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An assessment of road construction in Walmer Township, Nelson Mandela Bay Municipality, South Africa

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Abstract: This paper reports on a study carried out in Nelson Mandela Bay Municipality, South Africa. It aims at assessing the road infrastructure provision and the financial sustainability of road infrastructure development from 2004–2011 in Walmer Township. The methodology used in the study was a simple method of overlaying the ordinance survey onto high resolution aerial photographs using Walmer Township as the basic unit of observation. Analysis involved the generation of descriptive statistics and applicable tables which are discussed later. The results showed the variation in the construction costs across time indicating spatial variation in road infrastructure developmental initiatives, discrepancies in budget allocation that favour certain areas, and a discord in the coordination of budget and planning. The study's significance lies in its highlighting of the need to review and redesign the planning of municipal infrastructure (township road) projects if they are to attain financial sustainability.

Keywords: road infrastructure delivery; financial sustainability; Walmer Township; Nelson Mandela Bay; gravel roads; South Africa.

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1 Introduction

Road construction is a vital component of the movement of people and goods, resulting in enhanced access to global markets, and road infrastructure undoubtedly forms an integral component of national economic gains and growth. Road networks rely not only on global connectivity, but also the principles sustainable build methodologies (Righi and Gardner, 2016; Lim, 2009). It is for that same reason that global road construction programmes are expected to yield 25 million kilometres of new road infrastructure by 2050. Laurence et al. (2014) modelled and predicted that 90% of this estimated road construction will take place in developing countries. As much as there is a dire necessity to provide road networks, there is an equal need to promote sustainable infrastructure planning and development. Righi and Gardner (2016) suggest that road development projects should not only focus on connectivity to global markets, but also incorporate the broader categories of sustainable developments. The broader synopsis of sustainable development can be categorised into aspects of consideration when implementing a road network. Although largely interwoven, those categories incorporate politics, economics, environmental and social impact, public participation, utilisation of local natural and labour resources and governmental department coordination.

These categories shoulder major roles in delivering a sustainable road infrastructure, and typically follows a general pattern of implementation:

1 planning the road (including sourcing appropriate funding)

2 construction of the road

3 maintenance of road

4 road rehabilitation/renovation (Dasgupta and Tam, 2005).

The basic principles of sustainable development ought to feature prominently in that four-stage pattern. Without underestimating the importance of other components of sustainable road infrastructure development, economic (or financial) sustainability is also crucial because it determines the continuity of road infrastructure provision through government departments.

1.1 Theoretical background

In this section, we discuss the synopsis of service delivery and sustainable developments. These are important components of the fabric of South African infrastructure development programme to redress the imbalances of the apartheid spatial planning and infrastructure provision. Access to basic services is a basic human right and is seen as a mechanism of improving the quality of live for communities at large. There has been noteworthy progress made in South Africa in terms of delivering basic services since the attainment of democracy (Harrison et al., 2008; Burgoyne, 2008; Cameron et al., 2004).

1.1.1 Synopsis of service delivery in South Africa

In the broader context, service delivery can be defined as a collective phrase coined by South African society to describe the allocation and distribution of basic municipal services to citizens (these include water and sewer reticulation networks, social and recreational facilities, housing, electricity and road infrastructure). The service delivery programme was masterminded under the Reconstruction and Development Programme (RDP) from 1994 onwards in the aim of transforming and redressing those apartheid infrastructure shortfalls in the formerly excluded areas of the typical cityscape. Several scholarly studies have been conducted that emphasise on service provision since the dawn of democracy, however focuses on housing, social inclusionary facilities, provision of basic services to residents (for example: Harrison and Todes, 2015; Cameron, 2014). There is a lack of research, however, that focuses on road infrastructure delivery in South Africa, and thus been the subject of numerous countrywide civil unrests, where residents' grievances related to perceived lack of service delivery – including Walmer Township (Du Plessis, 2012). The systemic stagnation of service delivery in many South African municipalities stem from a number of issues. Firstly, the dearth of human resource capacity, where large numbers of experienced engineers have retired and been replaced with young graduates. Secondly, the perceived high levels of political influences and corruption are seen to be major hindrances to implement meaningful service delivery. Thirdly, the lack of knowledge of communities in regards to their rights to access of basic services is as a result of lack of communication and education of communities. And fourthly, the economic constraints placed on the municipality due to the huge backlog of infrastructure (required to address the needs of the communities) is colossal (Mdlongwa, 2014).

1.1.2 Brief debates sustainable development

Adopted by the World Commission on Environment and Development (WCED) in 1987, sustainable development appeals to and mandates governments to implement: "developments that meet the needs of the present generation without compromising the ability of future generations to meet their own needs." Since the advent of the concepts of sustainability in the late 1969s, the global community have realised the vital importance of managing economic benefits, environmental and social impact, public participation, utilisation of local natural and labour resources and governmental coordination in road construction projects for the well-being of the present and future generations, in line with the WCED decree (WCED, 1987). However, Lim (2009) suggests that there is a discord between what sustainability in the urban development context means and how these sustainable practices are implemented. This view that was also echoed by Williams-Bruinders (2013, p.55); whilst Parnell and Crankshaw (2013) have further asserted that post-apartheid infrastructure delivery lacks the aspects of sustainability and adequate funding sources to implement a road construction programme to eliminate all gravel roads in the country.

At its infancy, the concept of sustainability was primarily based on economic influences (Kilbert, 1997). The evolution of financial sustainability to what is known presently, took place over the past 50 years. With specific reference to the civil infrastructure sector, sustainable developments take into consideration the entire project cycle inputs and outputs (for example: funding, sourcing and utilisation of raw material, planning, design, pollution, social impact, traffic management, environmental impact and employment opportunities through equitable allocation of works of the project). These variables play important roles in determining how sustainable an infrastructure project is over the long-term and addresses the WCED's mandate of enabling developments that cater for future needs. The underlining factor of the growth of the awareness of sustainable construction is the understanding of the management of natural resources in conjunction with socio-economic constraints (Lim, 2009).

Lim (2009) tabulated sustainable versus that of traditional approaches in his research. Table 1 is an abbreviated adaptation from Lim's (2009) study and shows sustainable developments take into consideration a number of sustainability elements. Firstly, the consensual approach that considers stakeholder participation in the development. Secondly, that the development is approached on needs assessment justified through using a business plan. Thirdly, that the development is beneficial to present and future generation in a long-term manner. Fourthly, that the customer (client), including all stakeholders, owns the process of sustainably implementing the development. Fifthly, that the design of the development is effective and considers aspects of environmental protection, cultural diversity of surrounding communities, housing for labourers, education of local residents, integral project management and equitable distribution of development functions. And lastly, that the development aspires to taking into consideration social and environmental impacts to assess longevity of the development. While this sustainable approach is ideal, through research, critics have stated that the element of the scope of the concepts of sustainability are not embraced and as such, leads to misinterpretations and confusion when implementing infrastructural projects and efforts to create sustainable developments have proved to be otiose.

Table 1 Comparative approach of sustainable and traditional projects

Comparative approach of sustainable and traditional projects	
Sustainable approach:	*Traditional approach:*
Consensus	Top down decision making
Business case justified	Risk-based
Long-term	Short-term
Customer owned	Generally outsourced
Design evolution	Design deliverables (static designs)
Social and environmental science	Engineering science

Source: Derived from Lim (2009)

A number of researchers have shown that spatial developers tended to adopt a more tradition approach on service delivery projects, particularly road projects (Williams-Bruinders, 2013; Donaldson and Du Plessis, 2013; Cameron, 2014).This is in direct contrast to Lim's (2009) sustainable approach. Firstly, decisions are made using a top-down approach, and are very much a risk based operation. Secondly, as opposed to the using a long-term strategy, more shorter term technologies are used to meet the

present generation needs. Thirdly, the customer (client) is not in control of the implementation process, where this is generally outsourced to third party groups. Fourthly, the design of the development is static and viewed from an engineering standpoint, with little deviation from norms and standards (Lim, 2009).

