INCORPORATING CONTRACTED MINIBUS-TAXIS INTO TRANSITIONAL INTEGRATED PUBLIC TRANSPORT NETWORKS: THE CASE OF RUSTENBURG

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ABSTRACT

Paratransit plays a vital role in passenger transport in African cities. Several cities are searching for ways of incorporating minibus-taxis (MBTs) into integrated public transport networks (IPTNs), rather than attempting to replace them through fleet buy-out and formalisation – a process that has frequently led to lengthy periods of negotiations with MBT operators, followed by an impasse or continued on-the-road competition with new IPTNs. Of the many questions that need to be answered, key is whether workable models of hybrid operations (i.e. combining both services with informal characteristics, and formal bus operations) can be found. The Rustenburg Local Municipality (RLM) has recently adopted a flexible IPTN system design approach with reduced PT infrastructure, that incorporates existing MBTs as a part of the transition towards a fully-fledged IPTN, in both formal and informal types of operation. This offers a learning opportunity to help understand the potential benefits and pitfalls of such hybridisation. The paper briefly describes the design approach and MBT contracting model for incorporating existing MBT operators in RLM. It then focuses on the evidence regarding selected key operational measures that affect the quality of the hybrid system: operational schedule reliability, in-service speeds, and route adherence, which could be assessed from GPS tracking of participating MBTs. The paper concludes with some implications for other medium-sized cities transitioning towards upgraded IPTNs.

1. INTRODUCTION

Paratransit caters for between 50% and 98% of all public transport (PT) trips in Sub-Saharan African cities. An advantage offered over formalised PT modes is the increased accessibility presented by flexible operations. Many users, however, are captive to the unscheduled and often unsafe and inefficient services (Jennings & Behrens, 2017). Regulating the saturated market is challenging and cities frequently look to reform the industry by replacement with a formal system (Plano, 2022).

In South Africa, the bus rapid transit (BRT) project designed to replace PT services has been revised to a hybrid system to integrate MBT services and reduce PT infrastructure investment (National Department of Transport, 2020). Subsequent attempts to formalise and incorporate MBT services into integrated public transport networks (IPTNs) has been met with resistance in many cities. Paratransit, however, provides a key service in urban transportation and its transformation is critical to the success of IPTNs. There is limited reporting on strategies on how to incorporate MBTs into IPTN and a need to document and share approaches of cities. Rustenburg Local Municipality (RLM) serves as an exemplar of a medium-sized city that successfully contracted MBTs into their IPTN. It is

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important to understand the context and performance-related implications of this hybrid model as this could potentially accelerate the transition to IPTN systems in other cities.

The key issues are:

- Is there a MBT contracting model that can be used to achieve hybridisation in South African cities?
- Can operational efficiency be achieved by contracting MBTs as scheduled services in the hybrid system?
- Can contracted MBT operating along priority PT infrastructure offer performance benefits in cities?

1.1 Objectives of the Paper

This paper aims to address the following objectives:

- To assess route adherence of MBTs contracted in a scheduled capacity along given routes.
- To offer evidence regarding the average headway of MBT contracted as scheduled services.
- To compare in-service average speeds of MBTs contracted in scheduled and paratransit capacities.
- To consider implications for other medium-sized cities transitioning towards upgraded IPTNs.

2. LITERATURE REVIEW

2.1 Paratransit Reform

Paratransit reform in African cities can be classified as regulatory to improve professional conduct, or transformative, through the introduction of a formal system (Ferro, 2015). Both approaches were used in SA to reform the MBT industry, namely, the Taxi Recapitalisation Programme (TRP) launched in 1999 to remove and upgrade unroadworthy vehicles, and the BRT system. The latter involved an initial approach to replace MBT operations, which was revised to a hybrid model consisting of bus and MBT operators (National Department of Transport, 2020).

While some MBT operators are willing to participate in IPTNs as a means of developing their businesses and to earn a reliable income (Mokoma & Venter, 2023), hesitancy exists among most operators. Amid the major factors dissuading participation are, being excluded from decision-making, lack of controlling rights or ownership of vehicles, and negative interactions with the formal sector (Asimeng & Asabere, 2022). This calls for a holistic approach and understanding of operator attitudes to reform (Klopp, 2021; Schalekamp, 2017), as disregarding paratransit operators or failing to include the industry in the reform approach and process, jeopardises the PT intervention (Jennings & Behrens, 2017).

