CIVIL & ENVIRONMENTAL ENGINEERING | RESEARCH ARTICLE

Municipal asset operations and maintenance performance in metropolitan and rural municipalities in Gauteng Province and Vhembe District Local Municipalities, South Africa

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Abstract: Municipal infrastructure asset operations and maintenance are critical for municipalities to provide basic services to communities in South Africa. The paper discusses the performance of municipal assets using Key Informants and literature review based on three metropolitan areas in Gauteng province and four rural municipalities in Limpopo province of South Africa focusing on asset operations and maintenance. Municipal assets in South Africa are saddled with poor performance because the infrastructure is aging in a context of rapid urbanisation and population growth and this impacts on the level of service delivery to the communities. The method used to analyse and unpack the findings were obtained from the review of literature and information obtained from Key Informants. The major official documents used includes the Sector Plans, Spatial Developments Frameworks, Integrated Development Plans as well as the review of books and journals on the general performance of the metros and rural municipalities with respect to municipal asset operations and maintenance. The information obtained from the Key Informants was used to refute or confirm the notion from the literature reviewed that inadequate operations and maintenance of municipal assets contribute to under performance in the provision of basic service delivery to the communities. The study shows that insufficient funding and low revenue base...
of the municipalities impacts on the renewal of municipal assets and provision of basic services to the communities in both metros and rural municipalities. The study recommends appropriate systems and asset management practices that can be put in place to improve on the under-performance of operations and maintenance.

Subjects: Infrastructure Planning and Services; Human Settlement Planning; Urban and Regional Planning; Built Environment

Keywords: Municipal asset operations; maintenance; performance; metros; rural municipalities

1. Introduction
The poor state of municipal infrastructure asset operations and maintenance in metros and rural municipalities of South Africa as well as rapid urbanization, reduces their performance in service delivery (DCOGTA, 2018). This study uses three metros in Gauteng province (Johannesburg, Tshwane and Ekurhuleni) and four rural municipalities (Mokhado, Musina Collins Chabane, and Thulamela) in Limpopo province as case study areas to unpack the performance of the operations and maintenance of municipal assets. In view of the uncertainties and limitations of capital investment to renew these assets and good asset management practices put in place, the provision of basic services to the communities is at risk.

According to (Kaganova & Kopanyi, 2014), municipal asset operations and maintenance is the process of implementing decisions regarding the operation, maintenance, refurbishment, acquisition, and disposal of infrastructure assets in a cost-effective manner with the aim of improving the performance and service to the local communities. In South Africa, rural municipalities more than the metros often have limited flexibility to raise their revenue base to increase the performance of operations and maintenance of municipal infrastructure (CSIR, 2016; Development Bank of Southern Africa, 2010). The study on three Gauteng metros and four rural municipalities in Vhembe district, shows that municipal infrastructure assets operations and maintenance with respect to the performance of electricity supply, sanitation, roads, and storm water and refuse removal are minimal (Cooperative Governance and Traditional Affairs, 2013). The funding for infrastructure provision is provided in the Municipal Infrastructure Grant (MIG) guidelines. However, to adopt a more sustainable mechanism for investing in asset management requires a rigorous budget provision and a comprehensive operations and maintenance plan (Bikam, 2019). Municipalities in South Africa are expected to improve their asset management to increase the level of service performance to the local communities (Department of Provincial and Local Government, DPLG, 2019; National Treasury, 2021).

According to (Heller, 2009), the Constitution of South Africa assigns responsibility for the delivery of water, sanitation, electricity and refuse removal services to many municipalities. The responsibility for managing and maintaining the infrastructure lies with the asset managers whom we consulted to give use to their views on the performance of municipal asset in their respective municipalities. In a report by the (National Treasury Annual, 2021), the financial backlog in 2014 in South Africa for operations and maintenance and related issues, it was estimated at a combined value of about R1.156 trillion. The challenge municipal asset managers face is how to improve the performance of municipal asset operations and maintenance to provide sustainable service to the communities. Poor municipal operations and maintenance in addition to under-budgeting and under-spending on maintenance and renewal of municipal assets impacts on service provision (Cooperative Governance and Traditional Affairs, 2013; Stenstrom, 2013; Stenström et al., 2013).
These challenges require an appropriate asset operations and maintenance strategy and system to ensure basic service delivery to the communities. According to a study by (Parida et al., 2014), investment in municipal infrastructure asset maintenance in South Africa requires a replacement value of not less than R200 billion in 2014. Similarly, municipal debt in South Africa which includes both non-current and current liabilities totalled R211 billion in 2016. With total assets worth R737 billion, this translates to a debt ratio of 29%. In the National Treasury (Division of Revenue, 2018/2019) annual report, it was indicated that municipalities should not have a debt ratio higher than 45%. Given the importance of this issue, the paper undertakes the analysis of why municipal asset operations and maintenance are underperforming in Gauteng metros and rural municipalities in Vhembe district.

1. Objectives of the study
The main objectives of this study are to:

(i) Use the case study from Gauteng metros and rural municipalities in Vhembe district municipality of the Limpopo province to analyse the performance of municipal asset operation and maintenance managers,

(ii) To analyse existing municipal infrastructure assets funding in the selected metros and four municipalities, and

(iii) To suggest strategic actions that the municipalities can take to facilitate the operations and maintenance of municipal assets to provide basic services and to municipalities to improve performance.

2. Methodology
This study uses the Key Informants (KIs) and literature review to obtain and analyse data in line with a similar study by (Zuashkiani et al., 2014) on the challenges faced by municipal managers with respect to the provision of basic service delivery to communities. The semi-structured questionnaire was administered to the Key Informants to determine the state of municipal infrastructure asset operations and maintenance in Gauteng metropolitan cities and rural municipalities in Limpopo province.

2.1. Literature review
The Guidelines for Infrastructure Asset Management in Local Government 2006–2009, Department of Infrastructure Development on Estimates of Provincial Revenue and Expenditure, 2019 Report, the Revised Spatial Development Plans of Musina, Makhado, Thulamela and Collins Chabane local Municipalities, and Vhembe District Municipality Integrated Development Plan (IDP) report 2017/18–2021/22 were the main secondary data reports used to extract current information on the selected metros and rural monticellites. To determine the status and performance of municipal asset operations and management, a semi-structured questionnaire was used to assess the opinions of Key Informants (KIs) on asset operations and maintenance in the selected metros and rural municipalities their performance with respect to basic unfractured service delivery and the challenges they faced (Department of Infrastructure Development, (DID), 2019; Division of Revenue, 2017/18, Division of Revenue, 2018/2019, Division of Revenue, 2018/2019, and Division of Revenue, 2020/2021).
2.2. Key Informants (KIs)
A semi structured interview questionnaire formulated on municipal asset performance themes was administered to Key Informants (municipal asset managers) to obtain their ample knowledge of the state of assets in the metros and rural municipalities. This approach was necessary to accommodate a range of different responses form the asset managers particularly from the point of view of the performance of the metros and rural municipalities with respect to asset management.