As quantified previously, this paper only considers a thin band of the total sustainability spectrum: financial sustainability. From a global perspective, there are calls to incorporate higher degrees of fiscal sustainability, particularly for new road infrastructure projects, whilst balancing the available funding with that of the well-being of the environment and other components of sustainability (Holden et al., 2017). Given that road infrastructure consumes a large proportion of the built environment in the aims of achieving global connectivity, surprisingly there is a lack of research in how financial sustainable road infrastructure projects are – this is more prevalent in African states given the need to provide infrastructure, and particularly in South Africa context, where this is evident in the formerly marginalised township areas and poorer municipal areas.

1.2 The South African context

Following the attainment of democracy in South Africa in 1994, the post-apartheid government has also adopted an ongoing programme of providing road infrastructure that is aligned to international best practices in sustainable development principles. This study was set to provide an assessment of the extend provision of tarred road infrastructure in one of the townships in Nelson Mandela Bay (NMB) (specifically to Walmer Township) and an examination into whether the construction of the surfaced roads in Walmer Township was financially sustainable. This implies that other aspects of sustainability are not discussed in this study. However, regarding the provision of infrastructure (excluding road infrastructure) in South Africa in recent years scholars (including: Papacostas and Prevedouros, 2001; Biermann and Van Ryneveld, 2007; Williams-Bruinders, 2013; Donaldson and Du Plessis, 2013; SAGI, 2013; Parnell and Crankshaw, 2013; Siyongwana and Chanza, 2017; Musvoto et al., 2016) have indicated many township infrastructure provision projects were not sustainable and the level of financial unsustainability was remarkable.

Government departments have conducted similar evaluations and they have reached contradictory conclusions by miscalculating the extent of gravel roads in the country. A report released by SALGA (2011) revealed that in 2007, the estimate of gravel roads was 118,500 km; whilst in 2010, the revised estimate was 317,000 km. The research findings by Siyongwana and Chanza (2017) on road infrastructure provision in Mdantsane Township (in the Buffalo City Municipality, South Africa) also indicated that while the provision of the road infrastructure has improved in recent years, the estimates show a substantial percentage discrepancy over a three-year period. A similar conclusion was reported in Biermann and Van Ryneveld (2007), where they reported that township infrastructural projects still reflect the continuity of the apartheid planning system, a view also held by the South African government (SAGI, 2013).

While research in township infrastructure has gained momentum in recent years, there still remain themes which fall short of rigorous and focused investigation. One of these is the provision of a sustainable, long-term road infrastructure. This is despite the fact that road infrastructure has proved to be a critical link in city-transport networks; as it provides a spatial organisation, from which diverse activities can take place in the

cityscape (Papacostas and Prevedouros, 2001; Mannering and Washburn, 2013; Mandle et al., 2016; Meijers et al., 2016; Zhang and Levison, 2016). While the benefits of a modern road infrastructure in urban settlements are well known, such an infrastructure is expensive to plan, construct and maintain. Acknowledging this, Akpa et al. (2016) have identified the ever-increasing need for an effective and sustainable road network, when taking into consideration the global figure of 25 million kilometres of roads to be constructed over the next three decades. The evidence in the SALGA (2011) report suggests that there is an element of uncertainty surrounding the length of gravel roads in South Africa. The report states that there is a popular belief that rural and/or smaller municipalities are struggling to upgrade and maintain the road networks. This was found to be true; and most (if not all) municipal authorities are in fact unable to manage their road network backlogs in a sustainable manner. The same SALGA (2011) report suggests that road infrastructural funding is allocated less than that of sports and recreational facilities – which do not contribute to the economic opportunities, as does road infrastructure. It was found that some municipal budgets for road maintenance and upgrades was as low as R200,000 ($15,200) per annum.

In this light, the Centre for Scientific and Industrial Research (CSIR) has indicated that to construct a new road or to conduct major repairs to an existing road, the cost would be approximately R3.0 m ($228,000) per kilometre (for light traffic surfaced road and depending on the urban settings – as would be the case for the majority of township settings). However, on the opposite side of the spectrum, constructing a road for a heavy trafficked freeway can cost millions of rands per kilometre (Hayes, 2016). Indeed, while minor gravel roads in the townships are largely viewed as non-critical infrastructure (compared to that of sanitation, potable water or health services), providing an effective and sustainable road infrastructure still remains essential for most activities (Akpa et al., 2016).

Since 1994, the South African programme of road infrastructure provision has been governed by a focus on sustainability and the integration of communities in the mainstream economy. Stevenson (2016) reports on some benefits of implementing and providing a sustainable road network in cities, which include narrowing of minor roads, creating local employment through sub-contracting parties; and creating safer roads through engaging in innovative design. In Cape Town, van Dijk et al. (2015) concluded that these benefits have been realised through road construction. To ensure the long-term sustainable infrastructure, engineering practice dictates that social, economic and environmental aspects should be considered when implementing projects (Mihelcic and Zimmerman, 2014). Government departments have, since the 1994 dispensation, complied with the principles linked to the Millennium Development Goals (MDG). The provision of road infrastructure that contributes to sustainable development forms part of this context.

Broadly outlined, road transport falls under the jurisdiction of the Department of Transport, whose mandate it is to ensure that effective legislative and policy-making is implemented at lower spheres of government. Firstly, *The National Transport Policy White Paper* of 1996 (DOT, 1996) identified that the last major transportation policy amendments were implemented in the mid-1980s. The transport department undertook to review all policies related to transport infrastructure, and to allow all stakeholders to participate in the revised policy-development process (DOT, 1996). Secondly, *The National Land Transport Act (No. 5 of 2009)* broadly outlined the general responsibilities of the three levels of government (RSA, 2009). The first is the national ministry of

transport, where policies are developed. The second is the provincial transport ministries, where the monitoring of the infrastructural projects and funding allocation occurs. The last is local municipal branches of transport to adopt and implement local area policies (that complements national policy) to ensure a co-ordinated road provision in a sustainable manner to improve the quality of lives for the affected community (RSA, 2009).

Financial planning and budgeting with regard to land transportation (planning, administration, operation, contract management, implementation and maintenance) is the responsibility of the local municipality. Generally, priority is given to higher-order civil and social infrastructural development in township areas. Therefore, the surfacing of gravel roads does not feature high on the agenda of service delivery. The South African government funds the road infrastructure through several funding structures. The first is the municipal infrastructure grant (MIG); and this grant is aimed at assisting municipalities to deliver basic infrastructure to poor communities. The second source of funding the road infrastructure at municipal level is the public transport infrastructure system (PTIS), which is a conditional grant administered by the Department of Transport; and it can also be used for planning, the establishment of the road infrastructure, and the improvement of the existing public transport infrastructure. Significant municipal investment has been made with respect to the upgrading of township gravel roads since in recent years.

Apart from other categories of sustainability, there is little evidence that financial sustainability has been incorporated in the infrastructural implementation process. The Spatial Planning and Land Use Management Act (Act No. 16 of 2013) (SPLUMA) in 2013 introduced a set of six objectives for sustainable developments, including that of civil infrastructure (such as road construction). These six objectives clearly map out the direction in which infrastructure ought to be implemented. It further endorses the need for eliminating the spatial injustice, unsustainability, inequality, resilience and inefficiencies (Republic of South Africa, 2013). The synopsis of the framework of the SPLUMA (and supporting development policies) is the intention of affecting transformation of the urban space by promoting economic budget allocations for civil projects and efficient use of land for municipal services. Not uncommon and inevitably, road infrastructure consumes a large space of land that could be otherwise utilised for purposes.

Road construction at local level ought to be primarily informed by the issues of settlement/spatial development and economic node growth. The Nelson Mandela Bay Metropolitan Municipality (NMBM) adopted the tarring of gravel roads (ToGR) programme in 2008 (prior to the SPLUMA); and this is still an ongoing project. Walmer Township forms part of this programme in the NMBM. The aim of the programme is to surface all gravel roads within the municipal area – in a phased approach over a number of years. There are eight engineering consulting firms employed by the NMBM (under a programme management firm) to facilitate this project, each of which is responsible for a cluster (zone) area. Besides that, there are several construction contracting firms that oversee the implementation of the programme under the supervision of the respective engineering firms.