In addition, the establishment of a transport managing authority is promoted for the co-ordination of different modes and to achieve operational integration in IPTNs (French Agency for Development (AFD) and French Ministry of Ecology, Sustainable Development and Energy (MEDDE), 2014). The transport managing company (TMC) can be used as a "stepping stone in incremental changes to paratransit organization towards greater collective management and formalization" (Plano, 2022). In the case of paratransit reform in Nairobi, TMCs facilitate the consolidation of operators and provide more control over operations, without government subsidies. Owners use the TMC brand and must pay a percentage of revenue to the TMC and comply with company standards, a way of enforcing driver training for an improved service quality and passenger experience (Plano, 2022).

2.2 Contracting Models

A hybrid PT system combines formal and informal services. This model was adopted by the City of Cape Town (referred to as the hybrid trunk-feeder reform approach) for MyCiTi Phase 2. Buses operate along trunk routes and MBTs run feeder services. The initial strategy involved the amalgamation of bus and MBT operators into a vehicle operating company (VOC) for all scheduled ITPN services, intending to replace paratransit operations along routes. Lessons learnt from Phase 1 of MyCiTi, however, led to the adoption of a hybrid approach for MyCiTi Phase 2 with paratransit operations along feeder routes through the establishment of a transport operating company (TOC) comprising MBT shareholders. This shift to incorporate paratransit operations through the TOC, recognised the role of paratransit services with smaller vehicles as feeders to the main corridor and was necessary in rendering the network financially viable (Jennings et al., 2023).

In contrast, the launch of the BRT system in Durban was halted due to deadlock with the MBT industry in negotiations over vehicle ownership in the establishment of a VOC. City authorities have since permitted the operation of competing MBT services (Dlamini, 2023). This attempt to reach resolution (to allow the system launch to proceed) highlights challenges experienced by government agencies in incorporating paratransit operators. This will directly impact system users and may create conflict in the implementation of future corridors, and lead to further delays (Jennings & Behrens, 2017).

3. CASE STUDY

3.1 Introduction

Located in the North West Province of South Africa, RLM has a population of 719 000 (Rustenburg Local Municipality, 2022), 85% of which rely on PT services. The IPTN, Rustenburg Rapid Transport (RRT), branded as Yarona, began operation in 2022 with the aim of formalising PT services (Rustenburg Local Municipality, 2016). Yarona comprises three phases, as shown in Figure 1.

The system is being implemented using an incremental approach according to availability of infrastructure, vehicles and funding. Phase 1A comprises 13 complementary routes which overlap along the R104, with services extending from the CBD to Thlabane, Thlabane West and Geelhoutpark. Services along 11 complementary routes were introduced by December 2023.