2.3. Problem identification
According to the (National Treasury, 2021), report in the last ten years community residents in metropolitan and rural municipalities in South Africa witness frequent protests due to poor provision of pipe borne water supply, inadequate provision of electricity, poor sanitation infrastructure maintaining, and irregular refuge removal. The study was undertaken to determine the performance of the municipalities with respect to municipal asset operations and maintenance and the reasons for the poor provision of services to the communities.

2.4. Problem outline
The problem in this study hinges on the inadequate performance of municipal assets operations and maintenance in metropolitan and rural municipalities to provide satisfactory services to the communities.

2.5. Benefits of the research
The benefits from this research are that the findings, analysis recommendations, and conclusions will give a general picture of the status of assets operations and maintenance in both rural and metropolitan monticellites in South Africa and their implications for service delivery. The discussions from the results throws some light on the poor state of municipal asset maintenance, aging assets, irregular maintenance and inadequate funding of municipal infrastructure provision in South Africa. The analysis of the findings and recommendations were used emphasise the need to use the Asset Performance Management System (APMS) to improve their performance and response to the service delivery challenges faced by municipal asset managers in metropolitan and rural municipalities in South Africa and other countries in similar situation.

2.6. Data collection
The data collection phase consists of information obtained from the KIs to confirm or refute if the findings from the literature review are a fair reflection of the state of municipal asset operations and maintenance in the respective municipalities. The questionnaires were predetermined to highlight the fundamental issues of municipal infrastructure assets operations and maintenance in the metros and the four municipalities in the light of poor service delivery to the communities (Municipal Systems Act 32 of 2000).

2.7. Date processing
Data processing was based on arranging the secondary and primary data collected from the municipal reports and from the KIs, respectively. The data processing was to determine the performance and effectiveness of municipal asset operations and maintenance in the metros and the rural municipalities (Elizaveta et al., 2020). In addition to this, the information obtained from the KIs were compared with the information collected from the secondary data sources. The data arrangement was set to determine the authenticity of the information from the KIs and those from the approved municipal reports on inadequate assets operations and maintenance performance.

2.8. The implications for service delivery
The implications of the study focused on the state of poor asset operations and maintenance and the implications for service delivery to the communities in rural and metropolitan municipalities. In
addition to this, the study determined why there were irregular maintenance of the assets and inadequate funding for assets, in the light of increasing urban population and aging infrastructure.

The preceding method of approach accommodates a range of different responses from the Key Informants from Gauteng metros and the rural municipalities in Vhembe district of the Limpopo province of South Africa. The information obtained from the Key Informants was to confirm if the findings from the literature reviewed are a fair reflection of the state of municipal asset operations and maintenance in the respective municipalities. The questionnaires were predetermined to highlight the fundamental issues of municipal infrastructure asset operations and maintenance and their performance on service delivery in the four municipalities and the metros. A semi-structured interview questionnaire was directed at the municipal officials in 2018 and 2019. A total of 20 Key Informants from Gauteng metros, comprising two representatives each from Tshwane, Ekurhuleni and Johannesburg including a GIS representative from each metro and a town planner participated in completing the questionnaires. Similarly, 10 municipal asset managers from Vhembe district municipalities including the directors for infrastructure and the deputies from each of the four municipalities comprising, Musina, Makhado, Thulamela, and Collins Chabane local municipalities and Vhembe district infrastructure development director and his deputy were consulted. The analysis was limited to municipal infrastructure asset operations and maintenance performance (Draft Gauteng Spatial Development Framework, (DGSDF), 2020; Gauteng Province, 2011; Kailin & Aurobindo, 2017; Rashid, 2017).

The Key Informants were requested to indicated if the municipalities use the MIG guidelines in their respective municipalities (Makhado Local Municipality Asset Policy, 2016). Additional information from the municipal officials were obtained as follows:

- Review of available reports on the state of municipal infrastructure funding from the (National Treasury report, Division of Revenue, 2018/2019).
- Telephone discussions with the asset managers or Key Informants from the rural municipalities in Vhembe district.

3. Factors Affecting the Performance of Municipal Assets Management in South Africa
Outlined in the paragraphs that flow are factors that affects the performance of the management of municipal infrastructure assets operations and maintenance in South Africa in general. Municipal infrastructure assets support the development of communities and provides essential services to sustain a vibrant economy at the municipal level in South Africa. The factors are related to municipal infrastructure financing, infrastructure regulatory policy, aging infrastructure, and asset monitoring matters (Zuashkiani et al., 2014a, 2014b).

3.1. Municipal infrastructure funding factor
According to (Elizaveta et al., 2020), most municipal infrastructure asset managers are under immense pressure to provide and maintain an acceptable level of service and performance within shrinking municipal infrastructure budget allocation for operations and maintenance. In most municipalities in South Africa, the availability of funds plays an important role in maintaining the level of municipal assets operations and maintenance because lack of funds affects service deliver performance. Asset managers need to strike the right balance between expenditure and taking additional risks which can adversely affect the life cycle of the infrastructure (Department of Infrastructure Development, (DID), 2019). When developing capital investment and maintenance plans, municipal infrastructure asset managers and decision-makers rarely consider options that put initial investment that yield lower costs and risks and those that encourage higher performance during the life cycle of the assets (ISO, 2014a, 2014b; ISO 5500, 2014; Division of Revenue, 2017/18).
3.2. Regulatory and policy factors

In South Africa, the Municipal Infrastructure Grant (MIG) is the guiding policy and regulatory piece of legislation from which the funding and processes of providing water, sanitation and refuge removal to the communities in both rural and metropolitan municipalities are managed. However, many rural municipalities use the MIG for other purposes other than what it is meant for. In the (StatsSA, 2016), funds provided through the MIG are used for paying staff salaries which defeats the purpose of the MIG allocation for assets operations and maintenance (Department National Treasury, 2019). For example, the South African National Treasury has recognised that there are lapses in the criteria for the allocation of MIG to municipalities in terms of how the funds are managed. One of the major challenges of infrastructure delivery is related to inadequate management of expenditure for municipal asset operations and maintenance (Kailin, 2017). This affects the provision of bulk infrastructure for sectors such as transport, energy, water, sanitation, and refuge removal (Wijnia & De Croon, 2019). Note that the need to generate sufficient investment plans to satisfy regulatory demands for current infrastructure policies in South Africa puts more emphasis on compliance with MIG requirements than the performance of the asset (Makhado Local Municipality Asset Policy, 2016).

