DEVELOPMENT OF A GEOSPATIAL DATABASE OF MBT RANKS: LoS CATEGORISATION OF FACILITIES IN GAUTENG

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ABSTRACT

The transformation of local and township economies has been identified as one of the critical priority areas for the government's medium-term socio-economic developmental aspirations in Gauteng. Further, recent Gauteng household travel surveys have acknowledged the significant role of Minibus Taxis (MBT) in commuting most commuters daily and account for a substantial proportion of peak traffic demand.

This paper contributes to the evaluation and categorization of public transport facilities research by advancing the development of a weighted decision tool that can assist urban and transport planning authorities to better identify and prioritize areas for improvement and maximize investment when upgrading the quality and level of service provided to MBT commuters.

The focus of this paper is based on a) the development of MBT facilities GIS database based on primary data collection; and b) the synthesis of academic research on public transport facility evaluation, and Gauteng draft policy guidelines on MBT and bus facilities to facilitate analytical and functional categorisation of MBT ranks based on prescribed level of service.

Evaluation and categorization of MBT facilities (ranks) can assist the prospective guideline policy of developing ranks to become economic hubs that can support innovative solutions to creating jobs, modernization, and formalization of the broader township economy.

Keywords*:* MBT, Transformation, Public Transport Facility, Informal Transport, Policy, Sustainability.

1. INTRODUCTION

Section 11 of the National Land Transport Act of 2009 (NLTA) empowers the provincial transport authorities to develop provincial transport policy based on the policy and strategy framework prescribed by the national government. These provincial strategies and policies in turn are expected to inform municipal transport plans and policies across the province and facilitate integration of the provincial transport network and systems.

In Gauteng, Authorities are developing a technical and architectural design policy framework to guide the provision of public transport facilities within and outside of the road reserves of major Provincial Roads. The mooted guidelines are expected to encourage the development of Minibus Taxi (MBT) ranks to promote the modernization and professionalization of rank infrastructure and transform selected land spaces to become

economic hubs along major developmental nodes. This paper seeks to contribute towards the development of such policy and regulatory initiatives.

1.1 Background

The Gauteng Provincial Government jointly hosted a summit event with the MBT Industry in 2016 and 2019 to deliberate on different challenges raised by the taxi industry and government, as well as possible solutions on how these can be resolved.

The Taxi Industry Strategic Session had subsequently identified, the absence of good quality records as one of the major impediments to achieving sustainable public transport reform outcomes (*unpublished session report, September 2016)*. In response to these challenges, a primary data collection initiative of MBT operations was conceived as the initial fundamental stage to facilitate the development of appropriate reform initiatives.

A province-wide MBT facility data collection initiative was developed and implemented in Gauteng to support a) the Summit Resolutions on modernization and transformation in addition to, b) supplementing the geospatial digitization of routes, see Mhlanga (2021). The project involved gathering data about the status quo of Mini-bus Taxi ranks about GPS location and operational infrastructure characteristics (for both formal and informal facilities). Fundamentally, this initiative has important benefits in supporting urban and transport authorities to improve current and future integrated transport planning and spatial transformation practices.

1.2 Problem Statement

The 2016 and 2019 Taxi Summit Commission Plenary on *Formalisation, Empowerment, and Transformation of the Taxi Industry (unpublished plenary session report)* identified the absence of reliable official records as one of the major impediments and risks to the modernization and professionalization aspirations of authorities and MBT industry stakeholders. Furthermore, the majority of local planning authorities often lack the capacity, resources, and decision support tools to professionalize planning that can assist in prioritizing and maximizing public socio-economic investment.

Throughout the collation of existing datasets from authorities and other sources as part of the pre-planning activities before primary data collection, substantial discrepancies and inconsistencies were identified from existing MBT data in the province. The inconsistent quality of data highlighted the need to establish and implement data standardization that is promoted in the 2016 Minimum Requirements for Preparation of Integrated Transport Plans (ITP) regulations. These regulations seek to establish consistent and continuous approaches to professionalize planning, developing, and decision-supporting tools and dashboards that can contribute to improved transport planning practices that can support the modernization and transformation of the MBT operational environment.