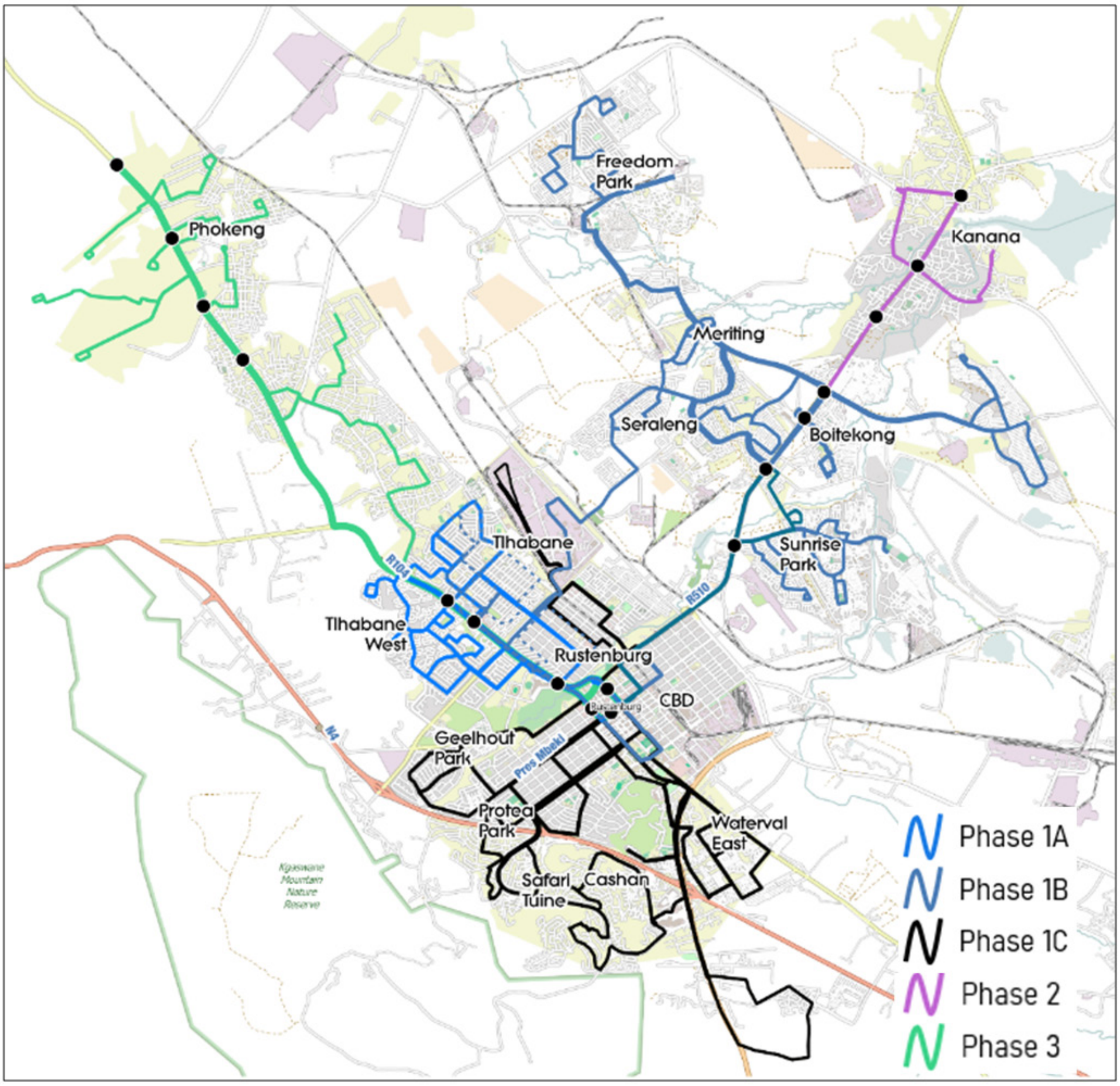

Figure 1: Yarona Phased Plan (Rustenburg Local Municipality, 2024)

3.2 Project Background

The platinum mining town was considered one of the fastest growing municipalities in 2007 with an anticipated growth rate of almost 5% per annum. Funded by the Public Transport Network Grant (PTNG), a fully-fledged BRT was planned as RLM was considered to be an emerging metropolitan municipality. The initial system design comprised a trunk-feeder network with a dedicated lane along the higher demand corridor (R104) and feeder routes. Majority of the trunk corridor and closed stations were constructed prior to the economic decline and reduced budgetary allowances from National Treasury, therefore under the new dispensation, the BRT design was subsequently scaled-down to a quality bus service encompassing the legacy infrastructure (Rustenburg Local Municipality, 2016).

3.3 Transformation of the MBT Industry

3.3.1 Compensation of Operators

RLM successfully achieved transformation of the MBT industry through compensation and establishment of a joint-operating company, referred to as the Integrated Public Transport

Operating Company (IPTOC). As part of the compensation agreement, associations affected by the IPTN received a package in the form of monthly installments (paid over 12 years) and were required to surrender their vehicles and operating licenses. Almost 250 operators were compensated and given the opportunity to invest and become shareholders in the IPTOC (Rustenburg Local Municipality, 2016). Negotiations with MBT operators were held from project inception to ensure participation and co-operation of operators. This relationship is unique to RLM and crucial to the success of the IPTN.