The original plan of the programme was to surface all gravel roads in NMBM area within a five-year period (2008 to 2012/13) in priority ranking, based on the discretion of the engineering firm, ward councillors and their communities, using the available R500 m

($38 m) budget in 2008. This budget was significantly eroded and redirected to other critical infrastructure projects – one being the FIFA 2010 World Cup Soccer projects. A recent review of the NMBM area revealed that approximately 250 kms of new gravel roads have been provided in mainly new housing development areas. This does not include the original roads identified under the programme in 2008. Road construction under the programme was estimated to be approximately 150 kms in 2008, thus yielding a total of 400 kms to be surfaced in the NMBM in 2016.

The majority of these gravel roads are concentrated in the townships areas or new housing development areas distributed across the NMBM. Given the escalating costs of road construction, and given the mandate of local municipalities to provide road infrastructure; the NMBM will continue to supply the required funds for the programme. This indicates that the new developments around the metropolitan area does not comply with the SPLUMA. By the addition of 250 kms of roads to be surfaced, the NMBM demonstrated that SPLUMA objectives of efficient land use and promotion of equal budget allocations for service delivery were not met. The continued practice of implementing low density government-issued (and funded) housing developments implies that road provision in the new developments will continue to display unsustainable constraints on the NMBM.

1.3 Aims and objectives

Against this background, the main aim of the study was to conduct an assessment of the roads and its condition in the Walmer Township, NMBM from 2004 to 2011 as a basis for assessing the financial sustainability of the ToGR programme. From the aim, the following three objectives were advanced to guide the study, namely:

1 to review the state of road construction costs in the NMBM

2 to conduct a comparative analysis of the road construction (conversion from gravel to surfaced in the Walmer Township

3 to assess the financial sustainability of the road-construction programme, with particular focus on Walmer Township.

A subsequent aim of this paper is to highlight the gap of spatial planning, sustainable urban infrastructural development, innovative road-construction methodologies, the general lack of adequate funds and overall project management.

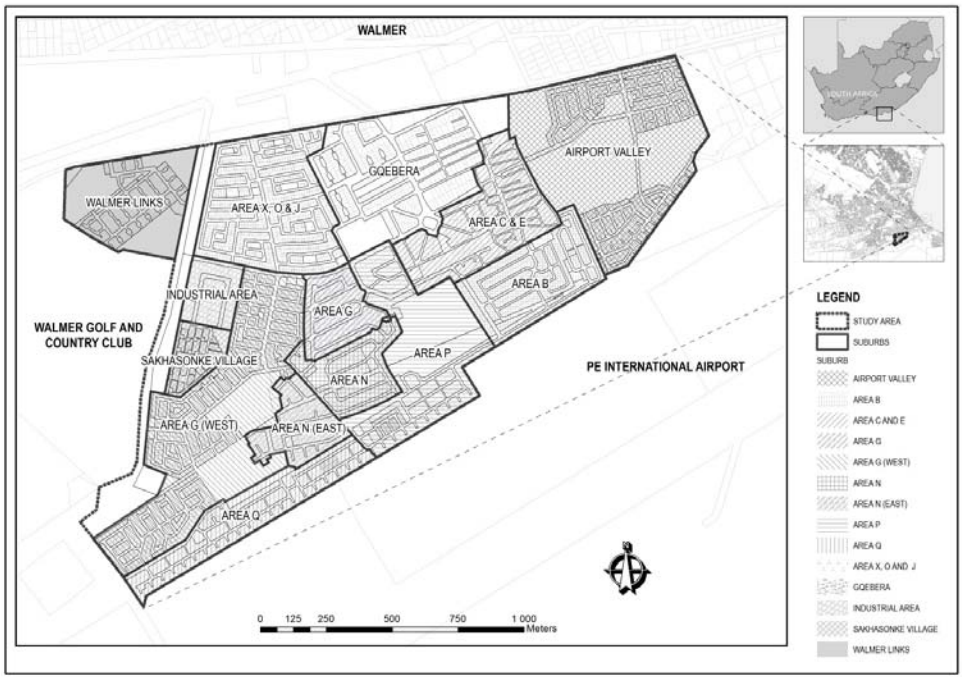
2 Research methods

2.1 The study area

Walmer Township is situated in the NMBM on the south coast of South Africa. The NMBM constitutes a merger of three municipalities (Port Elizabeth, Uitenhage and Despatch), thereby forming one metropolitan municipality. The research location (located in municipal Ward 4) is approximately six kilometres from the central business district of Port Elizabeth; and the township has developed rapidly, with an approximate population

of 27,000 people (StatsSA, 2011). As Figure 1 shows, the township straddles the Port Elizabeth International airport; and it is situated in the overall Walmer allotment area. The township is one of the oldest in the Port Elizabeth area; and it is made up of the residential suburbs of airport valley, area B, area C and E, area G, area G (West), area N, area N (East), area P, area Q, area X, O and J, Gqebera, Sakhasonke Village and the Walmer links housing development area and a small scale industrial area – collectively and commonly known as the Walmer Township. Whilst the majority of the area is formalised, large sub-areas are characterised by informal houses – particularly area G (West) and airport valley.

Figure 1 Location of the study area in the NMB city context, showing the sub-area boundaries of the Walmer Township



Source: Author

Although formalised town planning layouts are available for area G (West) and airport valley, these layouts have not as yet been approved by the city structures. According to a formative local resident – who has knowledge of the Walmer Township area (Respondent 'A', 2018), previous municipal road assessment projects have revealed that areas G (West) and Airport Valley were not considered because it forms part of another human settlements development programme. With the formalisation of these two sub-areas, the municipality will add approximately 15 kms of road infrastructure to its asset register. Airport valley was a municipal landfill site; and consequently, it remained void of any formalised developments; and it is currently pigeonholed as a squatter area, owing to the thousands of informal dwellings.

The following section briefly outlines the methodology we employed to derive at the results and findings for this study:

2.2 Methodology

The methodology used to achieve the objectives was a simple method of overlaying the ordinance survey onto high resolution aerial photographs using Walmer Township as the basic unit of observation. The high-resolution photographs serve as a bird's eye view of urban development, from which it is possible to identify the condition of the roads (whether surfaced or gravel). It also served as a starting point to digitise road alignments in a geographic information system (GIS), in order to determine the growth of the road infrastructure in Walmer Township during the period 2004–2011.

Although the road centre lines were available from the NMBM, it was established that the lines were not a true representation of the centre alignment of the road reserve. With the ordinance survey received from the NMBM and verified by the NMBM land surveyors, the ordinance survey were used to redigitise the road vector data, so as to reflect an accurate centre line alignment. Although the design of the roads needs to comply with engineering design requirements and standards, for the purposes of this study, where possible, either a right angle was maintained at road junctions, or the alignment followed the adjacent ordinance survey boundaries for consistency and accuracy in determining the road length.

The road centre lines were categorised in GIS by using the 2004, 2007, 2009 and 2011 aerial photographs as a background in those specific years. As a measurement for analysis, it was deemed critical to understand the length of roads still to be surfaced for budgetary purposes for infrastructure development. The comparison of the surfaced versus gravel roads during the eight-year period using aerial photographs illustrates the pace of roll-out of the road infrastructural projects. The associated costs of a 2.5 m wide road construction were obtained from the NMBM infrastructure and engineering (Roads and Storm Water Department in 2014) during unstructured interviews held with municipal officials. The costs (presented in Figure 2) were assigned to the length of roads to determine what the level of expenditure was for the time periods of 2004–2011. Although this method is unconventional, it does, however, provide a realistic estimate of the expenditure and that of future projections.

In addition to the extraction of the information from high-resolution aerial photographs, face-to-face questionnaire interviews were administered with the relevant stakeholders, the town planners, the cluster engineers, the ward councillor and the local residents. The core questions of the questionnaire revolved around the extent of tarring of the gravel roads, the backlog of road provision, the satisfaction in terms of project implementation, the funding of the tarring of roads, the financial sustainability of the tarring project, the stakeholders' participation in the tarring project, in addition to its impact to the local community. The responses of the participants were used to back up the findings and the discussion section.