A project was conceived and undertaken in 2020 by the Gauteng Department of Roads and Transport (GDRT) to develop a comprehensive geographical information system (GIS) database of MBT facilities operating in Gauteng to complement the recently developed Gauteng MBT routes database. See Mhlanga (2021).

1.3 Aim of Study

Fundamentally, this research is seeking to provide impetus to the *2020 National Taxi Task Team (NTTT) discussion document on professionalization* which focuses on the need to provide universally accessible minibus taxi facilities. Broadly, this study presents the results of the minibus taxi rank survey and thus contributes to a) road-based public transport and minibus taxi facility evaluation literature and b) to the development and implementation of the provincial transport policy, regulations, norms, and standards on public transport facilities and operations.

2. STUDY AREA

The MBT Facilities data collection was based in Gauteng Province of South Africa. Gauteng province has 2 district municipalities and 3 metropolitan municipalities. This is despite the province sharing its borders with 4 other provinces. Situated in the northeastern interior of the country, Gauteng is South Africa's smallest but most densely populated province. Once a mining and industrial center, Gauteng is now South Africa's financial capital and most important economic node, producing 34% of the national GDP on 1.5% of the country's land area.

3. DATA COLLECTION

Primary data collection activities were planned and implemented in Gauteng between 2020 and 2022. Extensive detailed planning was undertaken in collaboration with the provincial regional MBT industry structures of the South African National Taxi Council Gauteng (SANTACO GP) and Gauteng National Taxi Alliance GNTA to ensure transparency and achieve industry endorsement of the project objectives.

The preferred technological methodology for the data collection was the use of a Computer Assisted Personal Interviewing (CAPI) method. The technological architecture for CAPI supports the transfer of survey data collected to a central database (CSIR ICT servers) and facilitates better control of survey data whilst ensuring that issues concerning the collection of data are dealt with timeously and expeditiously. Mobile devices running Android 9 or higher operating systems were used to conduct interviews with MBT rank marshals concerning the operational characteristics of each MBT facility identified. The collected rank datasets were later stored in a Smart Mobility database that contains a separate module titled "*Taxi Rank Facilities System*".

The system modules are Windows desktop-based with local data files. The system modules run on standard Windows 10/11 laptops or desktops and were developed in VB.Net code and make use of Microsoft database (MDB). The system modules also make use of GIS shp files, hence as the system runs locally, there is no central server used. The MBT facility app was also developed in VB.Net code and made use of the mdb database (MS Access database format) with some use of GIS shp files. The data can be exported to MS Excel and various graphs and tables generated in MS Excel. Lastly, a laptop should preferably have 8 GB RAM and 200MB disk space for the app plus 2GB for map tiles.

The survey dataset were assessed using the MBT rank system to automate analysis the results of the large data collection. The dashboard of the rank facilities system is illustrated in Figure 1 and shows the numerous reporting components (data, static images, and photo outputs) that can be navigated to enable visualization of every rank/facility surveyed. The dashboard was developed to enable end users to search, discover, analyze, and visualize

qualitative and quantitative data elements spatially for each facility surveyed. Lastly, the geo-location of enumeration points captured for quality control processes enabled and supported remote and spatial field survey supervision and oversight.

