Planning Considerations for Smart and Sustainable Transportation Infrastructure: Case Study of Non-Motorised Transport Facilities in Johannesburg South Africa

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Abstract

Non-motorised transportation (NMT) infrastructure, including for walking, cycling and other forms of active or human-powered transport, is a key part of the overall transport network of any “smart” city. Attention to key factors that could potentially influence the sustainability of NMT infrastructure systems at the planning stage is arguably crucial in achieving a sustainable and smart transport network. This study examines critical factors taken into account in the planning and delivery of NMTs to ensure the delivery of sustainable and smart transport networks. Three projects in Johannesburg, South Africa were selected using convenience sampling, based on the availability of information. Document analysis and interview were employed for data collection. Thematic content analysis was conducted with the aid of atlas-ti software. Findings revealed that community’s specific needs with regard to accessibility and services, design, costs, distribution and speed of traffic, distances, as well as occurrence of accidents and incidents were critical factors considered in the planning of NMT infrastructure. Other factors included locational characteristics such as topography, and existing land uses which may affect facility costs and integration of NMT infrastructure. The provision of non-motorised transport facilities, not only ensures the safety of road users, but improves liveability and quality of life and welfare of communities, as well as environment and as such, attention to the factors which should ideally be considered at the planning stage to ensure sustainability of the NMT system is vital.

Keywords: infrastructure, non-motorised transport, safety, smart city, transport

1. Introduction

Transportation infrastructure confers mobility and impacts on the development and welfare of the population through employment and income creation, connecting and providing to businesses and vital services, and therefore enhances economic development and growth (Faturechi and Miller-Hooks, 2015). Sustainable and inclusive mobility is a prerequisite for economic and social participation (Republic of South Africa, 2018). Non-motorised transportation infrastructure is an integral part of transportation system, which is critical to urban mobility. Different forms of non-motorised transport
exists including walking, and cycling. Non-motorised infrastructure contributes to a holistic inclusion of all forms of transportation infrastructure. The provision of non-motorised transport facilities and services improves liveability and the quality of life of the citizenry, and reduces impact of motorized transport on the environment as well as the rate of traffic accidents. Transport solutions should include these different forms of transport for an inclusive transport system (Pojani and Stead, 2015).

However, NMT infrastructure projects still attract little focus as a means of transportation. In Brazil, most of the people prefer to use public transportation (44%) which is followed by the automobile (24%) and the motorcycle (13%); only 12% walk, 7% use their bicycle (Kiepsch, 2012). In South Africa, approximately 80% of South Africans are dependent on public transportation, which usually exists but often only in the form of privately owned minibuses (Republic of South Africa, 2018). The NMT road environment is inadequate, lacking infrastructure to provide safe passage of roads or moving alongside roads because there is limited or no space for cyclists on the road network (Labuschagne and Ribbens, 2014).

Safe cycling lanes and footpaths are still scarce (Republic of South Africa, 2018). Priority in transport planning, is mostly accorded to the needs of private car users. The expansion of public transport infrastructure to include NMT has been neglected in cities (Republic of South Africa, ibid.). The barriers related to the provision of NMTs are related to poor safety, inadequacy of provision, conflicting urban design patterns and unsupportive political environment (Pojani and Stead, 2015; Republic of South Africa, 2018). One of the ways to ensure delivery of sustainable transport is through provision and integration of NMT in transportation systems. This is especially crucial in order to ensure sustainable mobility for all (Kiepsch, 2012).

Continuous research on non-motorised transport is therefore warranted to identify ways to provide sustainable transport system for all, including the disabled. The current study argues that to ensure inclusivity and sustainability in the provision of non-motorised transport infrastructure is through attention to the factors that go into the planning stage of such transport projects. Although similar studies have been conducted on non-motorised transportation. For instance, Kiepsch (2012) dwelt on policies in Brazil, and Pojani and Stead (2015) included other forms of transport. South African studies, focused on policies and concepts that encourage and support the implementation of NMT infrastructure (Labuschagne and Ribbens, 2014); while Mkhize et al. (2009) compared NMT networks in South Africa and Netherlands with regard to the demography and mode, but acknowledged that there was a need to focus on effectiveness on non-motorised transport in relation to economic growth, reduction of poverty and quality of life in urban areas.

