutional Legitimacy, Looting and Infrastructural Vulnerability

Institutional legitimacy is partly constituted through citizens' trust in public institutions. South African evidence has long connected institutional trust to citizens' assessments of government performance and the trustworthiness of public institutions (Rule & Langa, 2010), with local government particularly exposed because service delivery forms a central part of citizens' experience of municipal performance (Gordon et al., 2015). Matjhabeng's infrastructural deterioration therefore occurs within a wider relationship between developmental performance, public trust and institutional legitimacy.

The vulnerability of Matjhabeng's service infrastructure is compounded by cable theft and vandalism. In August 2021, approximately R5 million worth of cable was stolen in a single incident, leaving six Welkom suburbs without electricity (News24, 2021). The evidence also records cable theft disabling a pump station (DA Free State, 2023a), demonstrating that disruption to electrical infrastructure can migrate directly into the water system. Cable theft therefore affects more than the reliability of electricity provision. It disrupts the interconnected infrastructure on which other municipal services depend. **Figure 11** consolidates these incidents, showing how theft and vandalism translate into disruption across Matjhabeng's interconnected municipal infrastructure.

Figure 11. Cable theft and institutional looting: impact on municipal infrastructure, Matjhabeng. Sources: News24 (2021); DA Free State (2023a).



The infrastructural vulnerability occurs alongside a wider deterioration in municipal governance and institutional capacity. Persistent financial and service-delivery failures ultimately resulted in the invocation of **Section 139 of the Constitution**, with the Free State High Court ordering intervention in October 2024 (*Democratic Alliance v Premier of the Free State Province and Others*, 2024). Constitutional intervention is particularly significant because it records a formal institutional response to a municipality whose capacity to govern and discharge its obligations had deteriorated sufficiently to require intervention from another sphere of the state.

Figure 12 consolidates the fiscal, infrastructural and governance pressures within which technological transformation is being introduced in Matjhabeng. Municipal obligations of approximately R14.1 billion (IOL, 2025), recurrent infrastructure theft and vandalism, smart meter deployment that cannot be traced to installation, the **October 2024 Section 139 intervention**, and the national decline in local-government trust from **55% in 2004 to 18% in 2025/26** (IEC, 2026; Sowetan, 2026) locate technological introduction within substantial institutional stress. Cable theft has also disabled water infrastructure, demonstrating how disruption can migrate across interconnected municipal systems and exposing the vulnerability of digital systems dependent on

continuous electricity and communications infrastructure (Graham & Marvin, 2001; Kitchin, 2014). **Figure 12** situates these conditions alongside the wider decline in public trust, showing the institutional environment within which technological transformation is being introduced in Matjhabeng.

Figure 12.Institutional Legitimacy Collapse — Evidence Dashboard

HEADLINE INDICATORS		
TOTAL MUNICIPAL DEBT	WATER BILL PAYMENT RATE	CONSTITUTIONAL INTERVENTION
R14.1 billion Eskom R6.8bn + Vaal Central Water R7.3bn	23% R15.8m collected of R67.5m billed (Feb 2023)	Oct 2024 Section 139 — Free State High Court order

***Figure 12.** Institutional legitimacy collapse: evidence dashboard, Matjhabeng. Sources: IOL (2025); DA Free State (2023a); Democratic Alliance v Premier of the Free State Province and Others (2024).*

These institutional conditions provide the context within which smart-meter deployment has unfolded in Matjhabeng, as traced in **Figure 13**. The smart-meter evidence reveals a different dimension of institutional capacity: the inability to trace technological investment from institutional intention and expenditure to territorial installation and use. Municipal recovery planning identifies smart metering as a revenue measure and budgets a project of 5,500 smart meters for 2025/26, and Eskom began replacing meters with smart meters in Thabong in February 2026 (Matjhabeng Local Municipality, 2025; Vista, 2026); yet the available records do not establish how many smart meters were ultimately installed or where they became operational. Smart-meter infrastructure consequently remains poorly documented in the territorial record. This makes it impossible to treat procurement or planned deployment as evidence of technological absorption. See **Figure 13**