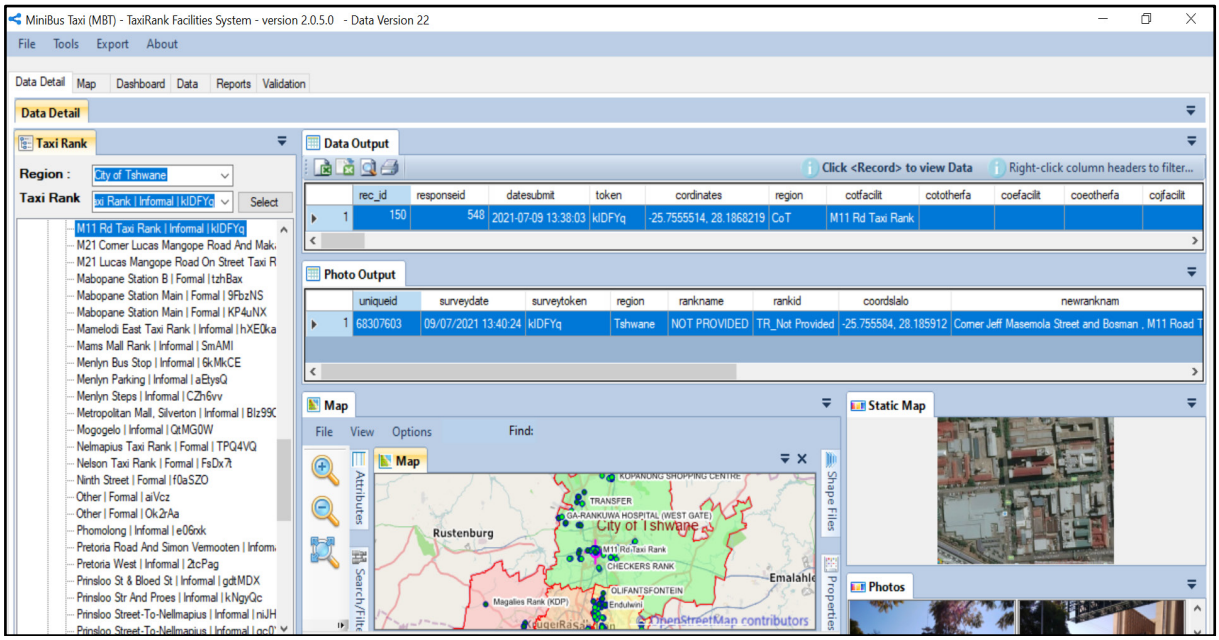


Figure 1: MBT Facilities Systems

4. DATA COLLECTION RESULTS AND ANALYSIS

The results of the survey are tabulated as Table 1 below and show the proportional regional distribution of ranks in Gauteng before and after surveys. During detailed planning before the implementation of field surveys, it was determined that most facilities were either non-existent or not operational. Notably, the collation of existing datasets could not provide a reliable base to estimate the probable number of MBT facilities due to obsolescence and outdated information, the latest dataset dates back to 2013 and was derived from the City of Johannesburg (CoJ). Further, it should be borne that the planned scope was estimated based on the MBT routes mapping datasets from Mhlanga (2021), wherein each route's origins and destinations were recorded as part of the survey.

Table 1: Data collection planned vs achieved

REGION	REGIONAL PROPORTION OF PLANNED FACILITIES	REGIONAL PROPORTION OF PLANNED FACILITIES (%)	REGIONAL PROPORTION OF SURVEYED FACILITIES	REGIONAL PROPORTION OF SURVEYED FACILITIES (%)
City of Ekurhuleni (CoE)	700	38%	252	35%
City of Johannesburg (CoJ)	573	31%	237	33%
West Rand (WRDM)	241	13%	87	12%
Sedibeng (SDM)	200	11%	60	8%
City of Tshwane (CoT)	117	6%	83	12%
Total	1 831	100%	719	100%

It was commonly assumed that most origins and destinations recorded would have a facility associated with them. The spatial distribution of MBT facilities found to be operational and subsequently surveyed is illustrated in Figure 2. Out of a total of 1 831

planned ranks, a response rate of 41% was achieved and this rate was primarily attributable to some facilities not existing whereas some O-D GIS points from the route survey could not be found to have a facility associated with the location.