3.3. Ageing municipal infrastructure factor

According to (Boshoff & Peters, 2006; 2013; Boshoff et al., 2009), municipal infrastructure assets in South Africa are ageing at an alarming rate. According to (Ruitenburg et al., 2016), it was estimated that about 60% of municipal assets in rural municipalities in South Africa have on the average passed their Remaining Useful Life (RUL) more than 10 years. This led to decreasing investment to replace aging infrastructure in metros and rural municipalities. On the contrary, investment in infrastructure replacements should be on the increase to maintain existing assets and cater for increasing demand for service delivery to the communities. Infrastructure assets are characterised by age, deterioration, high cost of maintenance (Department National Treasury, 2018; Division of Revenue, 2020/2021). In the report of the Department of Cooperative Governance and Traditional Affairs DCOGTA (2019), it was indicated that municipal operations and maintenance situations in South Africa, shows that aging infrastructures require an integrated approach to standardise the way municipal infrastructure assets are managed (Amekudzi & Mcneil, 2008).

3.4. Asset performance monitoring and prediction factor

The question of aging infrastructure in South African municipalities, presents increasing challenges in terms of understanding their current condition and performance because most municipalities do not have the capacity to monitor and predict how these might evolve in the future (Boshoff et al., 2009; De Gomes et al., 2018). For example, irregular inspections and infrequent monitoring of municipal assets lacks capacity in terms qualified artisans (Porlikad & Jafari, 2016). The current large-scale network of infrastructure in rural and metropolitan municipalities and lack of human capital makes it difficult to identify and locate all the assets. This affects the integrity and completeness of municipal asset registers (DLPG, 2012). Compounding these problems are the uncertainties of monitoring and documenting the nature and intensity of the performance of these assets over their RUL and long-life cycle. The technology and software for real-time monitoring of municipal assets are in the market but most rural municipalities lack sufficient funds to buy and use them to operate and monitor the assets (Boshoff & Peters, 2013, 2006).

3.5. Implications of inadequate attention to asset operations and maintenance in South Africa

The International Infrastructure Management Manual (IIMM) requires that the estimation of asset maintenance budget be a percentage of current replacement cost, but in South Africa the challenges is that this is not adequately adhered to (http://www.imgs.zanews-articlesaccesed 2020).
For example, for the period 2005/06–2011/12, the total amount of “deferred maintenance” in annual financial statements) was R16.46 billion. Incidentally this was equivalent to the 2011/12 maintenance budget, which means that 1-year’s maintenance is foregone every 6 years (Parida et al., 2014; Parida, 2012; Parida & Stenström, 2016; Parida 2009; Parida 2010). In addition to this, when it is measured against the accepted international benchmark, the municipalities in South Africa should have spent not less than R21.66 billion on maintenance in 2011/12 alone. The results presented shows significant under-spending on both asset renewals and maintenance in most municipalities in South Africa (NAMS & IPWEA, 2011; StatsSA, 2016). According to StatsSA (2016) community survey, not <50% of their maintenance budget is used for other purposes other than municipal assets operations and maintenance. In addition to this, the current regulatory, planning and institutional arrangements are inadequate. Municipalities have not addressed pressing inadequate quality of existing regulatory regime due to poor asset management practice in South Africa (Christer, 2014). Inadequate maintenance of existing municipal infrastructure in South Africa undermines service delivery and increase the service backlogs. Note that adequate spending on municipal assets improves the lifespan of municipal infrastructure and contributes to sustainable service delivery to communities. However, due to mis-calculated project prioritisation in municipalities with respect to Integrated Development Plans (IDP) and budgetary constraints, infrastructure operations and maintenance have become soft targets for cuts in spending on infrastructure maintenance and renewal (Zhang & Karim, 2014a, 2014b).

3.5.1. Implications of weak municipal fiscal management challenges

Briceno (2011), indicated that municipal infrastructure is a critical vehicle for the promotion of economic development and competitive in the communities. In South Africa, the civic/public sector is the main funder of infrastructure and administrations but maintaining municipal infrastructure assets is well below what is expected for good performance (CSIR, 2010). There is need for rehabilitation and restoration across most municipalities in South Africa because it is characterised by inadequate budget provision which leaves municipal assets maintenance neglected. This is because maintenance yields little observable immediate political benefit and is easily deferred until the assets become very old and cannot perform effectively. In addition to this, budgets for the maintenance of aging infrastructure are often neglected by the politicians. According to a report by (DLPG, 2012), it was indicated that one of the reasons for poor infrastructure maintenance is the disjuncture between those who decide on new infrastructure investment and those who are responsible for recurrent spending. The emphasis in the municipalities is always on providing new infrastructure thus neglecting the maintenance of the existing (Kaganova & Kopanyi, 2014; Kopanyi, 2013).

In order to increase expenditure on infrastructure maintenance, two key conditions need to be satisfied: (i) recruit qualified and experienced personnel for municipal asset operations and maintenance and (ii) municipal asset champions and stakeholders should be prepared to make funds available for maintenance purposes (Bourne & Neely, 2000, 2003; https://www.imqs.co.za/news-articles, 2020). The local government Infrastructure Asset Management Guideline manual requires that local governments adopt a comprehensive approach to infrastructure asset, operations and maintenance to come up with strategies which stipulates that an asset life cycle should be maintained on a regular basis (Department of Provincial and Local Government, DPLG, 2019). According to (Parida et al., 2014), current literature on the state of municipal infrastructure in South Africa shows that little emphasis is placed on infrastructure assets maintenance and renewal in metros and rural municipalities. A comprehensive approach to municipal infrastructure asset maintenance requires the planning, design, management, implementation and maintenance of the assets so that services to the communities can be provided throughout its life cycle (Rouse & Putterill, 2003). This observation is pertinent because most municipalities devote little attention to accurate infrastructure assessments especially with respect to water and sanitation, electricity,
roads, and refuge removal. The Department of Water Affairs (DWA) estimates that the provinces with major water services bulk infrastructure backlogs include Eastern Cape, KwaZulu Natal, and Gauteng provinces. In Gauteng province where Johannesburg, Ekurhuleni, and Tshwane metros are located, there are challenges in providing water and sanitation to many communities because of lack of funds and rapid urbanisation. This means that the maintenance of and roll-out of infrastructure projects cannot be addressed promptly guarantying performance success (DCOGTA, 2014).

