TOWARDS A MORE SUSTAINABLE INTEGRATED PUBLIC TRANSPORT NETWORK

JM VORSTER* **and WR DUFF-RIDDELL****

Zutari (Pty) Ltd; 1 Century City Dr, Century City, Cape Town;
*Tel: 083 578 1107; Email: michael.vorster@zutari.com
**Tel: 063 073 9132; Email: wayne.duff-riddell@zutari.com

ABSTRACT

The need to improve public transport (PT) across South Africa is unquestioned. However, the Integrated Rapid Public Transport Network (IRPTN) approach promoted in the main centres has proven to be expensive and in fact, difficult to implement, with only a few cities having made significant and sustained inroads into service delivery. A key problem has been the attempt to completely replace other existing road-based PT modes with universally accessible Bus Rapid Transit (BRT). Universal access (UA) is a noble goal but should not dominate to the extent that it diminishes the usefulness of the services delivered. We argue that there are alternative models that can guarantee regular, scheduled, universally accessible services at a much-reduced cost.

In our view, “integrated”, means multiple modes, including minibus-taxi (MBT), conventional bus, BRT, and rail, working together with some coherence, and basic arithmetic will establish that the optimum mode for a route depends on the level of demand over a sustained distance. BRT is a medium capacity, medium speed road-based mode which operates in dedicated right-of-way and offers little travel time advantage in the off-peaks when there is little or no demand, and general traffic congestion is reduced. This then begs the question of the insistence of trying to provide the full system capacity in the peaks with BRT.

A better approach may be to provide a level of BRT type service throughout the day that is adequate for around the average weekday off-peak demand levels. This ensures universally accessible, scheduled services, providing peak capacity, and a competitive peak period speed advantage. The remaining required capacity is then provided by other existing modes. Using this model, as much as 70% of a full week’s passenger demand (i.e. Monday to Sunday) can be accommodated with the fleet required to satisfy between 20% and 40% of the weekday morning peak demand. Conventional buses can conditionally use the bus lanes, but not stations.

Other measures to reduce the cost of BRT systems and improve the integration of modes include the use of lower cost modular stations and the transition to an accounted-based ticketing system, which facilitates the principle of “bring your own device” or BYOD. Savings can then be used to expand coverage instead of being wasted on unused capacity in off-peak periods.

Keywords: Bus Rapid Transit (BRT), conventional bus, Integrated Public Transport Network (IPTN), Integrated Rapid Public Transport Network (IRPTN), minibus-taxi (MBT), public transport (PT), universal access (UA).

1. INTRODUCTION

1.1 Problem Statement

Bus Rapid Transit (BRT) is a mode best suited to relatively high-density corridors with a medium level of demand. South Africa has very few truly high-density corridors, but the BRT concept has been applied based on the idea of bringing passengers to terminal points and then using bus lanes to join these (i.e. hub and spoke model). This works but relies on a feeder system and transfers, especially at the terminal points. Problems have arisen through deploying BRT concepts and vehicles onto the feeders, displacing the existing feeder services, mainly minibus-taxis (MBTs). This approach has been costly, requiring MBT industry compensation and new BRT compatible vehicles, with only limited results. The deployed BRT buses are not always suited to the feeder route conditions, user requirements and demand levels given the low-density environment associated with these routes. Concurrently, BRT specified buses with reduced seating have been deployed on services operating in mixed traffic, often with long journey times for which buses with higher seating capacity would be more appropriate. We argue that perhaps the whole BRT concept in South Africa needs to be turned on its head to achieve a more advantageous outcome.

The essence of the alternative approach proposed is to displace as little as possible of the existing service provision by MBT and conventional bus. Rather, examine those corridors where there really is a high level of passenger demand over a sustained distance, very often on highways, create bus lanes and establish a core level of BRT type operation that guarantees 16-18 hours per day of scheduled, universally accessible service, complementary to the range of other public transport services in operation. A key element of this is ensuring that there is a contiguous network across as much of a city as possible. Why do this? Well, most conventional bus and MBT operations derive their income from peak periods and are not particularly viable in the off-peak times, leaving a very poor level of service out of peak periods. These services also, in general, make no provision for special needs users and, in the case of the MBTs are not scheduled either. So, the objective is to cover these bases of off-peak, scheduled, universally accessible services over as wide an area as possible whilst increasing the efficiency of peak period services on the main corridors through dedicated bus-ways that create an attractive alternative to private vehicles in congested environments.