Figure 13 : Smart meter deployment in Matjhabeng, 2025 to 2026

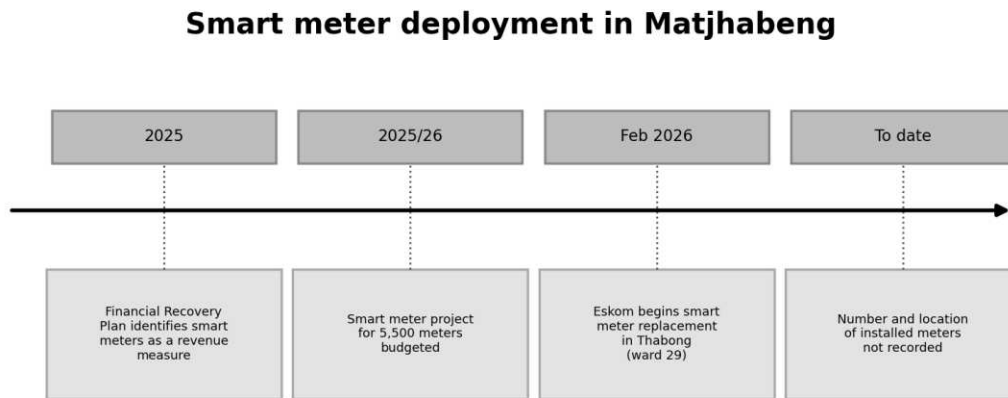


Figure 13. The trajectory documents movement from municipal recovery planning and budgeting to phased replacement, but available records do not establish the resulting territorial footprint of smart-meter infrastructure.

6. Discussion

The Matjhabeng case complicates the assumption that smart urban transformation begins with the technological capacity of the city. The findings show that technological transformation encounters a territory whose capacity to absorb and reproduce it is constituted through productive employment, fiscal mobilisation, service delivery, human capability and institutional legitimacy. These are simultaneously dimensions of the developmental capacity of the city. Their significance lies in the relationship between them: employment sustains household income and economic participation; the economic base contributes to municipal fiscal capacity; fiscal mobilisation supports service delivery and infrastructure; service delivery sustains the institutions and material conditions that reproduce human and territorial capabilities; and institutional legitimacy shapes the governance environment within which public interventions are implemented. Smart urban

transformation therefore enters an already constituted developmental system rather than an empty technological space.

6.1 The Developmental Capacity of the City Conditions Smart Transformation

The contraction of Matjhabeng's productive base demonstrates the first dimension of this relationship. Mine decline is significant not only because it reduces employment in an historically dominant sector, but because it alters the economic foundations upon which both developmental and technological transformation depend. From a developmental-state perspective, the contraction of productive employment weakens the capacity of the territory to sustain livelihoods and participate in structural transformation. Through the critical smart-urbanism lens, the same contraction affects the breadth of the population able to consume connectivity, devices and digitally mediated products and services. The digital divide therefore also reflects the employment and income structures of the territorial economy that shape the capacity for broad technological participation.

This exposes a limitation in smart-city approaches that begin from technological supply. Connectivity, platforms, sensors and digitally mediated services may be introduced without producing correspondingly broad technological participation where the economic base required to consume them is contracting. In such circumstances, technological modernisation can coexist with declining developmental capacity. The result may be a selectively smart territory in which technological systems advance while the social and economic capacity to participate in them becomes increasingly differentiated. The post-extractive condition therefore adds an important temporal dimension to critical accounts of uneven smart urbanism: inequality in technological participation may arise not only from historically unequal urban development, but from the

continuing contraction of the productive systems upon which household and territorial economic capacity previously depended.

6.2 Fiscal Mobilisation

The fiscal findings widen this argument from households to the state, by bringing municipal fiscal capacity into the analysis. Smart urban transformation requires more than the initial procurement of technology. Digital infrastructures generate continuing obligations of operation, integration, maintenance, security, upgrading and replacement. Matjhabeng's fiscal condition therefore raises a developmental question about the sustainability of technological transformation where the municipality is already struggling to finance and reproduce its existing obligations. The significance of fiscal mobilisation therefore lies in whether technological systems can be incorporated into the recurrent institutional and financial reproduction of the city.

This creates a potential tension between technological ambition and developmental obligation. Where fiscal capacity is constrained while constitutional responsibilities remain intact, expenditure on new technological systems enters competition with the maintenance and restoration of existing developmental infrastructure. Smartness cannot resolve that contradiction simply through efficiency gains because the underlying problem concerns the resource base that must sustain both existing and new systems. The Matjhabeng case therefore shifts attention from the affordability of technological acquisition to the fiscal reproducibility of technological transformation. A technology that can be procured but cannot be maintained, secured, integrated or renewed does not constitute durable urban transformation.