3.5.2. Population growth and municipal service delivery challenges

South Africa’s population is currently growing at about 1% per annum and in terms of population and the urbanization rate of growth is put at about 1.2% per annum (StatsSA, 2016). Population growth and infrastructure needs in South Africa occur mainly in urban areas and this constitute not <64% of the approximately 57.78 million people that live mainly in cities or large urban areas, of which 40% are situated in the large metropolitan cities such as Johannesburg, Ekurhuleni and Tshwane. It is expected that the urban population will rise to 70% by the year 2030 (StatsSA, 2016; Harrison & Todes, 2013; Integrated Urban Development Framework (IUDF), ; DCOGTA, 2014). Metropolitan areas and rural towns provide about 80% of South Africa’s Gross Value Added (GVA), which is about two-thirds of the South African towns. South Africa has one of the lowest population densities in the world but as an upper-middle income country, it has one of the most profound socio-economic disparities in Africa (Integrated Urban Development Framework (IUDF), ; DCOGTA, 2014). This is reflected in rural-urban migration and spatial disparities within towns with inadequate access to basic service provision and city amenities and community services. It is also a reflection of the past apartheid segregation settlement planning and provision of services which have adverse consequences on low revenue-based municipalities such rural municipalities (Draft Gauteng Spatial Development Framework, (DGDF), 2020; Government Digest, 2019).

3.5.3. Challenges of the deterioration of municipal infrastructure assets

Whereas the pace of infrastructure deterioration in South Africa cannot be modelled according to the Expected Useful Life (EUL) of infrastructure so as to inform planning, in practice the assets are often pushed to their limits because of constraints regarding capital budgets, age, and delayed maintenance of municipal infrastructure (ISO, I, 2014a, 2014b; ISO 55001, 2014; ISO 55001, 2014; Moodley, ; Ruitter, 2015; Woodhouse, 2014). For example, the conditions of water and sanitation and electricity infrastructure in 2020 and what can be expected in the next 5 years, based on current investment levels show that municipal asset portfolios will deteriorate from poor to very poor, and capital renewal backlogs will grow further because of the need for capital renewal programmes (CSIR, 2010; Zhang & Karim, 2014a, 2014b).

3.5.4. Challenges of maintaining existing infrastructure in South Africa

Section 4 (2)d of the Local Government Municipal Systems Act (MSA), 32 (2000), states that “a municipality has the duty to strive to ensure that services are provided to communities in a financially and environmentally sustainable manner.” According to the (ASCE, 2013), good asset operations and maintenance can improve the provision of basic services in a financially sustainable manner. In South Africa, the emphasis is on providing new infrastructure to meet the backlogs in previously disadvantaged communities and broadening service delivery. There is insufficient focus on planning for maintenance and renewal of municipal assets Parida & Kumar, 2010). The backlog for the maintenance of water, sanitation, electricity, roads and storm water, and refuge removal impacts on the quality and quantity of basic services to the communities. This explains why (Parida, 2016; Parida & Stenström, 2016), maintains that a new strategy is needed for the integration of planning, sector coordination and life cycle sustainability of municipal assets to maximise service delivery to the communities (Government Digest, 2015; Ministry of Development and Construction, (MDC), 2011; Stenström et al., 2013; Vhembe; IDP 2017–2019).
Section 4(e) of the Municipal Planning and Performance Management Regulation of (RSA (Republic of South Africa), 2002), promulgated in terms of the Municipal Systems Act (MSA) Section 120 (4) requires that the Capital Investment Framework (CIF) be put in place to ensure sound municipal asset operations and maintenance in terms of Section 21 (n) of the Spatial Planning and Land use Management Act 16 of (2013) & (Woodhouse, 2014). However, the importance of maintaining municipal infrastructure assets is critical to address the challenge of maintaining existing municipal infrastructure assets (Petchrompo & Parlikad, 2019; StatsSA, 2016) points out that the problems of lack of capacity, poor infrastructure provision, poor operations and maintenance and sometimes weak leadership contribute to inadequate prioritisation of municipal assets.

3.5.5. Increasing municipal infrastructure maintenance backlog challenges
According to (Boshoff & Peters, 2013; Sasha, 2013) and StatsSA (2016), capital renewals programmes are required to address the backlogs of infrastructure operations and maintenance in South African municipalities. This requires that municipalities spend annually at least an additional R4 billion per sector for (water and sanitation, and electricity), whereas current levels of investment in capital renewals are between R600 and R800 million per year (Petchrompo & Parlikad, 2019). If current investment levels in infrastructure asset operations and maintenance are not improved in the next 5 years, the conditions of water, sanitation, and electricity infrastructure will deteriorate from poor to very poor. In addition to this, capital investments in renewals will deepen and a much greater capital renewals programme will be needed to restore them to acceptable standards in the medium to long term periods (Bikam, 2019; Rashid, 2017; & Sasha, 2013).

4. Study locations and discussions
Outlined below is the presentation of the study locations and the analysis and discussions of the research results.

4.1. The study locations
The study locations are the three metros in Gauteng province and four rural municipalities in Vhembe district municipality in Limpopo province. Their choice stems from assertion that among the nine metropolitan areas and 205 local municipalities in South Africa. Gauteng metros (Johannesburg, Tshwane, and Ekurhuleni are the most affected in terms of demands for infrastructure upgrading and basic service delivery. Similarly, in the reports of StatsSA (2016) and SALGA (2019), the Audit Performance which is the criteria set to measure how metros and rural municipalities perform in terms of infrastructure asset operations and maintenance were critical of the levels to which Gauteng metros and rural municipalitieies in Vhembe district (Collins Chabane, Makhado, Musina, and Thulamela) performed. These metros and rural municipalities constitute some of the most affected with respect to the management of the provision of water, electricity, sanitation roads and storm water and refuge removal to the communities. Figure 1., shows the location of the selected metropolitan and rural municipalities for this study.

Figure 1., shows the three metropolitan cities in Gauteng which included Johannesburg, Ekurhuleni, and Tshwane. Figure 2., shows the four rural municipalities in Vhembe district of the Limpopo province which include Thulamela, Makhado, Collins Chabane, and Musina local municipalities.