Central to the overall tenet of the proposal set out in this paper is recognising that efficiency comes, in particular, from deploying the optimum mode for the demand patterns on a route or corridor given the very diverse travel needs of the population. This means having and integrating multiple modes, each with its own optimum operating characteristics, rather than trying to replace them all with less appropriate centralised operations. The optimum role of BRT type services is as an intermediate level of capacity and performance between conventional bus and rail and nowhere else in the supply-demand continuum, as shown in Figure 1 from Vuchic (2007), which illustrates the relative performance and cost of different generic modes of public transport.

What we propose is that the focus of a rapid road-based public transport service be exclusively on core Integrated Public Transport Network (IPTN) trunk routes that are currently not serviced by rail. The existing conventional bus and MBT industries are harnessed to provide an affordable and resilient feeder and distribution system and supplementary direct routes between key origin-destination (OD) pairs. With this integrated approach, trip frequency between OD pairs is then based on multiple modes, as opposed to that provided by a single mode. Effective cross-modal information, communication, and fare systems will be required to maximise the efficiency and convenience of transferring between modes in the inter-modal network, noting that the technology to facilitate this is already available. The implementation may require some adaptation in system design and some adjustments to the organisation structure used to oversee IPTN delivery.

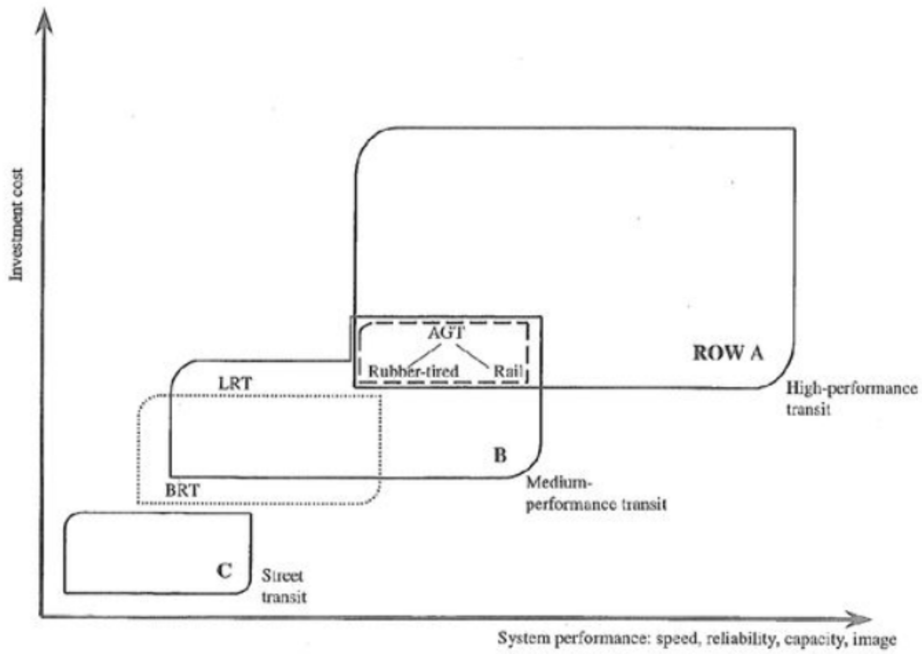


Figure 1: Performance-cost packages (PCPs) of different generic classes of transit modes (Vuchic, 2007)

Of course, there are also constraints in terms of providing BRT services. Fleet acquisition and operating costs; infrastructure costs, especially for busways; compensation for displaced operators, some of whom may not want to be displaced; and so on. Can a service offering within these constraints be maximised? We believe so.

1.2 Aim of Paper

Based on the authors' experience in planning, implementing, and operating various IPTN type public transport systems in South Africa, the aim of this paper is to propose an alternative approach to IPTN implementation in South Africa, given the limited success and high cost of that implemented to date. The proposed approach leverages existing modes of public transport and supplements, rather than replaces them, by filling in a capacity gap in the public transport supply continuum as illustrated in Figure 1. The intention is increased overall IPTN cost efficiency and effectiveness whilst ensuring a high-quality core service that provides universal access, peak-period congestion management, and reliable off-peak services.