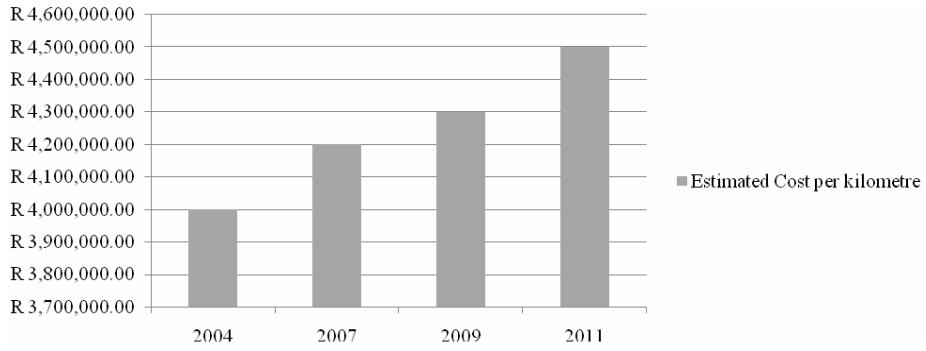
3 Findings and discussion

In order to provide a detailed account of the provision of road infrastructure and the financial feasibility and sustainability of road infrastructure provision in Walmer Township, the section below presents the findings; and it also discusses them in line with the objectives of the research objectives.

3.1 Road construction costs

In this section, the approximate construction rates of roads per kilometre of 2.5 m wide roads in the period 2004–2011 are presented. Although the width of the road is narrow, several road reserves are restricted owning ordinance survey constraints, accomplishing Stevenson's (2016) aim of sustainable development. Similar to Walmer Township, several roads in the Zwide (in the NMBM) area were constructed in the 2008/09 period at 2.5 m wide. These costs are assumed to include engineering fees, value added tax (VAT), sub-contractors' fees (for example, environmental consultants, social facilitators, geo-technical engineers and community liaison officers), and contingencies. The rates depicted in the Figure 2 do not reflect the community-associated costs (for example small, micro and medium enterprises participation in projects – according to the allowance of the municipal by laws). Evidence from the unstructured interviews with the relevant selected NMBM government officials and engineering professionals revealed that, on the one hand, they concurred with these figures (refer to Figure 2); but on the other hand, they suggested that the 2004 amount of R4 m ($304,000) is indicative of an inflated cost. This is in line with the CSIR costing reported in Hayes (2016), alluding to the costs of developing road infrastructure. Here, it was rightly pointed out that to develop new roads, approximately amounted R3.0 m/km ($228,000) for light-traffic surfaced road. In this study, the rate per kilometre of 2.5 m wide road construction is used as a benchmark for the future availability of finance in terms of the municipal budget. For the purposes of this study, the costs stipulated by the NMBM were used.

Figure 2 Construction rates per kilometre for surfaced roads based on a 2.5 m wide road



Source: NMBM Roads and Storm Water Department (2014)

A closer look at Figure 2 shows the escalation in costs of construction rates per kilometre for surfaced roads, based on a 2.5 m wide road from 2004 to 2007, from 2007 to 2009, as well as from 2009 to 2011. At face value, the impact seems to be a relatively small escalation from year to year. However, considering that the entire NMBM area has to be catered for, these small increases are vastly significant, when factored into the backlog for the entire municipal area of gravel roads. However, although there was a general consensus among the residents on their satisfaction with the ToGRP and road infrastructure provision in Walmer Township area, Respondent 'A' (2018) and Respondent 'B' (2018) during the face-to-face interviews contended that the inadequate funding was a challenge in the light of the ToGR in Walmer Township; as a fair share of the budget to improve and deliver road infrastructure was syphoned off for the implementation of Fifa World Cup projects.

It is for this reason that there is an understanding between residents and the municipality that heavy-trafficked roads in the township would be asphalt; whilst the minor, less-trafficked roads would be block-paved, using locally based construction firms, as indicated by Respondent 'C' (2018), hinting at elements of sustainability approach of construction.

3.2 Comparison of road condition (surface and gravel roads) from 2004–2011

This section presents a comparison of the trends or extents of surfaced versus gravel roads development in the four timeframes of the study period. Where possible, the extent of the gravel roads was assigned a cost for each associated year and a critical evaluation of the road network development for the study period is provided, in line with objective 2. This section is categorised into the four study periods of 2004, 2007, 2009 and 2011.

3.2.1 Walmer Township in 2004

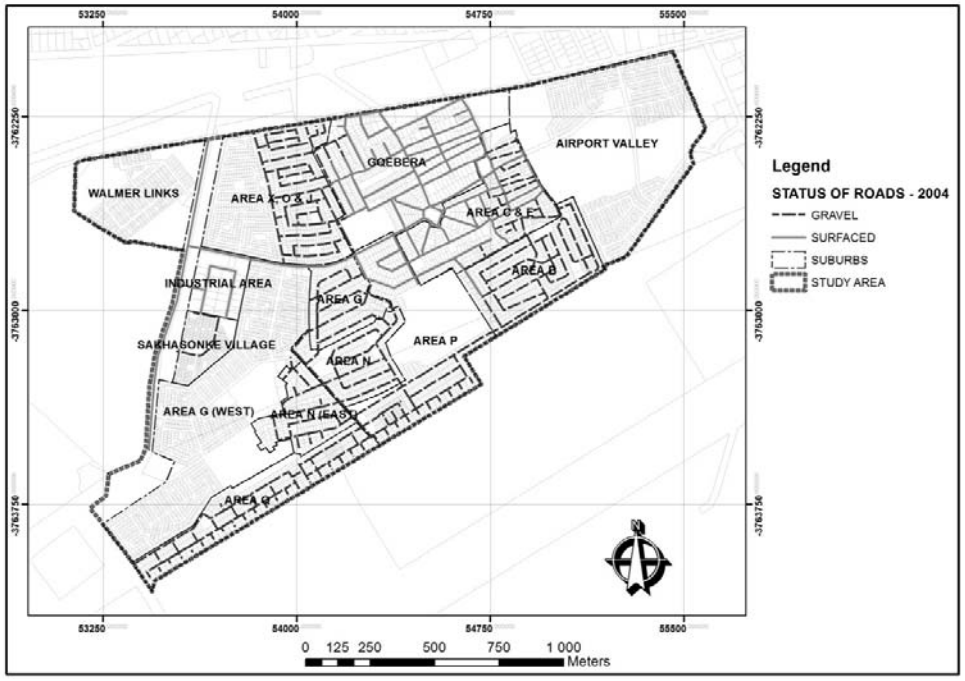
As reflected in Table 2, there were approximately 33.5 kms of road in 2004, of which approximately 64% of the total roads in the area were gravel. As illustrated in Figure 3, surfaced roads were clearly concentrated in the suburbs of Gqebera and area C and E. The information retrieved and later calculated as a percentage is shown in Table 2. This indicates that Gqebera had almost 86% of surfaced roads in the suburb; whilst 60% of the roads in area C and E were also surfaced. The airport valley and area G (West) of the ordinance survey layout did not exist at the time; so no formalised roads existed in 2004. Sakhasonke and Walmer links residential areas did not exist at the time. Furthermore, there were no surfaced roads in the established suburbs of areas G, N, N (East), Q and X, O and J.

The results reflect an interesting trend of a smaller concentration of surfaced versus gravel roads in the study area in 2004; and this can be expressed as a ratio of 36:64% ratio between surfaced and gravel roads. It is worth mentioning that the financial cost of providing this road infrastructure in 2004, would have cost the municipality (based on the construction figures provided in Figure 2) approximately R87 m to upgrade the 21.6 kms of gravel roads to surfaced. According to the municipal IDP of 2002/03 of the R963 m

($73 m) required to surface the gravel roads over the ten-year period for the entire municipal area, by summation, R9.63 m ($731,000) would be dedicated to each year within the ten-year period; and this would have to be distributed throughout the entire municipal area. This equates to only 11% of what the Walmer Township area required at the time to eliminate the backlog in 2004. Coincidentally, a budget of R9.3 m ($729,000) was allocated to the Walmer Township at the time for the surfacing of the gravel roads.