6.2.1 Obligated Incapacity

The fiscal findings reveal a condition that can be understood as obligated incapacity: the persistence of developmental obligations alongside declining institutional capacity to finance and reproduce them. Matjhabeng's obligations to provide water, sanitation, maintain infrastructure and sustain other municipal functions do not contract with its revenue base. They remain institutionally binding while accumulated creditor debt and deteriorating infrastructure increase the resources required simply to reproduce existing systems. Fiscal incapacity in this context therefore describes an institutional condition in which obligations persist while the capacity through which they can be discharged progressively weakens.

Digital transformation changes the significance of this condition because technological systems introduce additional obligations into the same fiscal architecture. Acquisition represents only an initial cost; integration, connectivity, maintenance, cybersecurity, technical skills, upgrading and replacement create recurrent demands that must be financed over the life of the system (Kitchin, 2014). A digitally augmented water system, for example, does not displace the obligation to maintain pumps, pipes and treatment infrastructure. It adds another infrastructural layer that must itself be maintained and reproduced. Where existing developmental systems are already inadequately financed, technological expansion can therefore enlarge the municipality's field of obligation without correspondingly enlarging the fiscal capacity available to sustain it.

Obligated incapacity consequently changes the question of fiscal readiness for smart urban transformation. The relevant consideration is whether a municipality can sustain the combined developmental and technological obligations that follow from the introduction of new technology.

In post-extractive territories such as Matjhabeng, this question is sharpened by the contraction of the productive and fiscal foundations from which those obligations must be financed. Smart transformation pursued without attention to this relationship risks adding technologically sophisticated systems to an institutional architecture whose capacity to reproduce its existing developmental functions is already under strain.

6.3 Service Delivery Connects Territorial and Digital Capability

The service-delivery findings reveal perhaps the clearest point at which the two frameworks intersect. Developmental services do not terminate at the household connection, pump station or municipal network. They sustain schools, health, household reproduction and economic activity across the territory. Their deterioration consequently affects these dependent institutions and activities. The school evidence demonstrates this relational character particularly clearly: failure within municipal infrastructure reaches educational institutions and consequently the environments that reproduce human capability.

This relationship complicates narrow understandings of digital readiness. Digital inclusion is frequently approached through connectivity, devices and skills, but the Matjhabeng evidence shows that the reproduction of digital capability itself rests upon more foundational developmental systems. Where infrastructural failure compromises the continuity and safety of schooling, it can also disrupt the acquisition and use of the skills upon which meaningful digital participation depends. The causal pathway identified in the findings therefore runs in the opposite direction from much smart-city thinking: rather than beginning with technology and asking what it can do for service delivery and education, it begins with the developmental infrastructure of the territory and asks whether it can sustain the institutions that reproduce technological capability.

This does not imply that technological intervention is irrelevant to deteriorating infrastructure. Monitoring, sensing, data analytics, and automated management may improve the monitoring and coordination of infrastructure systems. The distinction is between informational capacity and material capacity. Technology may make a failing system more legible without itself restoring the physical, fiscal and institutional capacities required to make that system functional. The developmental value of smart infrastructure therefore depends upon its relationship with the underlying capacity to maintain, repair and reproduce the systems being made smart.

6.3.1 Schools as Sites for Scaling Digital Capability

Schools connect service delivery and digital transformation beyond individual access to technology. They are institutional sites through which digital capability is reproduced across populations and over time. Van Dijk's (2020) distinction between physical, skills, and usage access is important in this regard because the availability of devices and connectivity does not itself produce the capabilities required for meaningful digital participation. Skills must be acquired, practised and reproduced, and schools provide a principal institutional environment through which this occurs. Their significance therefore lies in enabling individual learners to acquire digital skills while reproducing those capabilities across successive cohorts and widening the social reach of digital transformation.

This gives schools a territorial scaling function. South Africa's developmental ambitions depend upon institutions capable of translating national objectives into capabilities distributed across places and populations. The National Development Plan locates education and skills formation within the development of human capabilities required for economic and social participation (National Planning Commission, 2012).