Gauteng province represents one of the core economic nodes in South Africa and the four rural municipalities are expanding rapidly in population and require regular maintenance of their infrastructure assets. According to (StatsSA, 2016) community survey report, the four rural municipalities in Vhembe districts are among those in distress with respect to municipal asset
operations and maintenance. Gauteng metros have a combined population of 14,459,649 people with industrial zones that are expanding rapidly and require regular upgrading and maintenance of the assets. The four rural municipalities in Vhembe district have a total population of 1
393,949 million people according to the StatsSA (2016) and the residents protest for infrastructure services to improve (https://www.imqs.maintenance-management-municipal, accessed 29 March 2020).

4.2. Discussions

4.2.1. The Impact of rapid population growth on asset funding in Gauteng metros

Johannesburg, Tshwane, and Ekurhuleni metropolitan areas constitute the primary economic hub of Souths Africa accounting for about one third economic activities in the country and as such the pressure on infrastructure demand in on the increase (SALGA 2019). For example, Ekurhuleni metropolitan accounts for one quarter of all industrial hubs production in South Africa and there is a huge demand for services such as electricity, sanitation, waters supply roads, and storm water drainages. The population of Gauteng province has been growing faster in comparative terms than the other large municipalities in South Africa (Rashid, 2017) and this puts immense pressure on service delivery. From Rashid’s analysis, the population of Gauteng increased by 3.2 million between 1995 and 2011, which was more than a third of the annual rate of 2.6 per cent growth compared with the national rate of 0.6 per cent (Rashid, 2017; StatsSA, 2016). The growth scenario estimates by (Rashid, 2017) shows that metropolitan Johannesburg attained almost 15 million people in 2017. Figure 3., shows the estimated trend in population growth across Gauteng metros.
Figure 3., shows that the total projected growth of the population of Gauteng metro including West Rand and Sedibeng by 2025 will be 16.3 million and 18.7 million peoples by 2037, respectively. The great concern regarding the capacity of municipalities to meet their service delivery mandates, particularly in the face of rapid urbanization occurring in such large metropolitan areas such as in Gauteng as well as inadequate infrastructure operations and maintenance is of great concern for service delivery to the communities (Rashid, 2017).

4.2.2. Funding for infrastructure provision in metros and rural municipalities

Table 1., shows the estimates of departmental transfers to local government by category of municipalities to fund infrastructure development in South Africa in accordance with the Municipal Systems Act 32 of 2000 classification or definition of municipalities.

Further to the allocation the figures in Table 1., shows that conditional grants were used to finance capital projects, while unconditional grants were used for operational spending whereas it is supposed to be the opposite. This is because conditional grants are meant for funding infrastructure development in the municipalities. MIG allocation should not be used for any purpose other than for operations and maintenance of the assets. This explains why there are shortfalls in the money made available for infrastructure development in the metros, district and rural municipalities in South Africa (Draft Gauteng Spatial Development Framework, DGSDF, 2020). The figures show that total allocations to local governments have been on the increase over the years, from R18.2-billion in 2006/7 to R101.3-billion in 2015/16 and were projected to increase to R128.4-billion in 2018/19. However, during the same period, the unconditional portion of the total allocations was higher than the conditional component of the allocations which there was the shortfall for infrastructure development (Kailin & Aurobindo, 2017). The share of local government allocations to the total nationally increased, from 6.3% in 2006/7 to 9.0% in 2015/16, and was projected to reach 9.4% in 2018/19. Similarly, between 2008/09 and 2012/13, the total conditional allocations to municipalities increased from R15.6-billion to R41.7-billion, with grants for infrastructure accounting for a larger share. These estimates show significant increases, but the municipalities still face service delivery challenges as well as operations and maintenance challenges in, district, rural and metropolitan municipalities. The problem is not that funds were made available through the MIG but due fragmented decision, off-budget spending, and liabilities, as well as lack of consolidated financial reporting on asset maintenance and management the metros and the rural municipalities could not performed as required (Bikam, 2019).

4.2.3. Capital investment and asset portfolios of Gauteng metros

From the analysis in the previous paragraph, in the three metros in Gauteng there was sufficient funding allocation for diverse infrastructure projects however, they were not used as prescribed in the guiding policy document of the MIG. This looked as if there was inadequate funding for municipal asset maintenance, asset inventory keeping and aging infrastructure across all categories of the assets. Hence the provision of basic service to some parts of the community in Gauteng such as West Rand, Sedibeng, Mamelodi, Kopongong precinct and Soshanguvre to mention a few was inadequate. Figure 4., is the summary of the cost of providing and maintaining municipal infrastructure in Gauteng metros. These cost estimates were presented at the Gauteng Infrastructure Funding Summit in May 2017 with respect to the long term spatial and infrastructure plans of the province.

Figure 4., shows an ambitious cost estimate for long term spatial and infrastructure development from 2017 to 2030 for Gauteng metros. As at 2017, the average value of the rand to the USA dollar was 16 Rand to one dollar in the money market. The implications for infrastructure provision were that for example, transport infrastructure required Rand 538 billion which corresponds to 33.8% of the total budget estimate for all infrastructure from 2017 to 2030, followed by energy
with Rand 438.7 billion or 27.6% of total budget, pipe-borne water with Rand 132 billion or 8.2%, sanitation budget was estimated at Rand 65 billion accounting for 4.1% of the total budget and solid waste was Rand 17.5 billion which was about 1.1% of the total budget allocation. The estimated rand value allocations did not include the replacement values of the assets and their operations and maintenance because municipal asset maintenance comes from MIG allocation. The estimates were high, but they were not meant for operations and maintenance because municipal assets maintenance comes from conditional allocation and as such were not used for asset upgrading or maintenance. Table 2, shows the analytical deductions and implications for infrastructure assets operations and maintenance situations in Gauteng metros by asset category (Department of Infrastructure Development., (DID), 2019).

Table 2. Infrastructure category and implications for services delivery in Gauteng

| Asset category | Implications for basic infrastructure service provision |
|----------------|---------------------------------------------------------|
| Water          | • Unsustainable level of consumption such as free basic water  
|                | • High water losses due to aging infrastructure          |
| Electricity    | • Supply disruption due to theft, vandalism and inadequate maintenance  
|                | • Over reliance on coal but there are many opportunities for renewal energy production |
| Sanitation     | • Lack of adequate bulk infrastructure in Sedibeng and West rand has delayed the implementation of infrastructure projects in such areas |
| Transport      | • Fragmented spatial forms and low densities in some areas do not support increase in road freight transport has compounded the problem |
| Solid waste    | • Landfills nearing capacity as well as shortage of new sites  
|                | • Recycling of solid wastes is not viable without volumes if it is not rationalised |
| Education      | • Backlog of 220 schools with implication for the placement of leaners  
|                | • Inadequate maintenance of smart IT, theft and vandalization of classrooms |
| Health         | • Increasing demand on public health facilities and infrastructure  
|                | • Indecision on build new or refurbishment of large health facilities |

**Sources:** Authors’ deductions from, (Draft Gauteng Spatial Development Framework, (DGSDF), 2020)
From the analytical deductions in Table 2, the Draft Gauteng Spatial Development Framework, 2030 vision raises concerns for all asset operations and maintenance.