Christopher (2001) has pointed that service delivery of the basic needs, including the road infrastructure, was marginal in the Walmer Township prior to 1994 – due to the apartheid ideology, which restricted the presence of blacks (Africans), and consequently the developing of the townships would be contrary to its ideology. In response to this apartheid ideology, the democratic government when it came to power in 1994 introduced a major paradigm shift in the provision of the basic services in former marginalised areas by improving the financial budget that would be used to improve the living conditions in the townships. Indeed the financial budget to improve the road infrastructure in the townships was one of the major break-through deals. Despite the democratic government's efforts to improve the delivery of the basic services, including the road infrastructure indicated that 64% of the roads in the study area in 2004 were gravel. This pattern reinforces the assertion that the municipal spending patterns had exerted minimum efforts on road infrastructure improvements during the first ten years of democracy (1994–2004).

Figure 3 2004 – gravel and surfaced roads in Walmer Township in 2004

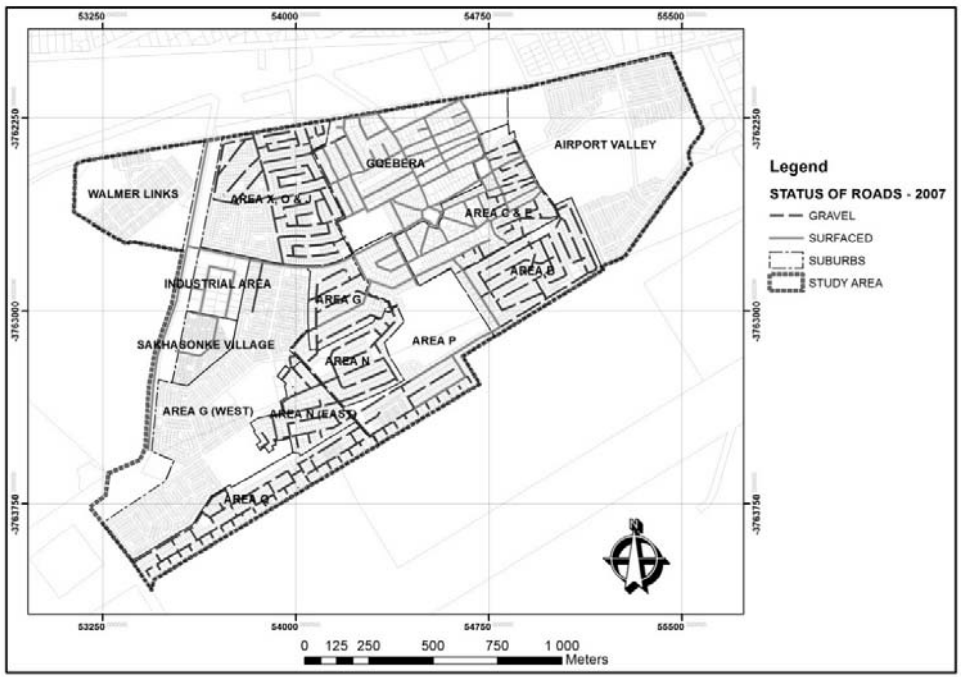


Source: Author

3.2.2 Walmer Township in 2007

In 2007, the total road length was 35.5 kms (also refer to Table 2), of which approximately 60% was gravel. As illustrated in Figure 4, very little has changed in terms of the development of the road infrastructure; since a large concentration (approximately 71%, combined) of the surfaced roads remained in area C and E and Gqebera suburbs. There were still no formalised roads in the airport valley, areas G (West) and X, O and J. However, a loop surface road (about 370 m) was constructed at Sakhasonke Village. It can be argued that road infrastructural development was still marginal 13 years after the democratic rule; and despite national government incentives to deliver services; there was an approximate increase of 1km of surfaced roads in area P from 2004 to 2007. There was also a reduction of gravel roads of approximately 1 km in the same suburb. Area G experienced an increase of approximately 572 m of surfaced roads compared to 2004. There were no surfaced roads in the established suburbs of areas N, Area N (East), Q and X, O and J. Evidence reveals an increase of approximately 2,327 m of surfaced roads compared to 2004. In total, there was an increase in the overall (surfaced and gravel) road length of 1,983 m since 2004.

Figure 4 2007 – gravel and surfaced roads in Walmer Township in 2007



Source: Author

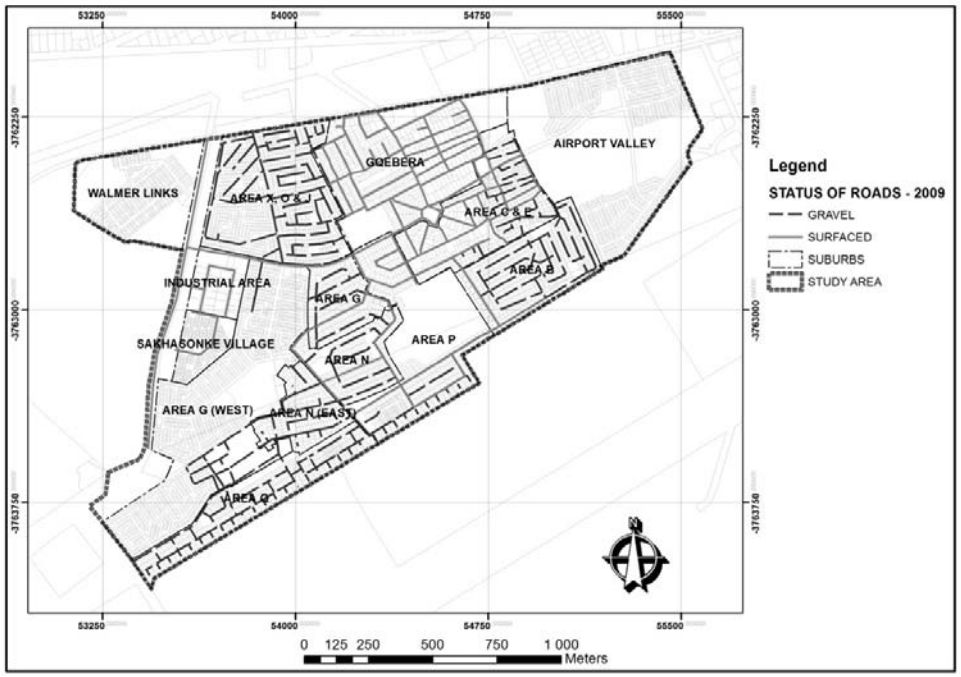
There was a 40:60% ratio between surfaced and gravel roads. The data reinforce and maintain that the majority of surfaced roads were still located in the old suburbs of Walmer Township, namely: area C and E and Gqebera. Even more important is that in 2007, it would have cost approximately R90 m ($6.8 m) to transform the 21.3 kms of gravel roads to be surfaced. With the available budget of R50 m ($3.8 m) allocated to surfacing gravel roads in the entire municipal area, it would have been impractical to dedicate the complete budget to Ward 4 for the purpose of surfacing roads. The municipal budget is almost half of the amount required to renovate the entire backlog of gravel roads for that financial year.

Despite the radical implementation of post-apartheid development initiatives, which aimed at restructuring South African urban areas; and more particularly, the townships during the period between 2004 and 2007, there was a mere increase of the total length of surfaced roads by 2,327 m. At the same time, the NMBM made limited progress in eroding the backlog of approximately 21 kms of gravel roads. Although the statistics suggest that there was a 4% decrease of gravel road component of this study, this is not the case. It is interesting that the length of the gravel roads remained almost constant in 2007, compared to 2004, showing a very slight decrease of approximately 340 m, equating to a 1.5% decline. As in the 2004 scenario, the NMBM demonstrated its commitment to the formalisation of dwelling units and to other infrastructure development in the Walmer Township area – particularly in area X, O and J, thereby yielding an additional 1,120 m of gravel roads to be surfaced. There is neither any conclusive evidence of allocated ward budgets; nor of that which was spent on delivering a road infrastructure in the Walmer Township for 2007.