2. ORIGINAL INTENT OF BUS RAPID TRANSIT

BRT is generically defined as a high-quality bus-based mode that provides relatively fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service (Wright & Hook, 2007). As noted by Wright and Hook (2007), it aims to emulate the performance and amenity characteristics of a modern rail-based system, particularly Light Rail Transit (LRT), but at a fraction of the cost. The relative performance and cost of these and other modes is illustrated in Figure 1.

The motivation for BRT as a mode is that it is one of the most cost-effective mechanisms for cities to rapidly develop a public transport system that can achieve a full network as well as deliver a rapid and high-quality service (Wright & Hook, 2007). This motivation was accepted in the National Department of Transport's (NDoT) Public Transport Strategy of 2007, where BRT was identified as the appropriate road-based mode for integrated rapid public transport networks (IRPTN's) within at least the six metro cities (National Department of Transport, 2007). Of course, there are 13 Cities that have since been part of the programme, noting that provision for adapted versions of BRT was permissible outside of the 6 metros.

3. SOUTH AFRICAN CONTEXT

3.1 Spatial Planning

South African cities generally have relatively low-density development with long travel distances between separate, homogenous land uses, particularly the residential areas of those most reliant on public transport and their places of employment. This configuration has the dual impact of limiting the viability of very high-capacity modes, such as rail, and of resulting in a high level of travel-need diversity at the ends of the main corridors. The latter being something not well accommodated by higher capacity modes, including BRT.

Tied to the spatial planning, in general, is highly peaked and directional demand as compared with what may be encountered in denser and more mixed land use environments. This combination of conditions reduces the financial sustainability of public transport, especially when service quality requirements include off-peak, time and direction, services be provided, resulting in poor overall fleet utilisation.

3.2 Evolution of Public Transport and Resistance to Change

Public transport in South Africa, as elsewhere, has been shaped by historical, political, and socio-economic factors. Public transportation in non-white areas was characterized by segregation and inequality under the apartheid regime, leading to the proliferation of informal MBT operations to fill the gaps left by formal public transportation services (Hugo, et al., 2024). This ultimately resulted in MBTs as the dominant mode of public transport in the country. One of the reasons for this dominance is the diversity of origin-destination options feasible with the smaller vehicles and limited physical restriction on routing. The MBT is in fact, a highly effective mode in certain operating environments. Where it is least efficient is on longer, high demand urban corridors, where BRT or rail are more appropriate.

Efforts to reform the public transportation system after the democratisation of South Africa have faced numerous challenges. The Public Transport Strategy of 2007 sought to improve public transport through the introduction of IRPTNs, and more specifically BRT as the first focus (National Department of Transport, 2007). The application of this was a full replacement model where negotiations with the MBT and bus industries were held and new companies formed to deliver the formalised BRT services. However, the taxi industry and to a lesser extent the legacy bus operators were largely against the integration, citing reasons such as exclusion from decision making, lack of controlling rights or ownership of vehicles, and negative interactions with the formal sector (Chetty, et al., 2024). BRT was set to offer full coverage by the end of 2020, however, 5 years on and cities are still a long way off the originally planned implementation. While the MBT industry and BRT are currently serving communities alongside one another, there is still conflict between the two parties, which has resulted in a rethink of how the conventional bus and MBT industries can be better integrated into IPTNs.

There appears to be a change in course, with legislation and plans moving away from the "displace and replace" approach and rather embracing and engaging with the MBT industry (Schalekamp & Klopp, 2018). An example of this is in the NDoT's Revised Strategic Plan for the Fiscal Years 2020/21 to 2024/25, where it is noted that cities who are recipients of the Public Transport National Grant (PTNG) are encouraged to implement hybrid systems, which include conventional bus and MBTs as part of an integrated IPTN (National Department of Transport, 2021). This is an important acknowledgement as a large part of South Africa's population will continue to use MBTs for the foreseeable future, so it is important that proper integration and public participation is undertaken going forward (Hugo, et al., 2024).

3.3 Shortcomings in Service Quality for Passengers

MBTs and, to a lesser extent, conventional bus services are commercially driven. Bus services may receive a passenger fare subsidy, but still only operate select routes and timetables that are financially viable, based on demand. The result of this is generally high frequency services in the peak periods when demand is high, but little to no service in off-peak periods. Particularly in the off-peak periods, integration with formalised services becomes difficult and, combined with the overall lack of scheduling on the part of MBTs, it is thus difficult for passengers needing to adhere to scheduled appointments to make time efficient arrangements.