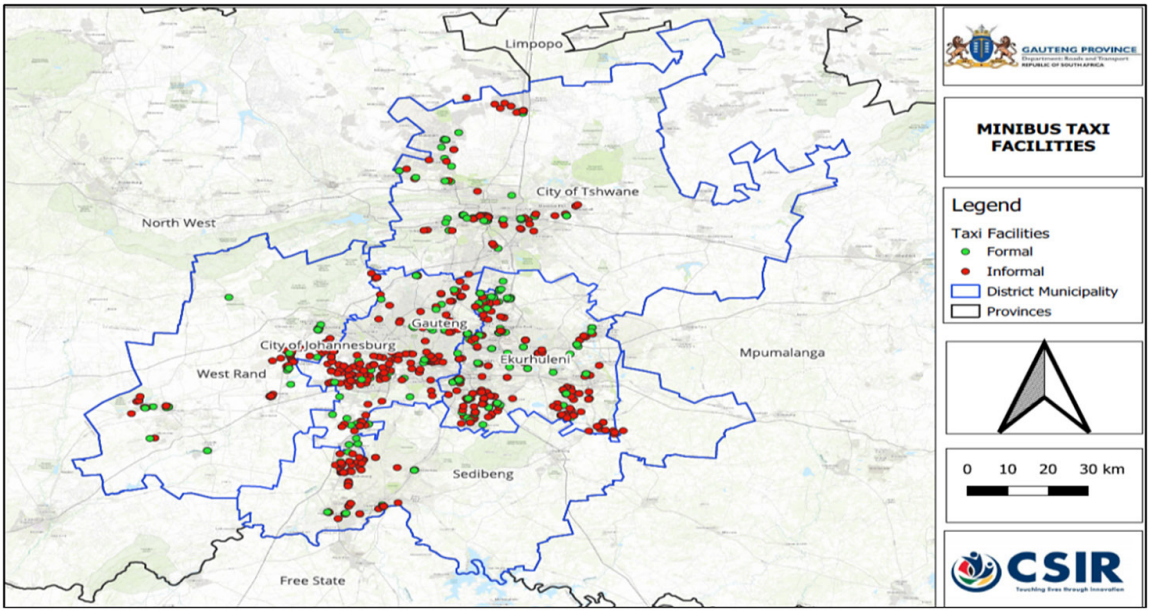


Figure 2: MBT rank survey results

Nonetheless, the survey results of the primary data collection for MBT facilities indicate that on average, 25% of the 742 estimated MBT ranks in Gauteng are classified as formal facilities (See Figure 3). From the figure, a substantial proportion of ranks are classified as informal with limited structural elements and amenities. The cities of Tshwane (CoT) and Ekurhuleni (CoE) had the highest proportional regional distribution of formal ranks whilst the District Municipality of Sedibeng (SDM) and City of Johannesburg accounted for the largest proportional distribution of informal ranks.

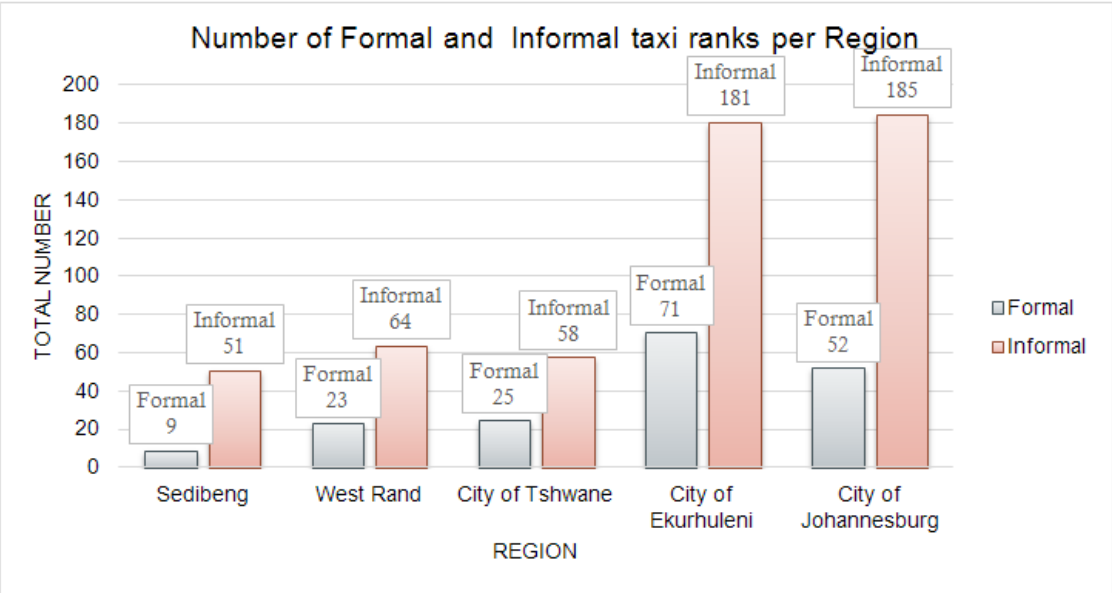


Figure 3: Survey Results of MBT Rank

Most ranks were identified in (CoE) and CoJ respectively whereas (SDM) had the least number of recorded ranks. Informal ranks are characterized by limited facility components

that can improve customer experience and improve operational environment. The ownership and maintenance of ranks are recorded to be by Municipalities, Province, MBT Industry, and Private ownership i.e., filling station, etc.