3.2.3 Walmer Township in 2009

With the ToGR programme in full gear of implementation, the municipality identified roads to be surfaced in the Walmer Township area (and by extension, the entire municipal area) in 2008. Corresponding engineering consultants engaged with construction firms; and subsequently, they surfaced 1,732 m of gravel roads. In 2009, the total road length was 38.0 kms, of which approximately 58% was gravel. In area B, the amount of surfaced roads (in metre length) increased by approximately 62% from 2007. Substantial increases also took place in area N, from zero (0) metres in 2004 to 988 m in 2009. This formalisation of roads also corresponds to the reduction of shacks from 2007 to 2009 to that of formalised housing settlements under the municipal drive to ensure decent human settlement conditions. In comparison to 2007, there was a total growth of approximately 2,500 m (equating to an increase of nearly 7%). There was a 42:58% ratio between surfaced and gravel roads. Figure 5 illustrates that the data also reinforce and maintain that the majority of surfaced roads were still located in the old suburbs of Walmer Township, namely: area C and E, area P and Gqebera.

Figure 5 2009 – gravel and surfaced roads in Walmer Township in 2009



Source: Author

In 2009, it would have cost approximately R91.5 m ($7 m) to transform the 22.1 kms of gravel roads to that of surfaced tarred roads. The IDP ward-based budgets were inconclusive and as such, they could not arrive at a budget dedicated to the surfacing of gravel roads in this time period. Although the estimated costs for surfacing all outstanding roads in the Walmer Township would have been R91.5 m ($7 m), a portion of funds for the programme was redirected to finance a portion of the 2010 FIFA World Cup Soccer tournament infrastructure projects, in order to comply with the FIFA requirements. The redirected funds (from the ToGR programme) were to target the tournament transportation action plan. This action plan promoted the improvement of the existing road infrastructure, to integrate transportation modal interchanges and to accelerate the procurement of a public transport network in the host cities including Port Elizabeth/NMB. Thus, the provision of road infrastructure (particularly in township areas) was deemed to be non-critical service delivery during the 2010 FIFA World Cup Soccer period (2009–2010) however, it still took place.

3.2.4 Walmer Township in 2011

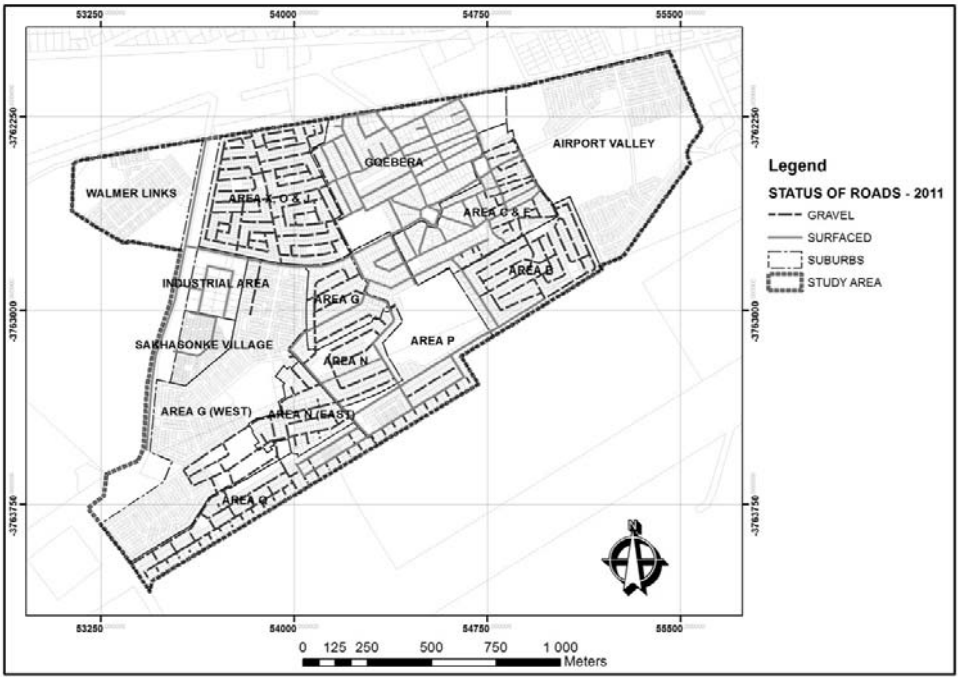
In 2011, and with reference to Figure 6, the total road length was 38.2 kms, of which approximately 56% was gravel (a 2% reduction from 2009). The length of roads remained reasonably constant (38.0 km in 2009 compared to 38.2 km in 2011 –also refer to Table 2). Area Q experienced an increase of 640 m of surfaced road compared to 2009. With the exception of area P, which grew by approximately 16 of surfaced roads, all the other suburbs remained constant with no meaningful increase or decrease in either

surfaced roads or gravel roads. However, in contrast, area X, O and J experienced a growth of gravel roads in 2011, of approximately 14% (or 966 m).

However, area N (East) still had not received any surfaced roads since 2004 but it had experienced a growth of approximately 500 m of gravel roads. Compared to 2009, there was a total growth of approximately 800 m of surfaced roads in the study area. There was a 44:56% ratio between surfaced and gravel roads. Significantly, the results reveal that in 2011, it would have cost (based on the construction figures provided in Figure 2) approximately R97 m ($7.4 m) to transform the 21.6 kms of gravel roads to surfaced. With the available budget allocated to Ward 4 at the time, based on the 2010/11 IDP document (supplied by NMBM IDP Department in 2014), of R14 m ($1.1 m) budget, only 3,180 m could have been targeted for surfacing, leaving an estimated 18,500 m still to be surfaced.

Indeed between 2009 and 2011, the majority of the sub-areas did not experience any significant road infrastructural development. Although the statistics suggest that 500 m of gravel roads was upgraded to surfaced road, some the individual sub-areas have improved provision of surfaced roads by 600 m to 1,000 m. It should also be taken into consideration that with four years into the ToGR programme, little funding had been realised – equally, there was little eradication of gravel roads after the completion of the soccer tournament. A significant amount of informal dwellings grew between 2009 and 2011, resulting in informal gravel accesses to haphazardly placed structures, particularly in area G (West) and airport valley.

Figure 6 2011 – gravel and surfaced roads in Walmer Township in 2011



Source: Author

Table 2 Comparative statistics generated for the gravel and surfaced road conditions during the 2004, 2007, 2009 and 2011 periods

	Comparative road conditions from 2004 to 2011							
Year	*Roads (2004) in metres*		*Roads (2007) in metres*		*Roads (2009) in metres*		*Roads (2011) in metres*	
Road condition	*Surfaced*	*Gravel*	*Surfaced*	*Gravel*	*Surfaced*	*Gravel*	*Surfaced*	*Gravel*
Sub-areas								
Area B	167.26	3,503.46	286.43	3,377.46	693.80	3,154.09	693.80	3,154.09
Area C and E	3,419.70	2,025.02	3,419.71	2,068.45	3,419.71	2,068.45	3,419.71	2,068.45
Area G	0.00	1,574.18	571.93	1,333.68	782.32	1,173.28	782.32	1,173.28
Area G (West)	181.53	45.28	181.53	291.19	181.53	1,848.66	181.53	1,588.98
Area N	0.00	2,052.47	0.00	2,089.97	988.00	1,101.96	988.00	1,101.96
Area N (East)	0.00	1,517.49	0.00	1,638.91	0.00	1,967.72	0.00	1,967.72
Area P	998.72	2,478.93	1,974.71	1,397.44	2,100.62	1,024.43	2,259.13	449.23
Area Q	0.00	3,202.13	0.00	3,379.28	0.00	3,412.45	639.19	2,759.19
Area X, O and J	0.00	3,954.26	0.00	5,073.86	0.00	5,789.43	0.00	6,755.60
Gqebera	5,653.85	922.06	5,943.93	650.98	5,943.93	558.81	5,943.93	558.81
Sakhasonke Village	0.00	370.00	370.00	0.00	370.00	0.00	370.00	0.00
Other (remainder)	1,436.24	0.00	1,436.24	0.00	1,436.24	0.00	1,436.24	0.00
Total per road condition	11,857.30	21,645.28	14,184.48	21,301.22	15,916.15	22,099.28	16,713.85	21,577.31
Grand total	33,502.58		35,485.70		38,015.43		38,291.16	
Ratio comparison	35.39%	64.61%	39.97%	60.03%	41.87%	58.13%	43.65%	56.35%