Other studies suggested a redesign of routes, speed and transportation characteristics to reduce accidents and incidents and assure pedestrians of safety while walking, greenway streets, priority junctions and so on (COJ, 2014). The objective of the current study was therefore to identify planning considerations, with special regard to the critical processes, structures, methods and criteria considered at the feasibility study stage to ensure that sustainbaility of the project.

2. Non-motorised Transportation Infrastructure

Non-motorised transport is the dominant transport mode in many developing cities, especially in Asia and Africa (Pojani and Stead, 2015). Several forms of non-motorised transport exist. These include cycling, horse and other human-operated vehicles such as camel and horse riding, etc, which provide essential mobility and accessibility to daily opportunities. Sustainable urban mobility is “the product of policies which provide broad and democratic access to urban space, prioritizes non-motorized and public transportation modes, eliminates or reduces spatial segregation, contributes to social inclusion, and encourages environmental sustainability” (Kiepsch, 2012).

A plethora of policies bound for the delivery and implementation efforts geared towards sustainability of NMT infrastructure. For instance, bicycle-sharing schemes in Rio de Janeiro (Brazil), Daejon
(Korea), and Hangzhou (China) (Kiepsch, 2012; Pojani and Stead, 2015). Some NMT policies in Europe are presented in figure 1. Other NMT concepts include Universal Design, Complete Streets, Road Diets, traffic calming, pedestrian and transit malls, accessibility measures, and Dignified Places. More recent international thinking includes concepts such as Modal Hierarchy, Last Mile/First Mile, Liveable Communities, Walkability Indices, and Greenways (Labuschagne and Ribbens, 2014). Further, non-motorised transport infrastructure policies are entrenched in several guidelines and frameworks. According to COJ (2014), some of these include the:

- Draft National Non-motorised Transport Policy (2008), which provides for integration of NMT as an essential element of public transport, provision of safe NMT infrastructure and allocation of adequate and sustainable funding for the development and promotion of NMT;
- DOT Pedestrian and Bicycle Facility Guidelines (2002), which acknowledges the needs of persons with special needs;
- Guidelines for Human Settlement Planning and Design (2002), which guides planning with regards to the development and incorporation of NMT into the design of areas;
- DOT National Public Transport Action Plan (2007), which provides actions required to realise positive NMT environments and improved connections within the public transport network, including planning, and implementation of NMT for maximum integration with existing public transport;
- Gauteng Province Draft NMT Policy (2011);
- 2025 Gauteng Integrated Transport Master Plan (2013); and
- City of Johannesburg Draft NMT Policy

![Figure 1: NMT policies in Europe (Source: Pojani and Stead, 2015).](image-url)

However, although these policies abound, NMT provision is still at a low level. Investigation of ways to improve the sustainability of such indispensable part of everyday mobility is necessary.
3. Methods

The case study approach was adopted to generate in-depth information regarding planning considerations for non-motorised transportation infrastructure its real-life context (Rowley, 2002). This approach was used to build on existing theory identified from a detailed literature review on factors considered in the feasibility studies for transportation infrastructure projects including expertise, data used, processes and methods used as well as criteria factors considered in evaluations. Although the case study approach had been criticized for being biased or having the possibility of selecting “wrong” cases resulting in lack of theoretical generalizations, this shortcoming was somewhat overcome by the use of more than one case to provide findings in different settings and increase the strength of research findings (Darke et al., 1998). In addition, different techniques were used to collect data in order to introduce rigour and increase reliability of the findings (Crowe et al., 2011). Document analysis and interview were used. Prior to data collection, ethical clearance granted by the researcher’s institution’s Ethics Committee. An introductory letter was issued for the field work. Formal consent in writing was also obtained from the entity to access feasibility reports, which the researcher understood could contain sensitive information. The interviews did not last long as it was observed that some of the information could be obtained from the feasibility study documents furnished.