4.2.4. Assets situations in rural municipalities of Vhembe District of Limpopo province

Established in 2000, Vhembe district municipalities which comprised of Makhado, Thulamela, Musina, and Collins Chabane had serious challenges with infrastructure asset operations and maintenance because they are vast rural municipalities with large land coverage. The four municipalities cover an area of 21,4007 km² and the population was estimated at 1,393,949 people which constitute about 382,358 household for 2017–2022 (Vhembe IDP, 2017/18–20/22; StatsSA, 2016; Stats SA Community Survey, 2016). According to the Community Survey of 2016, Thulamela had 130,321 households, Makhado 116,371, Musina 43,730, and Collins Chabane had 91,936 households in 2016. Table 3 shows the population of the four municipalities according to (StatsSA, 2016). According to the (Vhembe district municipality, 2019) report, the implications of rapid population growth is that the municipalities do not have the revenue base to provide and maintain existing municipal infrastructure given the land area to be covered. This is because rural municipalities have settlement patterns that are not compact but isolated thus increased cost of service delivery. As a matter fact the municipalities need a large amount of MIG allocation to cater for most of the population. Table 3, depicts the population estimates in the four rural municipalities in Vhembe district municipality.

Table 3, shows that the population of Vhembe District was 1,294,722 from the Census 2011 and this increased to 1,393,949 from the 2016 Community Survey. The information shows that from 2011 to 2016 the population of Vhembe increased by 99,227 people. The implication is that the municipalities had to maintain infrastructure assets and provide service to all amid additional population. Table 4., shows household's access to basic service (Vhembe IDP, 2017/18–20/22).

Table 4., shows a high number of households totalling 28,287 with access to drinking water. Note that the notion of basic water supply is that every household must be able to fetch water not more than 200 meters form any given residential building. From the StatsSA (2016) statistics, this was not likely to be archived in the four local municipalities in Vhembe district by 2030. Although some of the households get water from pipe borne water supply, (tap inside the yard), only about 10,917 households had access to water from flowing tabs and the others from streams/rivers in the four local municipalities. In terms of access to basic sanitation, the district reduced the sanitation backlogs but for Ventilated Improved Pit (VIP) it was reduced from 176,285 in 2003 to 118,743 during the 2015/16 financial year. In addition to this, the district was able to complete the provision of 57,542 VIP toilets but remained with a backlog of 118,743 households without VIP toilets during the 2015/16 financial year. The challenge is the huge sanitation backlog, lack of policy clarity on the operations and management of infrastructure on private land, non-availability

| Municipality       | Area in km² | Population in 2011 | Population estimates in 2016 | Population increase % in 5 years |
|--------------------|-------------|--------------------|------------------------------|----------------------------------|
| Musina             | 7,577 km²   | 68,359             | 132,009                      | 93.11%                           |
| Thulamela          | 5,835 km²   | 416,728            | 497,237                      | 19.32%                           |
| Collins Chabane    | 5,003 km²   | 328,636            | 347,975                      | 5.89%                            |
| Total Vhembe district | 2 893.936 km² | 1,294,722        | 1,393,949                    | 7.67%                            |

Source: StatsSA, 2011 and Community Survey, 2016.
Table 4. Households access to basic services in four rural municipalities in Vhembe district

| Municipality    | Population estimates in 2016 | Household access to basic services by type | Electricity | Sanitation | Water | Refuge removal | Education facilities |
|-----------------|------------------------------|------------------------------------------|-------------|------------|-------|----------------|----------------------|
| Vhembe DM       | 1,393,950                    |                                          | 364,358     | 200,500    | 382,358 | -               | 556,803              |
| Musina          | 132,009                      |                                          | 39,728      | 40,529     | 43,730 | 2479           | 132,009              |
| Thulamela       | 497,237                      |                                          | 121,639     | 259,266    | 130,320 | 11,812         | 49,237               |
| Makhado         | 417,727                      |                                          | 111,677     | 110,673    | 116,370 | 28,212         | 416,728              |
| Collins Chabane | 347,975                      |                                          | 87,076      | 77,195     | 91,935 | -              | 347,974              |

Source: Vhembe District Municipality IDP Report, (2017/18-2021/22) IDP.

4.3. Key informants’ assessments of municipal asset infrastructure performance

In this section the discussion looks at how the Key Informants (KIs), are saddled with the task of operating and maintaining municipal infrastructure in Gauteng metros including the four local municipalities in Vhembe district to unpack why there is under performance as far as municipal asset maintenance are concerned. According to the South African Integrated (IDP) definition of municipal performance and under performance of operations and maintenance of municipal infrastructure, they are defined in terms of basic which implies minimum access, intermediate representing average access and full representing maximum access to the services.

The KIs indicated that although funding for operations and maintenance of municipal assets is made available through the MIG, they indicated it is not adequate enough for the maintenance of municipal assets because some of the funds are rechannelled for other purposes other than for municipal assets maintenance (Vhembe IDP, 2017/18–20/22). According to the KIs the leading challenge with municipal asset operations and maintenance in the three metros and the four rural municipalities is inadequate availability of funds for asset operations and maintenance. This amounted to unreliable water supply, poor roads maintenance and below basic access to electricity supply. Not less than 43% of the key informants indicated that inadequate safe and reliable water supply was the biggest challenge, followed by poor roads and storm water maintenance with 56.2% of the informants confirming the poor performance. 74.7% of the KIs indicated that the cost of water provision was one of the major sectors that under performed in Gauteng metros and the rural municipalities during the 2018/19 financial year. Refuge removal was reported to have performed above average, where 84,5% of the key informant gave a thumbs up. Similarly, 78,1% of key informants strongly agree that operations and maintenance was the main problem facing the metros particularly in high density settlement areas. However, 36,3% of the KIs strongly disagree that their main challenge was lack of capacity to undertake operations and maintenance of the municipal assets against 85,6% who very strongly agree that that the main challenge they faced was inadequate allocation and use of funds for operations and maintenance. In addition to this, 14,4% of the key informants agree and a further 3,6% of them strongly agree that the municipalities have made frantic efforts to resolve the challenges of municipal asset operations and maintenance under performance.
From the analysis above and the key informants’ insights on the performance of operations and maintenance of municipal assets in Gauteng province of South Africa and the rural municipalities in Vhembe district municipality, municipal asset have not been performing well thus contributing to poor service delivery to the communities in both study locations. It is evident from the literature review that current spending on Operations and Maintenance (O&M) of municipal asset in the selected metros and rural municipalities were insufficient. According to the Key informants, the current practice of operations and maintenance of municipal assets face multiple risks ranging from inadequate provision of basic services to the communities and inadequate allocation of funds for O&M. The KIs assessments of the poor performance of the provision of basic service to the communities is as a result of poor municipal assets operations and maintenance. The KIs assertion on the notion of the under-performance of the assets was confirmed in a report by (Department of Infrastructure Development, (DID), 2019) which showed that the Remaining Useful Life" (RUL) of municipal assets have shortened by 33% because of inadequate investment in O&M. Critically speaking, this has increase long-term capital investment needs in metropolitan areas and rural municipalities by one-third. Similarly, underinvestment in O&M in the two study locations led to overall decline in the quality and quantity of service delivery to the communities (Department of Infrastructure Development, (DID), 2019). Figure 5, shows a hypothetical road asset depreciation in Gauteng metros modelled according to similar findings in the performance of roads and storm water depreciation in Ethiopian cities in 2011.