Source: Derived from GIS records by author

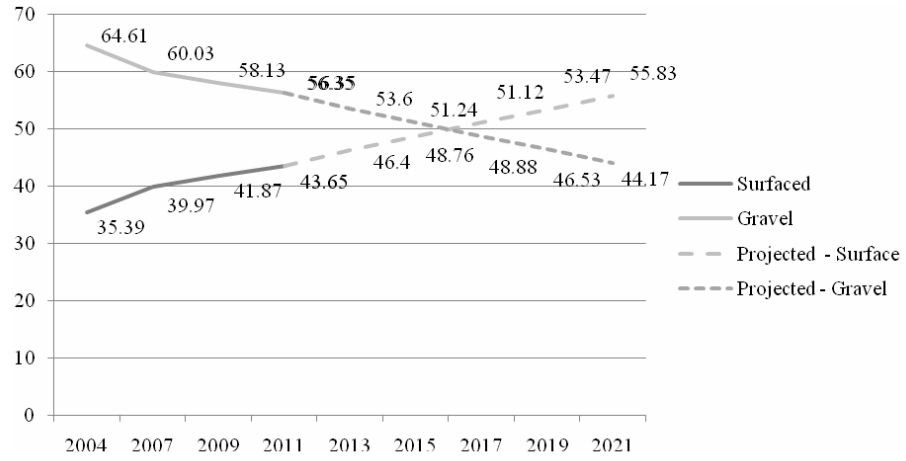
Table 2 provides a combined analysis of the surfaced and gravel roads of the study period in the different sub-areas of the study location for comparative purposes.

From this point, the focus is on examining the financial sustainability for the remainder of the gravel roads to be constructed in Walmer Township in the NMBM.

3.3 The financial sustainability of the road infrastructure

This section validates the financial sustainability and practicability of the road network (surfaced and gravel) over the 2004–2011 period. Figure 7 depicts a definitive percentage trend of increasing supply of surfaced roads with a corresponding decrease in gravel roads in the Walmer Township area over the study period of 2004 to 2011. Overall, the provision of surfaced roads has increased at a steady pace since 2004 (serving as the base of the study). Since 2004, the total lengths of surfaced roads have increased by 4,857 m, equating to a 10% increase from 2004 to 2011.The ratio of surfaced roads to gravel roads is seen to be narrowing. However, the gap between the two road conditions is predicted to be closed by 2016. To illustrate and interrogate the effectiveness of the ToGR programme, the financial sustainability of surfaced roads and the burden on the NMBM, the researchers have extrapolated the 2017 and 2019 percentages by extrapolation to show the future costs.

Figure 7 Percentage of surfaced versus gravel roads 2004 to 2011



Source: Author

Using this statistical analysis, it was predicted that in the year 2016, the linear graph would intercept and begin the erosion of gravel roads in the Walmer Township area (refer to Figure 7). However, a desktop analysis conducted in 2016 (by the authors) revealed that this prediction is inaccurate, as it does not consider the new developments in the Walmer Township since 2004. From the standpoint of considering the entire NMBM, there has been an approximate increase of gravel roads in large greenfield developments (for example, in Motherwell NU 29 and NU 30 and in the Chatty Township) of 250 kms of gravel roads to be surfaced and the financial muscle needed to surface these gravel roads is estimated to R2.5 bn ($190 m) for the surfacing of 400kms of gravel roads.

Table 3 shows a summary of the statistics from 2004 to 2011. It can be seen that from the data collected, the length of gravel road remained constant during the eight-year period. The available budgets have varied from R9.3 to R4.1 m ($729,000–$315,000). The table demonstrates that 2.33 kms could have been constructed. This seems likely since the calculated surfaced roads in 2007 suggest this length of road was indeed constructed (from 11.8 kms to 14.1 kms). Between 2007 and 2009, there is a discrepancy of approximately 1,000 m of surfaced roads unaccounted for (based on the comparative figures from 2007 and 2009). No evidence is available to explain this discrepancy. However, the statistics suggest a normalisation from 2009 to 2011, during which 860 m of roads were constructed using the available budget of R4.3 m ($327,000), clearly indicating that the NMBM had indeed utilised the full budget to provide surfaced roads in the Walmer Township for this period.

Table 3 Comparative statistics of road infrastructure provision from 2004 to 2011

Comparative statistics of road infrastructure provision from 2004 to 2011				
Description	*Roads (2004)*	*Roads (2007)*	*Roads (2009)*	*Roads (2011)*
Length of surfaced road	11,857.30	14,184.48	15,916.15	16,713.85
Length of gravel road	21,645.28	21,301.22	22,099.28	21,577.31
Total length of road	33,502.58	35,485.70	38,015.43	38,291.16
Percentage gravel	64.61%	60.03%	58.13%	56.35%
Budget available	R9,300,000.00	R3,000,000*	R3,700,000*	R4,100,000.00
Cost per kilometre	R4,000,000.00	R4,200,000	R4,300,000	R4,500,000.00
Gravel roads that can be done with available budget (in km)	2.33	0.71	0.86	0.91
Length of gravel road to be surfaced after budget allocation	19,320.28	20,586.93	21,238.81	20,666.19
Required budget before actual available budget	R87,000,000.00	-	-	R97,000,000.00
Required budget after actual available budget	R77,281,120.00	R86,465,124.00	R91,326,904.00	R92,997,895.00
Budget shortfall	R67,981,120.00	R83,465,124.00	R87,626,904.00	R88,897,895.00

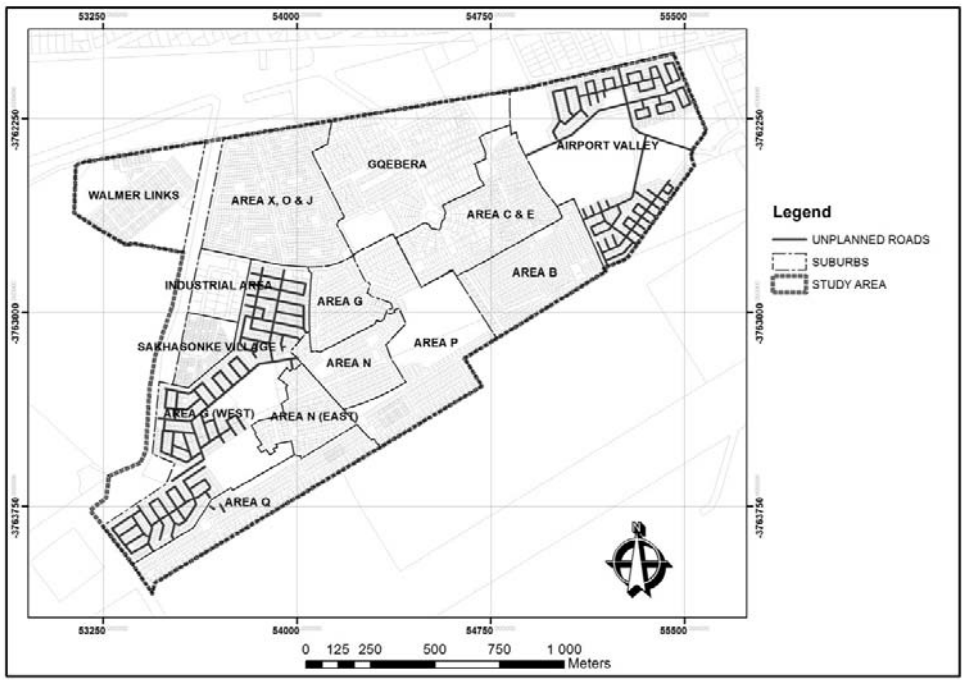
Source: Author

By comparing the actual available budgets (in which 2007 and 2009 are assumptions), this makes for a troubling trend that gravel roads in the Walmer Township will remain a feature in the local area for decades to come, thus supporting the notion that government records of gravel roads remain inconclusive and will continue to reflect no progress – displaying the symptoms of apartheid planning. With an approximate 20% increase in costs over the eight-year period, a question can be raised in terms of the financial feasibility of the ToGR programme in the NMBM. No conclusive evidence of budgets was available for the 2007 and 2009 periods and therefore, this is only assumptive.