Another shortcoming in both MBTs and conventional bus services is lack of UA compliance, making access to these services by persons with disabilities difficult.

3.4 Financial

Although relatively cheaper than LRT, BRT can still be costly to implement when considering the improvements in performance quality, infrastructural requirements, and industry transformation costs. Reduced budgets compared to other countries and sub-optimal expenditure of the funding available have limited the implementation of services to date.

4. AN ALTERNATIVE APPROACH

4.1 Core Operations

It is recognised that the approach proposed in this paper is contrary to the usual concept of providing the high-capacity services only, or at least mainly, during peak periods, i.e. that other services should operate at off-peak capacity levels and BRT should provide the additional peak period capacity required. Circumstances pertaining to guaranteed off-peak and universally accessible services mean however, that the normal conceptualisation results in excessive costs, delaying the delivery of sustained service quality across the operating day and the establishment of a core network to which to link other services. In short, we promote establishing a core network and growing that with demonstrated demand rather than attempting to provide the full experience in a small area at the expense of wider coverage with lower service level expectations.

Although the exact outcomes are route specific, observed passenger demand patterns on existing and planned IPTNs with which the authors have been involved suggest that a fleet sized to accommodate between 20% and 40% of weekday morning peak demand can accommodate up to 70% of the total weekly demand on a route. This is illustrated in the example demand pattern shown in Figure 2. A possible outcome of this arrangement is that there may be some level of peak spreading induced by a reduced peak period service although many public transport users do not have the luxury of being able to adopt flexible work and or travel hours.

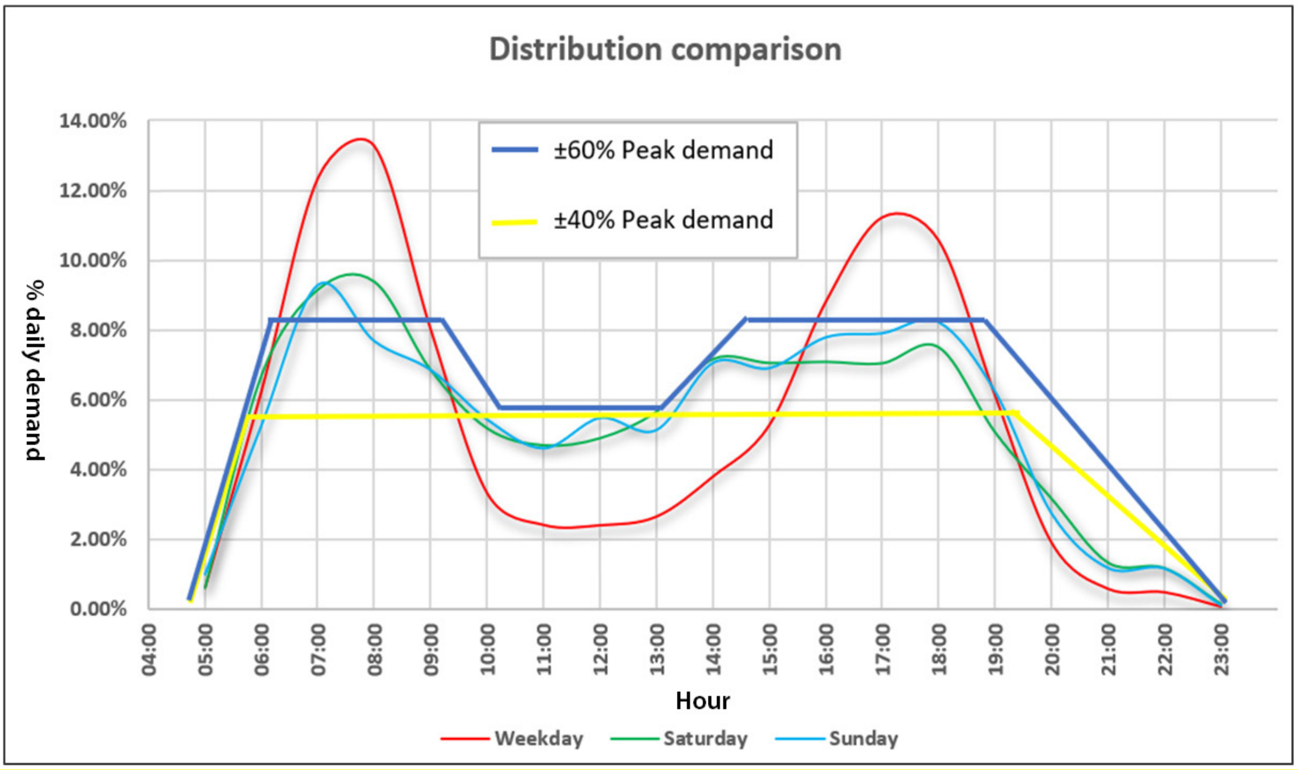
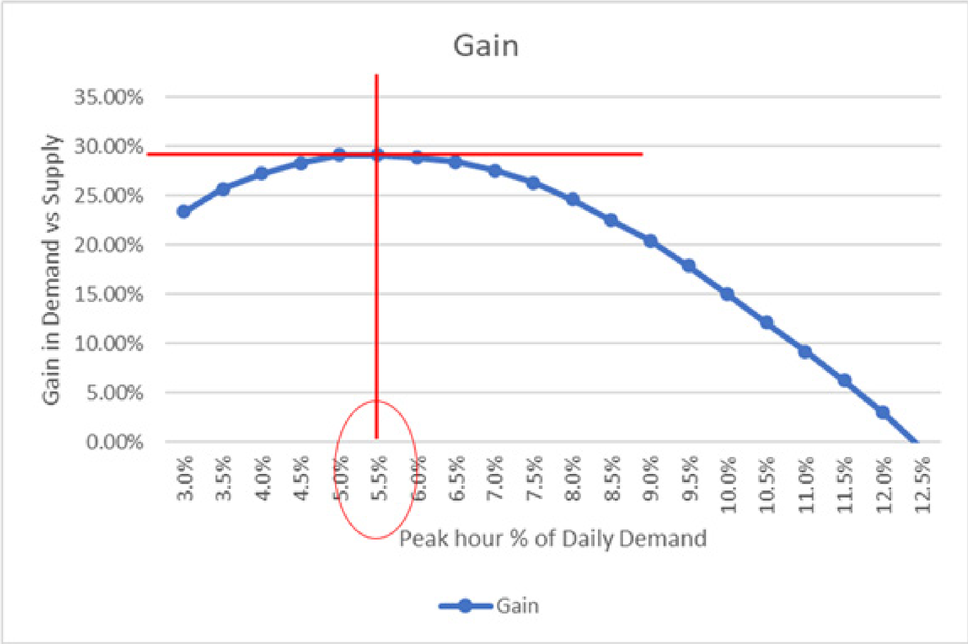