The municipal government is responsible for ownership and maintenance of 71% and 75% of all formal and informal facilities respectively, whereas the MBT industry was responsible for 21% and 19% of formal and informal ranks, and Private Sector was observed to be owning 5% and 9% of formal and informal ranks respectively. Interestingly, the provincial government-owned and maintained 1% of informal ranks with no ownership of formal ranks.

Formal ranks are mainly used for *ranking, pick-up point, holding, and drop-off* points whereas informal ranks are predominantly used for pick-up, drop-off, and holding ranking services. CoJ was recorded to service a substantial number of routes as measured by destinations for both formal and informal ranks and these were about 639 and 648 unique destinations for both formal and informal respectively followed closely by CoE with 851 destinations. Lastly, an estimate of about 46% of all Informal ranks were observed to be operating off-street, and 54% were reported to be operating as on-street facilities. However, all the formal ranks were identified to be operating as off-street facilities.

5. PUBLIC TRANSPORT FACILITY EVALUATION LITERATURE AND FRAMEWORK

Public transport facilities research in general and MBT rank research, in particular, is not typically abundantly available. However, based on the limited public transport and more particularly MBT facility categorization and evaluation readings identified and synthesized by past authors namely Chetty (2012), Naude (2005) and Rontiris (1990); a hierarchy of significance could be deduced from the various components that make up an ideal use of road and pedestrian space including public amenities.

Public transport and more specifically, MBT rank facility components that are considered to be critical in order of importance can be categorized according to the generic framework illustrated in Figure 4.

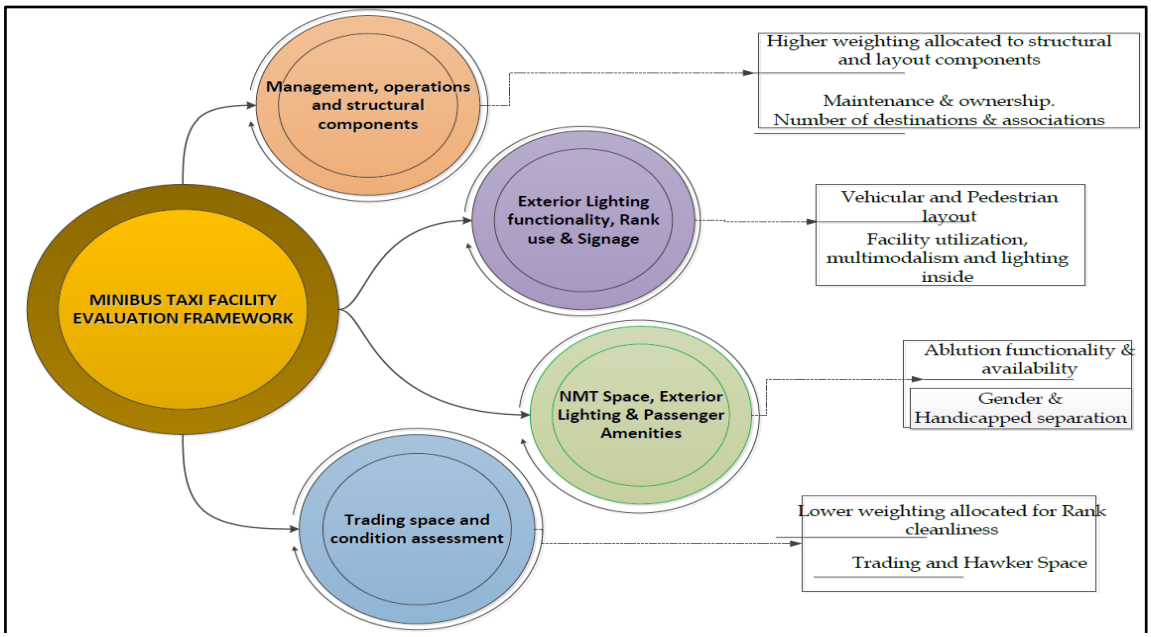


Figure 4: MBT Facility Evaluation Framework

Empirically, the first order of significance in terms of facility components is considered the provision of designated stops, enhanced pedestrian experience accessing facilities, and the availability of ablution facilities. Secondly, is the availability of street furniture, a basic passenger information system, and non-motorized transport amenities to encourage the use of sustainable modes such as cycling and walking.