The sub-areas of airport valley and area G (West) did not contain any surfaced roads, nor did they contain any formalised gravel roads since 2004. These two suburbs represent the new ordinance survey layouts. Based on the town planning layout, provision for roads in the new areas of airport valley and area G (West) (indicated as unplanned roads in

Figure 8) must still be taken into consideration. In 2011, no formalised roads were allowed, owing to the town planning not being approved. However, given that this study compares the financial sustainability of road infrastructure, it is the opportune time to highlight that the 15 kilometres of gravel roads in the two sub-areas would equate to approximately R83 m ($6.5 m at 2016 construction rates), notwithstanding the remaining gravel roads in the other sub-areas. This is a result of the continual implementation of low-density human settlements, [as in the case of area G (West) and airport valley in the Walmer Township], thereby leading to a relatively unsustainable road network that will require future maintenance.

Figure 8 Spatial distribution of additional gravel roads in the Walmer Township area G (West) and airport valley



Source: Author

4 Conclusions and recommendations

4.1 Conclusions

The common understanding in urban geography is that road infrastructure is a critical component of the successful link of global connectivity to movement of people and goods. The WCED has mandated that the infrastructural projects be delivered in a sustainable manner, one that caters for present and future generations simultaneously. Achieving the concepts of delivering a sustainable infrastructural development lies in interweaving politics, environmental and social impacts, public participation and economical use of natural and labour resources. The keystone to a successful and

sustainable project is to ensure that the fragile management of finances and budgeting throughout the project life cycle.

On a global perspective, with the yield of 25 million kilometres of roads are to be constructed by 2050, indications are that there are mixed reactions to how sustainable projects are to be rolled out, and much of the understanding and concepts of sustainability are still clouded by misrepresentation. Whilst the concept of sustainable developments is a broad term and as much as we recognise that we have broadly assessed, illustrated and discussed the road infrastructural provision in the Walmer Township between 2004 and 2011, and have shown that, on a local level, the financial sustainability of the ToGRP is brought into question.

As a fundamental component, it was argued and assessed that the gravel roads in the study area were consistent throughout this study period at approximately 22 kms. The main lesson of our study is that the NMBM did not significantly reduce the backlog of gravel roads over the period. This suggests that there is an unsustainable manner in which the road infrastructure is being planned and delivered. Although the study demonstrated costing using a 2.5 m wide road as a datum, most of the roads designed for public use are wider than 2.5 m, thus increasing the financial demands on the NMBM. Our findings have underscored the importance of sustainable urban development strategies, not just gravel roads, but entire community structures, as a whole.

The burden remains on the local authority to provide road infrastructure to facilitate the effective movement of goods and services in township areas, thus the slow pace of service delivery from a roads point of view. Based on estimates presented in this article, the budget in 2007 would have allowed for 2.33 kms of road to be constructed. This was reduced to 0.91 kms in 2011. This reduction in the scope of road construction calls for the NMBM to revisit the methods in which the institute rolls out the delivery of roads – particularly from a spatial planning perspective, in order to minimise the footprint of roads that service residents. This study has also reported on the high costs that the municipality incurs in providing surfaced roads. As much as the researcher acknowledges that while inflation has clearly played a contributing factor in the increase of costs, the NMBM has missed an opportunity to create a localised sustainable and effective road network in the Walmer Township area. Factoring in that no conclusive evidence is available, which indicates total gravel roads in urban settings, and using the R3.0 m per kilometre construction rate, to surface 317,000 kms would cost approximately R1.3 tn based, on the assumption that the majority of these roads are lightly trafficked roads.

From the tabulation of sustainable versus traditional approaches to build methodology, indications are that the NMBM has adopted the traditional approach to implementing the ToGR programme. For this ToGR programme, as is normal for typical road construction programmes of a similar nature, achieving tangible levels of financial sustainability will remain a challenge. The evidence presented in this research suggests that there is a 'perception-reality' misalignment on project deliverables between available funding and public perceptions/expectations. There is a dire need for municipalities to understand that road infrastructure is as critical and equal an investment in social upliftment, as the other basic services; and they will have to adapt municipal budgets to cater for upgrading and the maintenance of the road infrastructure.

Community members, who are generally not equipped with the technical know how of road construction, perceive the funding to be adequate to supply large tracts of surfaced roads. In reality, this is not the case; and funding remains a critical and essential aspect of sustainable road construction practices, thus spurring on the animosity amongst

local community members, resulting in civil unrest related to service delivery. Funding shortfalls were hampering the holistic completion of the backlog of the ToGR in the township. Although the community of the township claimed to participate in the development of their own areas, their involvement in road infrastructure development was of a limited scale, like providing labour (particularly for laying block pavers and sidewalk/pavement construction) through small business enterprise without divulging the details of the project. The lack of understanding and background knowledge of the budget allocation by community leaders and their constituency results in the perceived slow pace of service delivery, resulting the civil unrests the area experienced in recent times.

The reality is that engineers and municipal officials involved in the ToGRP decide on what roads are to be constructed (owing to technical considerations); the perception on the ground is that this is viewed as a one-side decision with limited engagement (Respondent 'C', 2018), in line with Lim's (2009) traditional, top-down approach of project development, where the designs are static and based on engineering constraints. Whilst there is a dire need to implement more prudent measures to ensure that road infrastructure delivery projects are sustainable, there seems to be a lack of impetus in driving the agendas of financial sustainability in the ToGRP in the Walmer Township area.

This research indicates and highlights the need to aspire to more sustainable approach to rolling out road programmes such as ToGRP in the NMBM area. As the traditional approach of implementing a roads programme of this nature becomes more acutely expensive, and with 25 million additional kilometres projected to be constructed by 2050, national governments will be faced with situations where delivering road infrastructure becomes even more financially unsustainable. The demand on stakeholders to deliver infrastructural projects in a sustainable manner has been escalating in recent years. This implies that the status quo of current infrastructure project operation and deliverables cannot be allowed to continue using haphazard project objectives and unsustainable implementation strategies, and such requires a new and integrated approach to meet the call for sustainable development from the WCED (Lim, 2009).

4.2 Limitation of the study

Despite the importance of this study, it is not free of limitations. Firstly, the research was based on road infrastructure provision and ToGR in a specific South African township in NMB (Walmer Township), adjacent to the Port Elizabeth Airport. Caution is therefore required when generalising the findings of this study to other townships in other geographic areas, as a replication of this study in other types of townships or other geographic areas might reveal different results. Secondly, the measurement of economic sustainability was confined to financial budget for road infrastructure provision and ToGR for Walmer Township.

4.3 Recommendations

In view of the lack of financial sustainability in road infrastructural provision in Walmer Township, it is recommend that urban and transportation planners investigate innovative town planning techniques and engineering practices to minimise the impact that new road development has on land requirements, financial and funding issues and the movement of

pedestrian and vehicular traffic. The following provides a brief summary of how this might be achieved, namely: firstly, the implementation of more stringent policies for the application of cost-effective materials and construction methods for a more sustainable road network to reduce reliance on scarce natural resources; and secondly, at municipal level, the implementation of the mechanisms that are more rigorous for forward planning and budgeting for road infrastructure provision must be investigated for the optimum usage of public funds for road construction – to reduce the gap between gravel and surfaced roads in a shorter time frame. Equipping government resources with the knowledge of the concept of sustainability is a crucial step in the right direction. It is to be understood that sustainability is intertwined with economic growth, environmental security, social aspects, and municipal asset, as well as demand-side management strategies.

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