Two projects, which were included based on convenience sampling, were available and relevant to the study, having rich and sufficient information in the feasibility study reports, to characterise and explain the considerations in feasibility studies of non-motorised transportation projects. Interviews were conducted with two managers in the City of Johannesburg who availed the feasibility study documents and were willing to participate in the study. Thus, generalisability and reliability, through triangulation, were enhanced.

Thematic analysis was used to analysis the empirical data collected, with the aid of the Atlas-ti software, version 25, for qualitative data analysis. The project were analysed case by case and discussed collectively using cross-case analysis to identity the factors captured in the feasibility study of both projects. The documents, transcribed interviews and raw noted taken during the interviews were ascribed codes based on themes identified during the literature reviews on feasibility study elements. Through cross case analysis, it was possible to point out and compare the attributes which are common to the cases, which could not have been possible with single cases (Ghauri and Firth, 2009).

4. Findings - Case-by-case Analysis

This section presents the analysis of each project under the different classifications which emerged from the qualitative phase of the study with regard to the feasibility studies undertaken. The findings are presented according to the themes which guided the coding of data in the Atlas-ti software. These include expertise involved, processes and methods, reference data used and criteria factors considered on each project.

4.1 Description of cases

Case study 1 –Soweto-Johannesburg CBD NMT infrastructure

The COJ proposed pedestrian linkages and infrastructure along identified routes requiring facilities for non-motorised transport (NMT). The routes are located in Soweto, Johannesburg CBD and Line 1B. The routes identified included streets providing major linkages to the Rea Vaya stations in Soweto, Johannesburg CBD and Line 1B project (including the UJ-Wits route). The feasibility study was conducted in 2012-2013. The estimated costs for the projects were approximately, R2, 315, 000 (COJ, 2013). These included costs for lighting, sidewalks and cycling infrastructure improvements.
Case Study 2: Rosebank-Sandton NMT infrastructure

The Rosebank-Sandton NMT project entailed improvements on existing NMT infrastructure, as opposed to the Soweto-Johannesburg-Line 1B project (new NMT provision). The COJ proposed the improvements to cater for walking and cycling passengers on the routes. The areas were major public transportation hubs in Gauteng, but with less NMT infrastructure. The facilities included sidewalks, cycle paths and lanes; lighting to improve security; signage, route markers and information kiosks; landscaping and street furniture; special needs passenger accessibility; and pedestrian crossings (COJ, 2016). The feasibility study for the projects was conducted in 2014.

4.2 Findings on feasibility studies

Case study 1 – Soweto and Johannesburg CBD NMT infrastructure

The feasibility study for the projects were conducted in 2012 and 2013. It entailed site investigations, interviews and surveys to determine the needs of the community in accessing the Rea Vaya stations by walking and cycling. Needs were assessed based on passenger volumes, needs, condition of facilities and safety within the areas, as one of the respondents confirmed:

"the feasibility report contains the needs…and the existing structure…the project description, location and so on…the problems….”

Who was involved - Local consultants including engineers and planners were involved. In addition, “….project managers were involved from the client side…”.

Processes and methods - Stakeholder routes and desire lines were identified. Needs of the community members and users were investigated through interview surveys and site observations. A Passenger Interview Survey to establish the peak hour commuter volumes as well as the station passenger counts, condition of facilities, amenities and pedestrian links, as well as accident occurrence along the networks. The UJ-Wits proposed routes in Johannesburg CBD were further verified and updated with stakeholder consultations and site visits (COJ, 2013).

Reference data used - For the feasibility studies, reference was made to existing infrastructure audit observations.

Criteria factors considered - The criteria for selecting priorities were demand (passenger volumes), community facilities, quality of infrastructure (percentage of poor or non-existent) pedestrian infrastructure (areas with the greatest need, within the statin precinct), and distances walked >30 minutes to access the stations (proximity to stations), and pedestrian accident occurrence (places within the station precincts which are unsafe for pedestrians to use) (COJ, 2013). In addition, the feasibility studies (in the case of the Johannesburg CBD – UJ/Wits route) incorporated topography, current land use and desire lines, urban quality, impact on current accesses and businesses, directness, personal security in addition to traffic volume and speed, personal security, urban quality.