The 2nd and 3rd categorization order of significance relates to desirable and luxury elements to the development of an ideal public transport facility and includes services such as the provision of café food shops, advanced passenger information, Wi-Fi connectivity, digital ticketing, and architectural placemaking.

The MBT ranks evaluation framework guiding the classification of quantitative and qualitative operational elements is depicted in Figure 4. The figure shows that varying significance (weights) were allocated to specific public transport facility components based on literature. For instance, the characteristics associated with the management i.e., ownership, maintenance, number of associations and destinations serviced, etc, and layout components i.e., roof structure, etc. were allocated higher numerical significance (weightings) whereas trading space and hawker-related components were allocated lower significance.

Table 2: Draft Policy guidelines on facility classification

Category	Descriptions
Category A: **Excellent Mini-bus taxi Facilities**	• Provision of high quality and provide excellent service. • Well-maintained taxis, efficient and friendly staff, clean and well-maintained waiting areas, and modern amenities such as toilets, drinking water, and Wi-Fi. • May have businesses, multimodal, and a variety of structure types (such as shelters or covered platforms). • Accommodate a minimum of 20 loading bays and Dedicated queue marshals. • Large usually with multiple taxi ranks and terminals. • Has signages and is Proximity to CBD. Usually have a holding area for washing and repairs
Category B: **Good Mini-bus Taxi Facilities**	• Provides good quality service with clean and well-maintained vehicles, • Efficient and friendly staff, clean and comfortable waiting areas, and basic amenities such as toilets and drinking water. • May have businesses and multimodal, but their structure types may be limited. • Dedicated queue marshals to manage the flow of traffic, and relatively moderate in size, with one or two taxi ranks and terminals. • Can accommodate a maximum of 20 loading bays.
Category C: **Satisfactory Mini-bus taxi Facilities**	• Provide satisfactory quality and service. • Moderately maintained taxis, efficient but not necessarily friendly staff, basic waiting areas, and basic amenities such as toilets and drinking water. • May have limited or no businesses, and their structure types may be limited. • There are some queue marshals to manage the flow of traffic, and their size is usually small, with one taxi rank or terminal. • Usually within the parking areas of malls. For loading and off-loading only. Usually accommodating a maximum of 10 taxis.
Category D: **Poor Mini-bus taxi Facilities**	• Provide poor-quality service and inadequately maintained vehicles, unfriendly and unhelpful staff, Dirty and uncomfortable waiting areas, and few or no amenities. • May have limited or no businesses and multimodal, and their structure types may be limited. • May have queue marshals, but their management of traffic flow may be poor. Their size is usually small, with one taxi rank or terminal. • Lay-by along routes and used as taxi stops on the road surfaces. They are mainly used for loading and off-loading.
Category E: **Unacceptable Mini-bus Taxi Facilities**	• Provide extremely poor-quality service and poorly maintained vehicles, • Unprofessional and abusive staff, dirty and unsafe waiting areas, and no or very few amenities. • Limited or no businesses and multimodal, and their structure types may be non-existent or very limited. • May have no queue marshals or poor management of traffic flow. Their size is usually small, with one taxi rank or terminal.

Ultimately, the weighted decision matrix was aligned with the draft provincial policy guideline on bus minibus taxi facilities titled BB10 (*unpublished technical guidelines*). The classification of ranks according to policy is summarised and depicted in Table 2 above. From the draft policy framework, a total of 5 classes of ranks are identified and produced from Excellent to Unacceptable facilities. Facilities are characterized according to levels of service (LoS)and use loading bays, proximity to economic areas, amenities, customer service, etc as a measure of significance for each facility.

6. MBT FACILITY CATEGORIZATION RESULTS

A weighted decision matrix was developed based on public transport facility evaluation research and draft policy guidelines to assist the analytical classification of different types of taxi ranks i.e., formal, and informal facilities. The categorization of ranks incorporates operational characteristics and conditional assessments of surveyed taxi facilities as well as COVID Regulations compliance-related attributes associated with facilities. COVID-related attributes were not incorporated in the final determination of MBT categories, and this is illustrated in the facility categorization framework for Level A ranks exhibited in Table 3.