The illustrations in Figure 5, shows a comparative resemblance of a similar study in Ethiopian cities to those in Gauteng metros and rural municipalities in Vhembe rural municipalities with respect to roads and storm water drainages. There was accelerated depreciation as shown in Figure 5 above. The crux of the matter with O&M under performance can only improve when the inventory of aged municipal assets and their conditions of frequently assessed for maintenance as well as forecast future capital investment needs to plan corrective and preventive maintenance and repairs measures to improve the performance of the assets. In Table 5, shows the key research findings as informed by the KIs estimate assessment and ranking of assets conditions requirements in percentage in Gauteng metros and the rural municipalities in Vhembe district, Limpopo province of south Africa.

The estimate ranking of asset conditions and maintenance required by the KIs, for all the municipal assets including (water, electricity, sanitation, roads and storm water, refuge removal and water) shows limited useful life and depreciation of the assets if nothing is done. The KIs indicated that the municipalities will face huge service delivery challenges to the communities. In a nut shell, Figure 6, illustrates the key informants assessment of the assessments in both the metros and the rural municipalities of South Africa.

Figure 5. Example of typical hypothetical depreciation of road assets.

Source: Redrawn from “Capital investment planning guide for Ethiopian cities” Ministry of Development and Construction, (MDC) (2011: 21).
5. Addressing Municipal Asset Operations and Maintenance under performance

Outlined below are the recommendations regarding municipal asset operations and maintenance including what municipal asset managers need to do to improve the performance and challenges faced by Gauteng metros and rural municipalities.

5.1. Addressing operations and maintenance expense liabilities

According to Marzouk and Osama (2017), growth and investment in new capital assets without adequate maintenance of existing and aging infrastructure will create future expense liabilities to manage, operate, maintain, repair, and recapitalize the municipal assets. The analysis implies that annual municipal infrastructure Operations and Maintenance (O&M) costs will increase if metros and rural municipalities do not undertake O&M in the first 6 years of the infrastructure facility (Marzouk & Osama, 2017). This is because it can trigger the accumulation of recapitalization funding if not done within the specified period. Moreover, there is need to address the lacunae in O&M policies for planning O&M expenses for municipal assets maintenance because funding estimates for infrastructure asset operations and maintenance are insufficient in rural municipalities and must be improved in metros because their needs are much larger than in rural and district municipalities where the population have been increasing in the last ten years. The key to improve the performance of municipal assets is to respond to O&M inadequate budget allocation which has been on decrease in the last ten years in South Africa. In addition to this, under-investment for the maintenance of existing and aging infrastructure such as water pipes, wastewater treatment plants, electricity and road systems should be improved by redefining the criteria for the allocation and use of funds for municipal operations and maintenance (Kailin & Aurobindo, 2017). In the case study areas, the municipalities do not often plan for capital repairs or replacement of existing infrastructure structures because they do not score political points for the politicians. However, according to (Nielsen et al., 2016; Petcrrompo et al, 2019), the key to improving municipal asset operations and maintenance is to address the issues of funding allocation and taking regular inventory of aging assets for replacements when the RUL has a few years to go.

5.2. Addressing aging municipal infrastructure assets and conditions

Municipal asset-related aging and conditions in the selected metros and municipalities in Vhembe district will continue to deteriorate depending on the level of investment in municipal asset operations and maintenance. There is need to avoid expensive asset maintenance expenditure and replacement of the assets when they are about 5–6 years after construction. According to Kailin and Aurobindo (2017), renewal or refurbishing of sanitation, water and electricity is required every 8 years; electrical systems need partial replacement every 10 years; and water and sanitation treatment buildings need resurfacing or replacement every 30 years (Parlikad & Jafari, 2016). Such maintenance schedules will reduce O&M costs in the long run when adequate budget is
Table 5. Estimate ranking of assets operations and maintenance requirements by KIs

| Key Informants | Operations and of maintenance required for all assets in the metros and the rural municipalities in percentage (%) |
|----------------|-------------------------------------------------------------------------------------------------------------|
| 20 Key Informants in 3 Gauteng province metros and 4 rural municipalities in Limpopo province | Asset’s operations and maintenance conditions | % estimate of maintenance required for all assets | Rank |
| • Perfect/ normal condition | (0%) | 1 |
| • Only normal maintenance required | | |
| • Minor defects only | (5%) | 2 |
| • Minor maintenance required | | |
| • Backlog maintenance required | (10–20%) | 3 |
| • Significant maintenance required | | |
| • Required major renewal of aging assets | (20–40%) | 4 |
| • Significant renewal/upgrading required | | |
| • Assets unserviceable | (≥ 50%) | 5 |
| • More than half of assets requires replacement | | |

Source: Author’s field data, 2019.

provided and used appropriately for such purposes (Department of Infrastructure Development, (DID), 2019).