3.3.2 The Contracting Model

A gradual approach was adopted to introduce services by operating smaller vehicles (15-seater minibuses) along certain routes to minimise operational costs and eliminate delays in roll-out due to challenges with procurement of buses. As ridership increases, buses would be introduced along routes (after a year or so). Surrendered MBTs were distinctly branded as Yarona vehicles and fitted with global positioning system (GPS) tracking devices to be used for contracted services along Yarona routes, reducing vehicle costs. 12-metre low entry buses (capacity of 56 passengers) run along three routes of Phase 1A and branded MBTs (referred to as BMBTs) have been contracted into the system to provide scheduled interim services along seven routes. Due to fleet procurement delays, BMBTs were utilised to increase vehicle frequency along one of the bus routes (detailed in Section 5.2), which prevented delays in service roll-out (Rustenburg Local Municipality, 2016). In addition, 65 MBTs were contracted to operate as unscheduled services (referred to as Mop-ups) in mixed traffic conditions to increase service coverage to areas where Yarona routes were not yet deployed. Mop-ups were operated with surrendered MBT which were equipped with GPS tracking devices and Yarona stickers, easily distinguished from BMBTs. As a means of catering for passenger demand, a managing company monitored and redistributed Mop-ups as needed. Mop-ups contracted to operate within a specific area paid a corridor operating fee and retained all user fares (Wattel & Marumoloa, 2024). This contracting model values paratransit operations and provides evidence of a stepped approach to regulate the informal industry with vehicle monitoring and stringent controls.

4. METHODOLOGY

A mixed methods approach was adopted, consisting of primary data from interviews with officials from the RLM and contracted consultants, and secondary data from GPS tracking. The quantitative approach utilised data obtained from RRT via the website link for Fleet Management and Vehicle Tracking. Data was tracked at 20 second or 10 second frequencies for MBT contracted for scheduled and unscheduled (Mop-up) operations.

<u>4.1 Data Analysis:</u>

GPS tracking data was downloaded and stored in Microsoft Excel for cleaning and processing. The raw data contained fields with date, time, latitude, longitude, and speed. Non-proportional quota sampling was used to obtain sufficient data from both the BMBT and Mop-ups for analysis (Etikan & Bala, 2017) to meet the study objectives.

- Objective 1: Route Adherence
  The cleaned data was plotted in Tableau 2023.2 to identify the routes along which the BMBTs contracted to perform scheduled services operated on. These routes were compared with the Yarona route maps to assess route adherence.

- Objective 2: Scheduling
  A sample of 7 BMBTs contracted to perform scheduled services was selected and data was extracted for seven consecutive days. The on-time performance of scheduled BMBTs was measured by comparing tracked departure times to Yarona route timetables. Operational reliability was determined as the difference between scheduled and actual departure times.

- Objective 3: Average Speeds
  Vehicle speeds of scheduled BMBT and Mop-ups were compared based on operation along the same routes. Route F6 was identified as common to both operations and only Mop-ups which adhered to the route were considered. The tracked in-service speeds of 10 scheduled BMBT and 10 Mop-ups along Route F6 were extracted for seven consecutive days to determine the maximum operating speed and average vehicle speeds. In-service average speeds of individual vehicles along with geographical co-ordinates were used to generated Heat Maps to show the spatial distribution of average speeds on Kepler.gl.

5. FINDINGS

5.1 Objective 1: Route Adherence

The BMBTs contracted as scheduled services operated along routes as shown in Figures 2 to Figure 9, indicating adherence to Yarona routes. The trips started and ended at the Central Stop, offering direct services between CBD and route destinations. Each BMBT was dispatched to a single route (or more than one route) daily.