Schools consequently connect developmental and technological transformation by converting educational continuity and institutional capacity into capabilities through which populations can participate in an increasingly digital economy and society. Digital education policy reinforces this function by positioning schools as institutional sites through which digital competencies and technology-enabled learning can be expanded.

The Matjhabeng findings reveal the vulnerability of this scaling function. Where failures in water, sanitation and related infrastructure disrupt schooling, the consequences extend beyond immediate losses in teaching and learning time to the institutional reproduction of digital capability. Connectivity, devices and platforms may therefore be expanded while the institutional infrastructure required to reproduce the capabilities for their meaningful use is deteriorating. In post-extractive territories, the capacity to scale digital transformation must consequently be assessed not only through the reach of digital infrastructure, but through the functionality of the institutions through which digital capability is reproduced territorially.

6.4 Institutional Legitimacy and the Social Absorption of Technology

The findings on institutional legitimacy and governance introduce a further condition frequently underdeveloped in accounts of technological transition. Smart systems are governed systems. They are procured, administered and maintained by institutions, but they also reorganise relationships between those institutions and citizens through billing, monitoring, data collection, service management and automated decision-making. Their successful introduction therefore depends partly upon the institutional environment into which they enter.

In a territory characterised by service-delivery failure, governance intervention and weakened public confidence, technological innovation does not encounter citizens independently

of their prior relationship with the state. New systems may be interpreted through accumulated experiences of service reliability, institutional responsiveness and administrative credibility. This is particularly consequential for technologies that make municipal authority more immediately present in household life, including systems of digital monitoring and consumption management. The question of technological absorption is therefore inseparable from institutional legitimacy: the technical functionality of a system does not guarantee its social acceptance or effective governance.

The untraceable deployment of smart metering demonstrates this relationship between institutional legitimacy and technological absorption empirically. Smart meters extend municipal capacity for consumption monitoring, billing and revenue management, but their introduction does not ensure their effective incorporation into the relationship between households and municipal government. In Matjhabeng, this untraceable deployment occurs within an institutional environment marked by declining public trust, recurrent service delivery protest and formal governance intervention.

These conditions do not establish that legitimacy deficits caused the inability to trace deployment, but they demonstrate why technological installation cannot be treated as equivalent to technological absorption. Digitally mediated billing and monitoring enter relationships between citizens and public institutions already shaped by service experience, institutional credibility and trust (Kitchin, 2014; Morozov & Bria, 2018). The Matjhabeng evidence therefore shows that the capacity to introduce a technological system and the institutional capacity to secure its sustained uptake are analytically distinct.

7. Policy Implications

The findings suggest that smart urban policy in post-extractive territories should begin with an assessment of developmental capacity rather than technological readiness alone. Conventional readiness approaches tend to foreground connectivity, digital infrastructure, data systems, technological skills and administrative modernisation. In territories undergoing economic contraction, however, these conditions are embedded within a wider developmental system. Productive employment shapes the economic capacity for household participation in digital consumption; fiscal mobilisation determines whether municipalities can finance and sustain technological systems; service delivery depends on infrastructure access and the functionality and continued reproduction of the systems through which services are provided; and institutional legitimacy and governance shape the environment within which technological interventions are implemented and absorbed. Smart-city planning should therefore assess territorial developmental capacity, including the operational functionality of existing infrastructure, alongside conventional measures of digital readiness before determining the form, scale and sequencing of technological intervention.

This has implications for the sequencing and fiscal assessment of public investment. Digital investment should not be treated as a substitute for the repair and reproduction of basic developmental systems, particularly where existing infrastructure is functionally compromised. Digital monitoring, sensing and data analytics may strengthen the management of water, sanitation and other municipal systems, but their developmental value depends upon corresponding capacity to maintain, repair and operate the underlying infrastructure. In conditions of obligated incapacity, investment decisions must therefore assess whether municipalities can sustain the combined costs of existing developmental obligations and the recurrent obligations created by technological

systems, including maintenance, security, skills, integration, upgrading and replacement. Smart urban investment should consequently be assessed over its institutional and fiscal lifecycle, rather than against the availability of capital for initial acquisition alone. This would reduce the risk of technological investment enlarging the municipality's field of obligation without strengthening the capacity required to sustain it.