The composite level of service (LoS) framework for each category was developed to guide the analytical determination of functional classification of MBT ranks. The categories describe the LoS of facilities from Category A as being "**Excellent**", Category B as "**Good**", MBT facility Category C as "**Satisfactory**", Mini-bus taxi Facilities Category D as being "**Poor**" and Category E as being "**Unacceptable**".

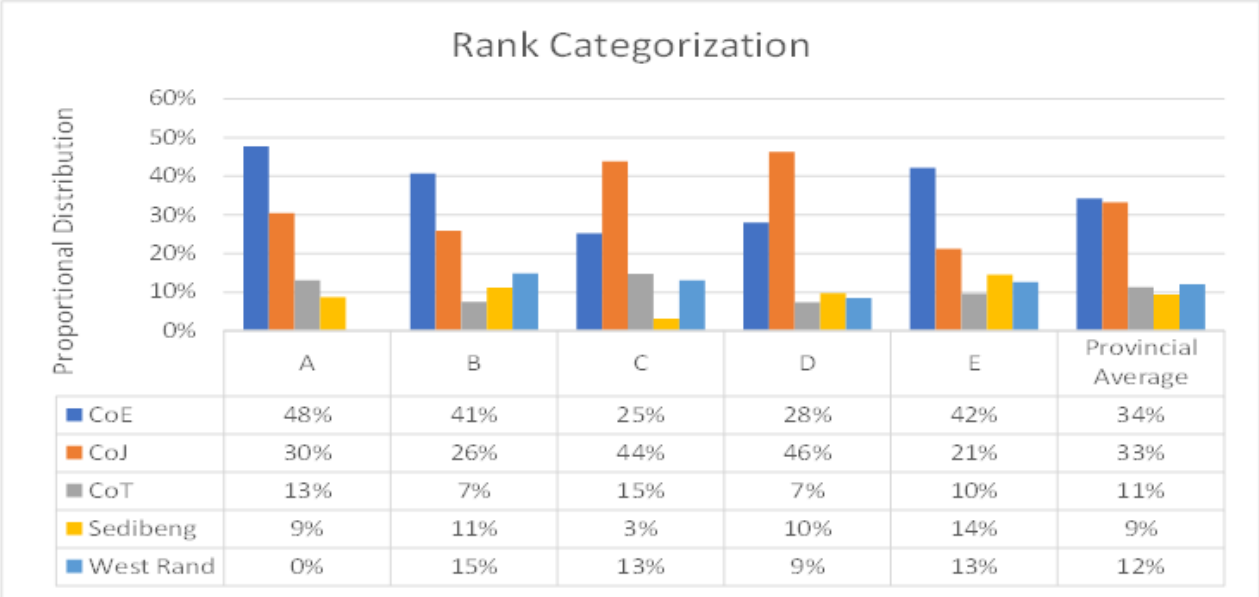
For instance, higher LoS operational parameters are prescribed for category A as illustrated in Table 3 below and these are reduced on an interval scale sliding scale to align and contribute to existing readings and perspectives on the public transport facility evaluation framework discussed in Section 4 above.

Table 3: Framework for Category A

Category	Description
A	Excellent Facilities
Queue Marshals	20>
Associations	10>
Destinations	20>
Roof Structure	Corrugated Roofing
Parking Bays	Available
Loading Bays	20>
Amenities	Ablution Facilities, Benches in good or Fair condition. Ablutions separated by gender type. Ablutions also provide for handicapped people
Businesses	35 < businesses < 60
Multimodal	May have multimodal (Bus and Private Transport e.g. Maxi Taxis)
Dustbins	Availible
Security	Physical and CCTV
Cleanliness	Clean or Fairly Clean
Ownership	Municipality
Signages	Have signages and close or within the CBD
Holding Area	15>
Electricity	lights available inside and outside
Facility Use	Ranking, Holding
Entrances/Exits for Taxis	4
Entrance/Exits for passengers	4 < Entrances and Exits < 6

The evaluation and weighted decision matrix of operational and structural characteristics of MBT ranks produced the facility categorization results, and these are illustrated in Figure 5. From the figure, CoE and CoJ collectively account for about 67% of all MBT ranks in Gauteng. Spatially, about 78% and 67% of category A and B ranks are estimated to be located in the same metros. A total of 25 ranks were classified as category A and 25 ranks were categorized as B.