Figure 2: All-day service level concept

Under this regime, BRT buses operate continuously during service operating hours. Depending on the route profile and determination of the optimal supply point, as discussed below, there may be a need for a slight off-peak reduction of services. This approach offers a rapid transit option on the longer, and higher demand corridors and guarantees scheduled, universally accessible services throughout the operating hours of the service but focuses on providing a core element of the IPTN, not the whole. Passengers have the choice of mode to best suit their needs with guaranteed off-peak services on the main corridors.

The trunk service speed advantage, observed on existing BRT systems, should make the BRT services attractive to passengers in the peaks and the services can potentially operate at or near capacity during all operating hours over the entire week given limited competition for passengers in the off-peak periods. Operationally, additional drivers per peak bus are offset by fewer buses and thus, potentially, fewer drivers overall. Similarly, per-vehicle kilometres may increase, but with fewer vehicles. In minimising BRT service provision costs, the limited operational impact on other services reduces the number of displaced MBTs and thus compensation that will be required.

With the foregoing in mind, analysis of the gain in benefit versus the supply provided, reflected in Figure 3, shows a quite clear point at which increasing supply has a maximum limit on the gain in the overall benefit achieved. This occurs because the hours of maximum fleet capacity utilisation decrease as supply is increased in the peak periods, resulting in large periods of time when expensive buses are sitting idle.



There is a quite clear point at which the marginal gain of adding fleet is a maximum, either side of that, changes in fleet size have negative overall revenue/cost impacts.

1

Figure 3: Optimum supply level

Ideally, a business assessment must be undertaken to determine where maximum socio-economic benefit can be achieved with the allocation of additional fleet beyond the optimum point, i.e. to areas where people are most in need of this type of service.