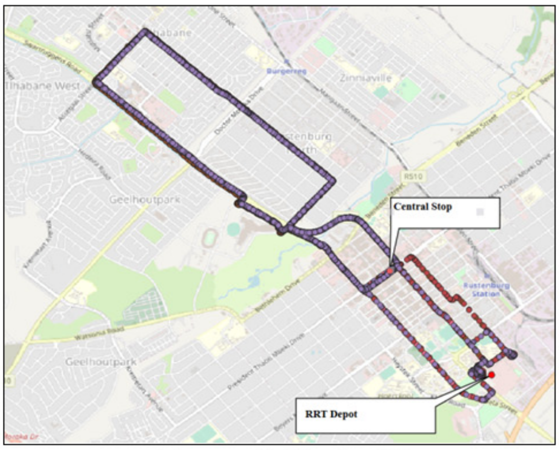

Figure 2: Route F6

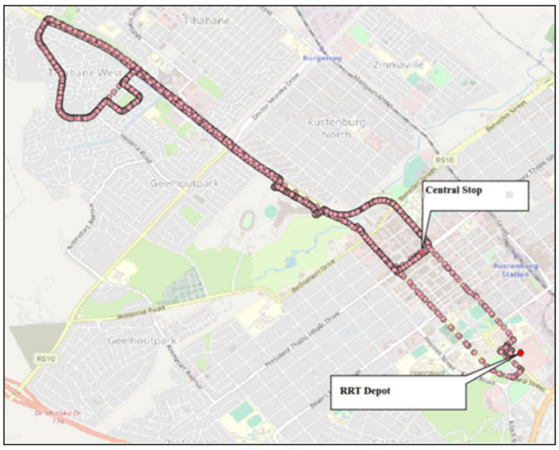

Figure 3: Route F11

Figure 4: Route F12

Figure 5: Route F13

Figure 6: Route F14

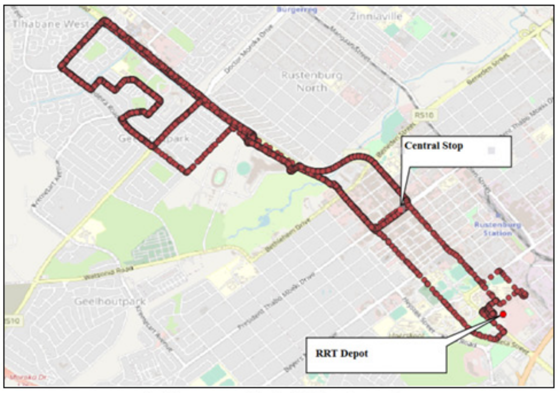

Figure 7: F15 Route

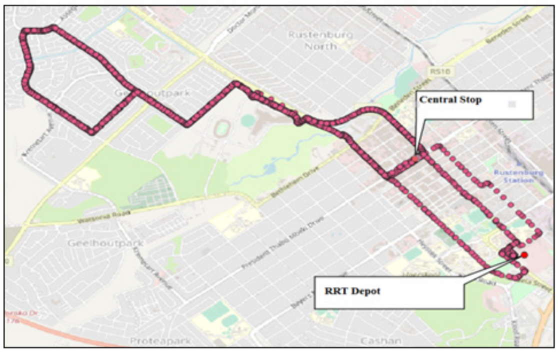

Figure 8: F16 Route

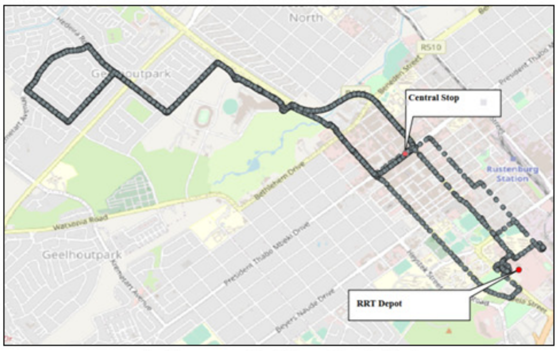

Figure 9: Route F17

Observed Mop-up operations are concentrated in Tlhabane East and North, serving a complementary function to scheduled BMBT services in Tlhabane West.

5.2 Objective 2: Scheduling

Weekday trips are scheduled from 5:00 AM to 7:30 PM and Saturday and Sunday operations commence at 6:00 and end at 7:30 PM and 6:30 PM, respectively. Operating headways and cycle lengths are shown in Table 1. Mop-ups are contracted for early-morning and late-night services outside of these operational hours.