The relationship between service delivery and human capability also requires greater recognition in digital transition policy. Infrastructure serving schools, health facilities and other capability producing institutions should be treated as part of the enabling infrastructure for technological transformation. Schools are particularly significant because they provide institutional sites through which digital skills and usage capabilities can be reproduced across successive cohorts, giving them a territorial scaling function. Digital education strategies therefore cannot be separated from the material functionality of the institutions expected to deliver them. Investment in connectivity, devices and digital learning should be coordinated with the reliability of water, sanitation and other services required to sustain educational continuity. Protecting the functionality of schools should consequently form part of digital transition planning, because the capacity to scale digital infrastructure territorially depends upon the institutional capacity to reproduce the capabilities required for its meaningful use.

Smart urban policy must also address the economic reach of technological transformation. Where productive employment and household incomes are contracting, market-based diffusion of digital products and services may produce increasingly selective participation. Digital strategies in post-extractive territories should therefore consider affordability and the distribution of household economic capacity alongside technological availability. The policy question concerns

both the territorial reach of digital infrastructure and whether sufficient numbers of residents possess the economic and human capabilities required to use it meaningfully. Without this consideration, technological modernisation may improve selected urban systems while leaving the underlying geography of developmental exclusion intact.

Finally, technological transformation should be approached as a governance intervention as well as an infrastructure programme. Digitally mediated billing, monitoring, data collection and service administration alter the relationship between municipalities and residents and therefore enter existing conditions of institutional legitimacy and public trust. The untraceable deployment of smart metering in Matjhabeng demonstrates why technological deployment should not itself be treated as evidence of successful adoption. Where institutional relationships have been weakened by persistent service failure or governance instability, technological systems cannot be assumed to secure sustained uptake simply because they promise greater efficiency. For post-extractive municipalities such as Matjhabeng, the policy objective should be to use technological transformation to augment the developmental capacity of the territory, rather than constructing a technologically sophisticated layer over economic, infrastructural and institutional systems whose capacity to sustain development continues to deteriorate.

8. Conclusion

This study examined what emerges when developmental state scholarship and critical smart urbanism are brought into dialogue in a post-extractive territory. The Matjhabeng case shows that technological transformation does not encounter a neutral urban space awaiting modernisation. It enters a developmental system already shaped by the contraction of productive employment, weakening fiscal capacity, infrastructural dysfunction and contested institutional

legitimacy. The capacity of a territory to absorb and sustain technological transformation is therefore inseparable from the developmental conditions through which that territory is reproduced.

The findings show how these conditions interact across systems. Fiscal contraction can produce obligated incapacity, in which existing developmental obligations persist while the capacity to reproduce them weakens and technological investment introduces additional obligations. Infrastructure access can coexist with declining functionality, while disruption to basic services can reach schools and weaken institutional sites through which digital capabilities are reproduced and scaled. The untraceable deployment of smart meters further demonstrates the distinction between technological deployment and institutional absorption. Smart transformation consequently depends on the technologies introduced and on whether the fiscal, infrastructural, human and institutional systems required to sustain and extend their developmental reach remain functional.

The paper therefore contributes a territorial developmental perspective to smart urban transformation. In post-extractive cities, technological readiness cannot be assessed independently of the capacity to reproduce the developmental foundations on which technological systems depend. Digital technologies may strengthen information, monitoring and administrative coordination, but they cannot substitute for the material and institutional capacities through which development is produced. The central question for smart urbanism in such territories is therefore not how much technology can be introduced, but whether technological transformation strengthens or further burdens the developmental capacity of the territory in which it lands.

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Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

Informed Consent

This article does not contain any studies with human participants performed by any of the authors.

Author Contributions

Kentse Sesele: Conceptualisation; Methodology; Investigation; Formal analysis; Writing – original draft; Writing ,review and editing.

Data Availability

The study draws exclusively on publicly available secondary documentary and administrative data. The empirical data extracted from these sources and used in the analysis are provided as Supplementary Data S1 (Source Dataset) and Supplementary Data S2 (Analysis Dataset). Supplementary Data S1 provides the source level observations and their provenance, including source locations and public access links. Supplementary Data S2 provides the analysis ready values used in the manuscript findings and figures and identifies any descriptive transformations applied. No primary, proprietary or confidential data were generated or used in this study.

The data and supporting materials used in this study are available through the supplementary files.

Supplementary Files

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