Predominantly (about 91%) except in the district municipality of Sedibeng, the location of higher-ranked categories of facilities is found in Metropolitan municipalities. Further, the analysis shows that overall, in Gauteng, about 3% of all the facilities surveyed are characterized as providing a category A LoS whereas about 4% of all MBT ranks in Gauteng are characterized as operating at a category level B. The district municipality of West Rand was identified not to have any Category A MBT ranks associated with the region. Indicatively, there are a limited number of MBT facilities that are graded as providing a higher LoS and are generally large thus facilitating the servicing of many routes and destinations.



	A	B	C	D	E	Provincial Average
CoE	48%	41%	25%	28%	42%	34%
CoJ	30%	26%	44%	46%	21%	33%
CoT	13%	7%	15%	7%	10%	11%
Sedibeng	9%	11%	3%	10%	14%	9%
West Rand	0%	15%	13%	9%	13%	12%

Figure 5: MBT Rank Categorization Outcomes

Typically, Category A and B facilities have built-up structures and are generally co-located to other economic opportunities and businesses such as government buildings, shopping, banks, and other modes of public transport modes i.e., bus, rail, metered taxi, etc. More importantly, the higher LoS MBT rank categories promote gender (separation) and people with disabilities in the provision of ablution facilities.

The analysis of the results further indicates that category C and D MBT ranks are estimated to account for a substantial proportion of all ranks respectively, a collective estimate of about 82% of all MBT ranks in Gauteng. Nonetheless, CoJ had the larger share of category C and D ranks in Gauteng whereas CoE had a significant share of category E MBT ranks. The results entail that a substantial amount of MBT ranks provide an average and lower LoS to commuters and typically such facilities are found to service a limited number of destinations and associations, do not provide basic amenities and security, are inherently medium to small in size, and have limited vehicular layout (movement), trading spaces for hawkers and management components.

7. LIMITATIONS

The final estimates of the number of MBT ranks in Gauteng are still outstanding at the time of publishing this paper and as such, stakeholder engagements and workshops planned with the MBT industry are expected to result in an improvement in the quality of MBT facilities datasets. The categorization of bus facilities was not considered as part of this paper and has been excluded.

8. CONCLUSION

Minibus taxi facilities are an important part of the public transport infrastructure in Gauteng. These facilities include taxi ranks, depots, maintenance facilities, and waiting areas for passengers. These facilities must be well-maintained, easily accessible, and equipped with the necessary amenities to ensure the smooth operation of minibus taxi services and the comfort of passengers.

The weighted decision framework promotes the analytical categorization of ranks as a useful building block for a decision support tool for purposes of prioritizing maintenance and upgrading of MBT facilities, particularly as it relates to the concept of development of economic hub taxi facilities i.e., “taxi rank of the future”.

Reforming the MBT sector is a complex task that requires consideration of various factors such as regulation, safety, efficiency, and service quality. Additionally, reform initiatives represent critical building blocks to modernizing, professionalizing, and integrating MBT operations and providing supporting infrastructure. However, the promotion of appropriate scientific decision-support tools and solutions rely on the availability of a comprehensive set of quality and preferably standardized information particularly where GIS is involved to enable standardization of analysis.

The development of a provincial MBT GIS database built with updated operational attributes can support government transport policy and decision-making processes. As a decision support tool input for asset management and integrated land use and transport planning this paper advances that the categorization of ranks provides a concrete foundation and appreciation of the operational characteristics that can be targeted to address professionalisation, equity, business transformation, and sustainability challenges.

Strategically, the weighted decision matrix facilitates the targeting of existing facilities that could be leveraged to become major facilities for purposes of integrating public transport systems with the provincial spatial development framework and municipal land use. Designation of preidentified MBT ranks to function as economic hubs can support localized innovative solutions to creating jobs, modernization, and formalization of the broader township economy that permeates the MBT economy.

9. ACKNOWLEDGMENTS

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