Table 1: Operating headways and cycle lengths (minutes)

Route	Mode	Cycle length	Weekday headway		Weekend headway: peak and off-peak	
			Peak	Off-Peak	Saturday	Sunday
F4	Bus	53	20	30	30	60
F5	Bus	58	20	30	30	60
F6	Bus/ MBT	45	15	30	30	60
F11	MBT	45	15	30	30	60
F12	MBT	42	15	30	30	60
F13	MBT	47	15	30	30	60
F14	MBT	44	15	30	30	60
F15	MBT	38	15	30	30	60
F16	MBT	43	15	30	30	60
F17	MBT	38	15	30	30	60

Buses operate exclusively along Routes F4 and F5 and BMBTs were contracted in a scheduled capacity to increase vehicle frequency along the bus route F6 (as mentioned in Section 3.3.2). Therefore, trips along Route F6 are shared between buses and scheduled BMBT. The seven remaining routes (F11 to F17) are operated by scheduled BMBTs, the introductory mode for subsequent routes. It is interesting to note that Route F11 is operated in an anti-clockwise direction during the morning period and clockwise in the afternoon, to reduce commuter travel times between residential stops and the CBD (Wattel & Marumoloa, 2024).

The weekday peak headway between buses along Routes F4 and F5 is 20 min and a reduced peak headway of 15 min was achieved by utilising contracted BMBTs with lower cycle times on the other routes. The schedule for the shared route (F6) is shown in Figure 10, where every third trip is run by a contracted BMBT during weekday peak periods and every alternate trip during off-peak and Saturdays, respectively. This demonstrates the operational integration achievable by interim hybridisation along a single route and within the system.

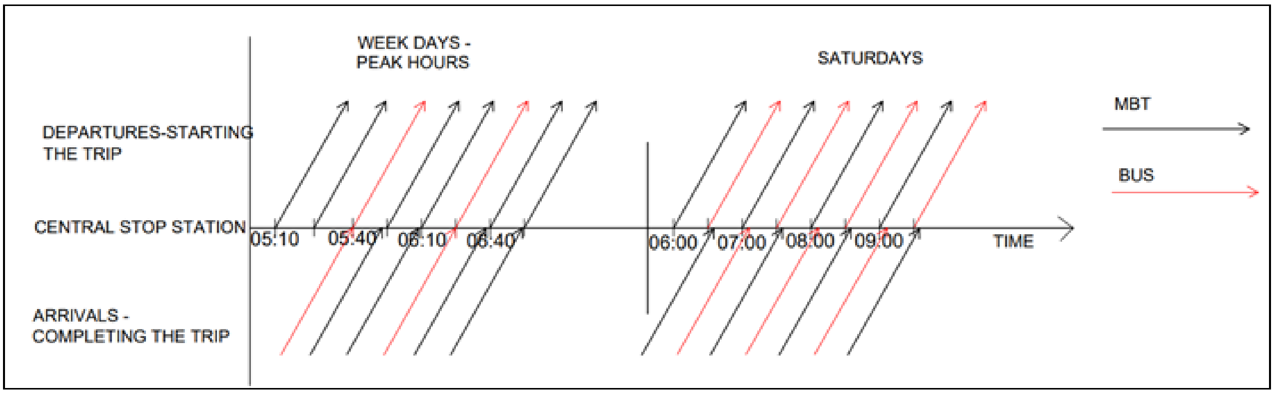

Figure 10: Route F6 peak hours operating schedules

Variations in scheduled BMBT trip departure and arrival times were observed along some routes, with an average deviation of 5 minutes and maximum of 15 minutes. These were mostly due to drivers not adhering to schedules. In such cases, vehicle monitoring can be used to implement controls to enforce on-time services.

5.3 Objective 3: Average Speeds

Average vehicle speeds vary between routes based on operational conditions in mixed traffic or priority infrastructure, number of stations or stops, timetables for scheduled services, driver behaviour and travel demand. The spatial distribution of average vehicle speeds of the scheduled BMBT and Mop-up sample along Route F6 are graphically represented by the heat maps in Figure 11.

The highest vehicle speeds are observed along the R104 (Swartruggens Road) which serves as a 2km expressway without stops. Single carriageway sections of the route without traffic signals generally result in lower operating speeds. Overall, average speeds of both modes comply with speed limits, however, Mop-ups are observed to operate at higher speeds than scheduled BMBTs. Mop-ups deviate from the route to access the Rustenburg Taxi Rank.