Case Study 2: Rosebank-Sandton NMT infrastructure

The feasibility study for the projects was conducted in 2014. It entailed site surveys, traffic counts and consultations with stakeholders including road users. The planning for the project included a feasibility study to determine the specific needs and constraints of the community with regard to non-motorised transport and accessibility. This was based on operational needs such as connectivity, comfort, convenience and safety. The feasibility study was done in consultation with stakeholder, designing measures to address identified issues and develop action plans.

Who was involved - The feasibility study for the non-motorised transport infrastructure in Rosebank-Sandton was conducted by a multi-disciplinary engineering and architectural consulting firm based in South Africa. The company was appointed by the COJ to conduct the study for the identified routes.
**Processes and methods** - The feasibility study entailed a comparison and consideration of the proposed routes and initiatives with others planned in the area. This was necessary in order to align and integrate the proposals with existing ones. Further, the feasibility study involved participation of stakeholders as the project was intended to benefit the community. The stakeholder consultations entailed focus group meetings, organisations’ and authority meetings as well as public open days. Additionally, traffic counts were conducted in order to determine the demand along routes and important intersections.

**Reference data used** - In the feasibility study, reference was made to the Rosebank Traffic and Transport Study. In addition, NMT policy guidelines, frameworks and Action Plans as well as National, Provincial and Municipal policies were referred to. These frameworks guided planning with regard to development and integration of NMT infrastructure into existing designs, and acknowledgement of persons with special mobility needs, for instance, DOT Pedestrian and Bicycle Facility Guidelines of 2002, Gauteng Province Draft NMT Policy of 2011; the 2025 Gauteng Integrated Transport Master Plan of 2013; and the City of Johannesburg Draft NMT Policy.

Further, “the professionals who conducted the feasibility study consulted international guidelines and planning documentation”. These included the Connect2 Greenways Guidelines, Sustrans, UK 2009, to supplement their work. This was done since there was relatively recent emergence of NMT infrastructure prioritising and cycling in particular, especially in Gauteng, and therefore not many comprehensive planning and engineering design guidelines and standards existed (COJ, 2014).

Therefore, during the feasibility study for the NMT in Rosebank-Sandton, reference was made to policy documents. This was essential in order to assess and identify the policy environment in support, and the implications of the proposed development as viewed in Gotz and Wray (2014).

**Criteria factors considered**

In the feasibility study for the Rosebank-Sandton NMT, the factors considered included stakeholders’ needs, existing land uses, design, costs, safety, as well as traffic. In addition, accessibility and walking distances to major land uses such as the Gautrain station were incorporated. Further, preservation of the natural environment and street furniture (including bus stops, billboards, pillar boxes), as well as street lighting and parking spaces for cyclists were considered. Site specific factors were also considered in consultation with stakeholders in order to refine the routes.

The selection of the most appropriate bicycle facility type (shared sidewalk or on-street cycle lanes) was dependent on factors including the ability of the users, specific corridor conditions and facility cost. It was important to find a solution that served the needs of multiple user groups at a reasonable cost within the physical constraints of the available road reserve.

Moreover, the level of usage of the facilities, combination or conflict of modes and satisfaction with different transport modes were considered, in order to estimate future maintenance needs and strategies. The popularity of cycle routes influenced the level of maintenance put in place during the operational stage because no public authority can afford to put funds into unwanted facilities (COJ, 2014). These factors influenced the level of priority given to particular routes since the need for the project has to be justified since governments have large financing gaps and must decide on allocation of limited resources for infrastructure development (Wray and Gotz, 2014).

Therefore, the factors considered in the feasibility study for the provision of non-motorised transport on the Rosebank-Sandton route included congestion levels (traffic), usage of (demand for) the services, needs of the users, safety, design, condition of existing infrastructure, natural environment, parking facilities, accessibility (distances to users) and costs. In addition, specific conditions of the environment (including topography, condition, land uses, walking distances and integration with exiting motorised transport facilities) were paramount considerations, as was the case in a study Malaysia (Yazid et al., 2011).
5. Summary and Discussion of Findings

The factors considered in the planning and feasibility studies for NMT infrastructure were investigated. These were related to human factors or expertise involved in the studies, processes and methods used, data referred to and criteria factors considered. With regard to who was involved in the feasibility studies, local experts and consultants including engineers, planners, and project managers were involved (from the client side). These were appointed by the client. The processes and methods included site surveys to determine existing conditions of facilities and safety issues, traffic counts to determine passenger volumes and distribution, stakeholder or public consultation to identify needs, assessment of mobility needs using interviews and audit observations. Other processes included consideration and assessment of the proposed routes and initiatives, identification of desire lanes, and subsequently, developing action plans to address the identified issues.