5.3. Improving the performance of asset expenses in metros and rural municipalities

The analysis has shown that the metros and rural municipalities of South Africa, four groups of current and future expenses are needed to improve municipal assets operations and maintenance performance as follows:

(i) Provide capital investment to replace aging municipal infrastructure assets in metros and rural municipalities that underperform,

(ii) Plan for future annual operation and maintenance (O&M) expenses of newly constructed municipal infrastructure assets,

(iii) Underperforming municipalities must invest in taking inventory of assets and providing the capital for repairs, renovation, and replacement of aging infrastructure on a regular basis to ensure service provision to communities in a sustainable manner, and

(iv) Municipalities should budget and set aside funds at the beginning of each financial year for the renewal of existing municipal assets.
5.4. Exploring the integration and use of asset Performance Management System (APMS)

According to (Kaganova & Kopanyi, 2014; Kopanyi, 2013), Asset Performance Management System (APMS) provides a holistic and balanced perspective for bridging the gap between municipal infrastructure failures and performance. In addition to this, in order to address the asset operations and maintenance, in the selected metros and the rural municipalities, an APMS system can be put in place to support O&M. However, the state of readiness of municipalities to consider asset performance management systems depends on their state of readiness to undertake such venture because it requires diligent and qualified staff. Considering the critical and complex nature of municipal assets O&M the utilisation of an Integrated and Dynamic Asset Management (IDAM) framework is required to plan to improve the Performance Management of metros and rural municipalities with respect to O&M (Parida, 2012; Parida & Kumar, 2009, 2010; Parida & Stenström, 2016). This is because the IDAMS works in “real time operations and maintenance” of municipal assets. The municipalities also need to explore the use of Municipal Infrastructure Management System (MIMS) to facilitate operations and maintenance of the municipal assets. The asset management systems when properly integrated, can enhance the following key ingredients of municipal asset management:

- Analysing municipalities infrastructure asset maintenance goals as per the municipalities service delivery needs,
- Determining issues and challenges related to municipal asset maintenance plans,
- Exploring associated regulatory compliance, safety and environmental issues,
- Reviewing of municipal operations and maintenance strategy,
- Investigating return on asset investment and return on capital employed and Return on Assets (ROA) and Return on Capital Employed (ROCE),
- Exploring the reliability of the design, dynamic reliability and risk analysis,
- Optimising municipal assets spare parts and inventory management and optimization,
- Improving asset performance assessment and integration of condition monitoring tools and big data analysis,
- Identifying Key Performance Indicators (KPIs) and benchmarking for each unit/department in the municipality,
- Integrating IT with operation and logistics, such as e-maintenance,
- Life Cycle Costing (LCC) for service delivery scenarios and decision making, and
- Specifying the end results, i.e., developing tassett management framework with software, hardware and demonstrations for implementation and verification of the assets.

5.5. Exploring the use of MIMS to manage municipal infrastructure asset data

According to Bourne and Neely (2000, 2003), Municipal Infrastructure Management System (MIMS) is primarily a data management system for water, wastewater, storm water, and road networks (KPMG, 2013). It includes parameters for managing municipal water and sanitation bulk and reticulation pipelines and buildings (Boshoff et al., 2009). The system can target small and medium size municipalities in South Africa because MIMS has extensive data import/export and reporting capabilities, and it can incorporate a wide range of pre-formatted reports. MIMS provides the opportunity for rural municipalities and metros with consistent set of information and tools for managing different infrastructure assets. It will enable municipalities to improve their performance with respect to O&M quickly. It enables each class of assets to be broken down into its main components, which can in turn be subdivided into asset types. In addition to this it enables each asset type in the municipality to be represented in a Database Management System format (DBMS) (ISO 55001, 2014). For example, water, sanitary and storm water network asset
classes can be broken down into lines, features, facilities, and equipment components, and the lines component can be subdivided into pressure mains, gravity mains, service/leads, and channels asset types to ensure efficient asset performance. Note that the MIMS can be used to supplement the use of GIS and satellite functionality images on a map depicting the location of all the assets in the municipalities. The GIS component provides access to the asset maps and database and maintains a link between asset IDs and spatial features of the assets. The “Data Quality Wizard” of the system allows users to identify the missing the links between assets and the spatial features of the asset. The system also allows municipalities to navigate through the map using typical GIS viewing functions, which can perform spatial queries to locate assets relative to a user defined shape or create thematic maps based on selected asset attributes such as asset condition rating (ISO, 2014a; ISO, 2014b; ISO 55001, 2014; ISO 55001, 2014). The system allows municipalities to retrieve asset records using a “Find” tool”, where users can search for assets before accessing the asset record or view the asset location on the map with ease. In addition to this, the “Locate Function” can activate the “Map Viewer” and zoom into the location of the current assets to monitor the conditions of the assets. Similarly, the cost function enables the municipalities to record cost data related to municipal infrastructure assets values. If MIMS is used in Gauteng metros and the rural municipalities in Vhembe district, the system can assist the municipalities to rate the overall performance and the level of service delivered by the asset into good, fair, or poor and can also be used for maintenance planning and prioritization of O&M projects. When and if the “Condition function” is used it will allow asset managers to rate the condition of the assets in a consistent and standard manner (ASCE, 2013; Rouse & Putterill, 2003).

6. Conclusion
In the preceding analysis, it is clear from the literature reviewed and information from the KIs that asset operations and maintenance performance and challenges in the three metros in Gauteng and rural municipalities in Vhembe district under-performed. The analysis shows that lack of prioritising municipal infrastructure asset operations and maintenance is responsible for the under-performance. A semi-structured questionnaire was used to obtain information from the Key Informants and the literature reviewed to analyse the performance of municipal assets in the study locations. Lack of appropriate use of asset software to assist with the management of operations and maintenance of municipal infrastructure was attributed to inadequate funding. The Municipal Infrastructure Grant (MIG) provides fund for the maintenance of municipal asset, but the funds are often diverted and used for purposes other than what the MIG guidelines prescribes. Considering that inadequate performance of operations and maintenance of the asset is also software related, the recommendations to improve the situation in the metros and the rural municipalities hinges on exploring the use of Municipal Infrastructure Management Systems MIMS to improve the management and maintenance of roads and storm water, sanitation, water, and electricity distribution infrastructure. The use of MIMS will maximise proper decision-making on the planning and control over the acquisition, use and disposal of municipal assets to the benefits of the communities. Municipalities can define asset management practices appropriate to different categories of the municipal assets because of the nature, extent and complexity of infrastructure, the financial and administrative capacity of the municipality, and other relevant factors suitable for each municipality to improve performance. Since, funds meant operate and maintain municipal assets are often diverted for for others uses there is the need for metros and rural municipalities with similar performance challenges to explore critically how integrated municipal asset management systems can assist in the management of the assets. Furthermore, provincial, and national government can institute further studies on how to increase and scrutinise the implications of inadequate capital funding to ensure that municipalities can adequately maintain and renew infrastructure for effective and efficient performance to provide services to the communities.
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