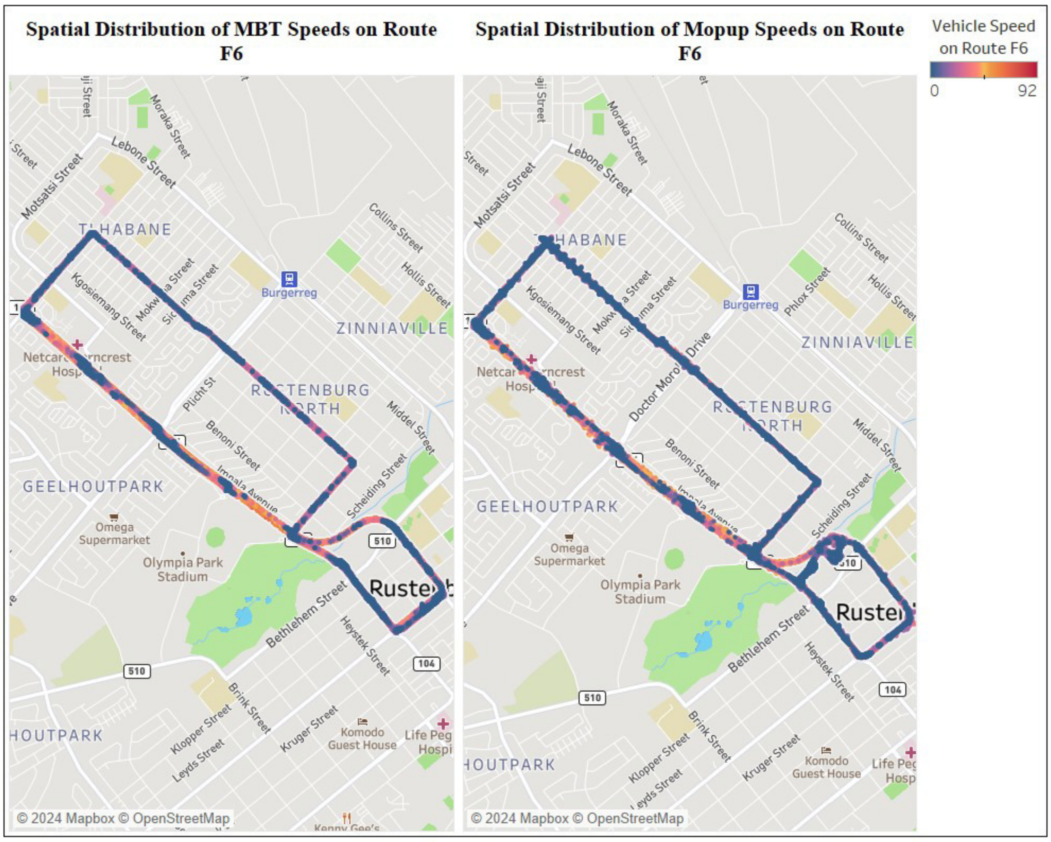

Figure 11: Average speeds of scheduled BMBT and Mop-ups on Route F6

The average of the maximum vehicle speeds observed in the seven-day operating sample is summarised in Table 2, compared with the averaged vehicle speeds of scheduled BMBTs and Mop-ups operating on Route F6.

Table 2: Average speeds of scheduled BMBT and Mop-ups on Route F6

	Scheduled MBT	Mop-ups
Maximum speed (km/h)	73.5	85.0
Average speed (km/h)	18.4	18.5

The average speeds of scheduled BMBT and Mop-ups are almost identical, suggesting similar travel time of users on Route F6 by scheduled and paratransit services. The standard deviation from maximum speeds for scheduled BMBT and Mop-ups along Route F6 is 14.0 and 5.5 km/h, respectively. The variability of the scheduled BMBT speeds may be attributed to changes in operating conditions between the dedicated lane in the CBD and mixed traffic sections along the route. Driver behaviour may also contribute to speed fluctuations. Distribution of average speeds from 5:00 AM to 8:00 PM are depicted in Figure 12.