With regard to data used, reference was made to existing infrastructure audit observations and transport studies, and policies. The criteria factors considered included traffic demand (passenger volumes to assess and predict level of usage of NMT facilities and desire lanes, and speed, specific mobility and operational needs of the communities (including connectivity, level of provision and quality of existing facilities and amenities for pedestrian usage, comfort, convenience and safety; existing land uses and urban quality, design; costs; traffic site/route specific factors (corridor conditions, topography, parking facilities, facility cost, future maintenance needs), as well as physical attributes and constraints including road layouts, intersections and reserves. Determination of traffic volume and corridor conditions are important since they influence the usage and distribution of trips and therefore choice of travelling by walking or cycling (World Bank, 2000). In addition, establishing the demand for non-motorised against motorized transport is essential because of the limited space for cyclists on road networks, especially if most users being private vehicle occupants, such as in Sandton (Labuschagne and Ribbens, 2014).

Other factors included walking distances to access the stations (proximity to stations); accident occurrence and personal security (places unsafe for use); topography; current land use and desire lines; impact on current accesses and businesses, preservation of the natural environment and street furniture (including bus stops, billboards, pillar boxes), as well as street lighting and parking spaces for cyclists; and more importantly, integration with exiting motorised transport facilities. These variables were deemed to have an influence on the performance of projects during the operational stage since their provision influences the quality of life of the populace and some of them, like accident occurrence rates pose potential risks to the society and should be considered at the feasibility stage (Bracarense et al., 2016). These views were also in line with findings from Vanderschuren et al. (2015), which captured that the feasibility study of non-motorised transport includes consideration of the current and potential users, their needs, the desire lines originators and destinations), layout and design, distances, travel time, accessibility, crash data, road traffic volumes and speeds, hazardous sections (unsafe for road users). In addition, categories of users were considered in Vanderschuren et al.’s study since needs and level of usage (demand) of NMTs are influenced by who makes use of the facilities, for instance, school going age group, physically-challenged or disabled and elderly. NMTs should cater for a wide range of users, a view was shared in another COJ study to justify managed lanes in the inner city of Johannesburg (COJ, 2016). The feasibility studies for the projects thus entailed site surveys and stakeholder consultation on factors including traffic counts and congestion, accessibility, costing, physical attributes of site (road layouts, intersections and reserves), desire lanes, trading operations as well as restrictions on site (COJ, 2016).

6. Limitations and Conclusion

The study sought to identify the factors considered in the planning and feasibility study of non-motorised infrastructure projects in Johannesburg, South Africa. The objective of the study was met. The findings revealed that experts were involved in the feasibility studies, Data and criteria for the
feasibility assessments were based on information obtained from site surveys of the physical infrastructure, stakeholder consultation as well as audit and policy reports. The criteria factors considered included a wide range of factors which were necessary to ensure that NMT infrastructure was sustainable. The provision of non-motorised transport facilities, not only ensures the safety of road users, but improves liveability, welfare and the environment and as such should be people-focused and consider factors affecting the users and the impact on the environment (locally and globally) in order to ensure sustainability.

The projects included in this study were those availed to the researcher at the time of investigation. Therefore, more future studies could include a larger sample to determine if the results would be different. Further, the cases were analysed collectively. A comparative analysis in future could benefit the study. In addition, alternative research techniques such as the use of a field questionnaire survey may reveal different results. Additionally, since the study was conducted in Johannesburg, future studies could undertake similar studies in another geographical area to determine if different results may emerge. Further studies are on-going to establish the performance of these projects during the operational stage.

7. References


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