While slighly higher speeds are reached by Mop-ups during the morning peak with express operations, speeds decrease throughout the day. This is possibly due to multiple pick-up and drop-off stops for passengers and searching for passengers during lower demand hours. The timetables of scheduled BMBT and fixed stops may account for generally consistent operating speeds throughout the day.

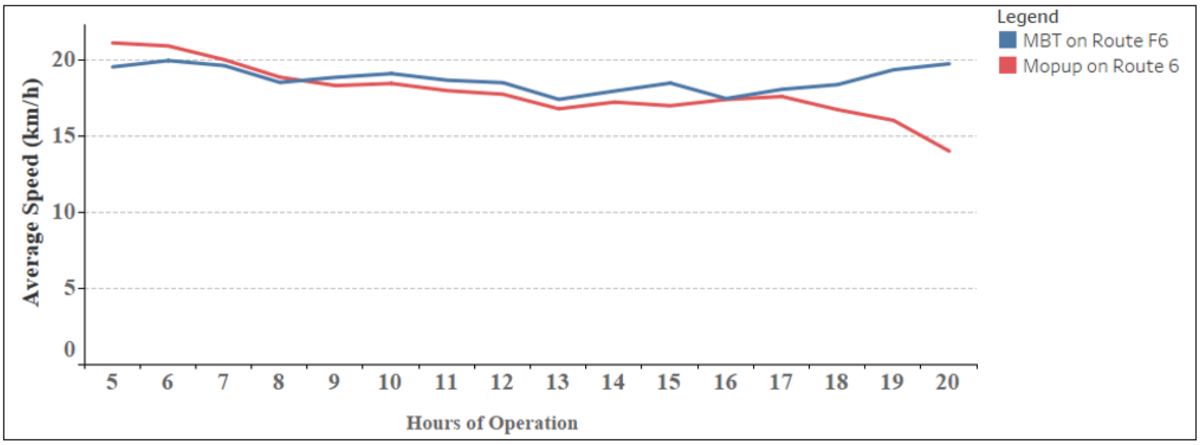

Figure 12: Distribution of average speeds during operational hours along Route F6

6. CONCLUSIONS

Cities in Sub-Saharan Africa with dominating paratransit operations are seeking industry reformation. A key component is a contracting model which effectively integrates operators into a hybrid system. In RLM, MBTs were successfully incorporated into the transitional IPTN, Yarona, through the formation of an IPTOC. The hybrid system is a scheduled service comprising buses and contracted BMBTs, as well as MBTs (Mop-ups) contracted in a paratransit capacity for improved service coverage in targeted areas.

This paper provides evidence of the operational schedule reliability achieved by integrating buses and BMBTs, and operational integration of the interim hybrid system. Phase 1A operations include two routes serviced exclusively by buses, one route operated by both buses and BMBT, and seven routes operated exclusively by BMBTs. Contracted BMBTs were observed to comply with Yarona routes and timetables (with an acceptable deviation from departure and arrival times). In addition, contracted BMBTs generally adhered to speed limits and achieved uniform operating speeds throughout the day, possibly due to operating timetables. The presence of GPS tracking devices in MBTs offers the advantage of vehicle monitoring and speed controls. Similar average vehicle speeds were observed for scheduled BMBT and Mop-ups, irrespective of priority infrastructure and mixed traffic operating conditions, suggesting similar in-vehicle travel times for users.

To conclude, there is much to be learnt from the MBT contracting model adopted by RLM. The incremental introduction of fleet and routes observed in RLM prioritises service quality and enables the gradual upgrade of the system as needed and according to the availability of funds in cities. Introducing smaller vehicles may increase vehicle frequencies along routes and improve service efficiency for users. Cities may consider rebranding surrendered vehicles for fleet flexibility and cost optimisation and to prevent interruptions in service roll-out, as achieved in RLM. The MBT contracting model recognises the role of adaptable paratransit operations in transitional IPTN and demonstrates how to accommodate passenger demand during the roll-out of services. Medium-sized cities seeking to achieve hybridisation and successfully integrate contracted MBT into a formal operating schedule, and cities in search of a stepped approach for improving the level of service from a demand-responsive paratransit service, may benefit from this study.

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