4.2 Extended Coverage

With a refocusing of the nature and level of supply of BRT operations, resources can be released to facilitate expansion of the core services over a far greater overall service area. This concept is illustrated in Figure 4.

Recognising the implications of working with existing MBT operations, some expansion can be implemented with very little infrastructural intervention other than conventional BRT stations, either using spare road capacity or peak hour bus lanes[1], mainly on motorways.

The operation of public transport services in BMT[2] lanes rather than dedicated BRT right-of-way provides an intermediate approach pending the construction of dedicated right of way where this is warranted by demand and necessary for traffic management. This approach aligns with the principles of infrastructure “lite[3]” and incrementalism, considered as necessary to balancing delivery against resources and expectations.

Noting that different market segments have different travel needs, prioritising the provision of trunk services using dedicated roadways implies that direct and feeder services in mixed traffic should be provided by other modes. However, exceptional circumstances may justify BRT trunk extensions in mixed traffic on routes where there are very limited

---

[1] There may be instances in future where the concept of “reversible lanes” can be considered to maximise network capacity. This is however not that practical where there are permanent median barriers. As encountered on most freeways.

[2] BMT – Bus, Minibus Taxi. Designated lanes for public transport vehicles.

[3] A colloquial term, in this case with respect to the minimum possible infrastructure to get things going.

options owing to the local geography, e.g. where dedicated right-of-way would be ideal but is not practical.

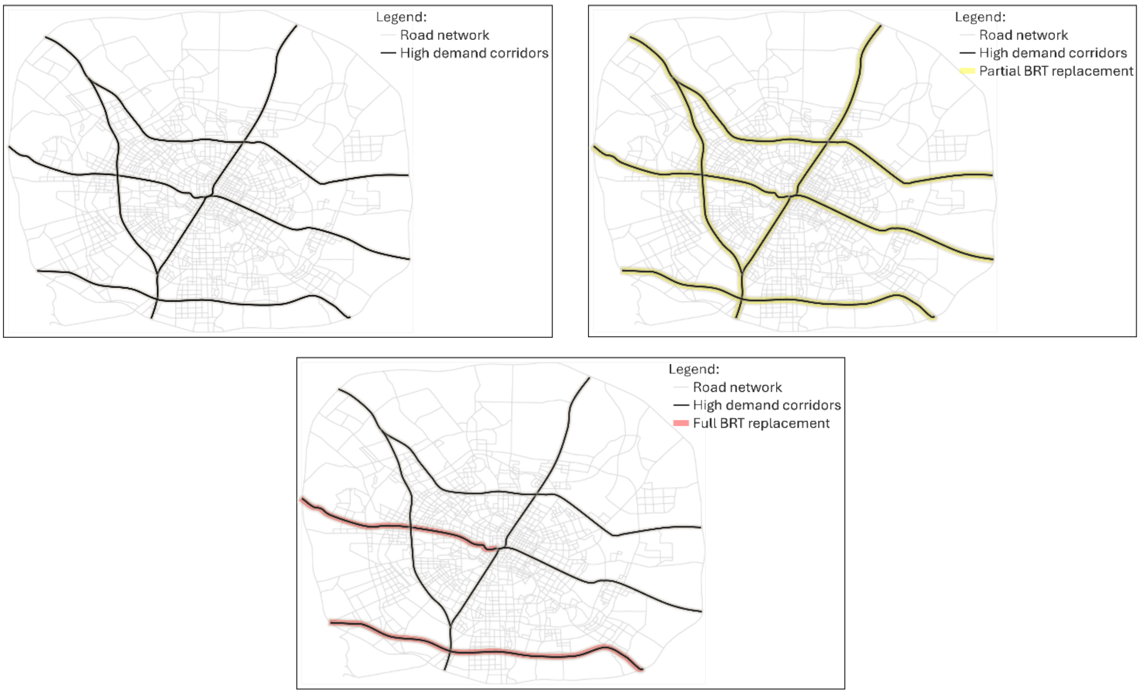


Figure 4: Illustration of extended coverage depending on nature and level of BRT supply Feeders and direct services

Where a full replacement approach has already been adopted in the first roll out of IPTNs, an option is that current non-core services transition to a concession-type approach during the next contract period. The contracted VOCs would be required to provide such non-core services on a concession nett cost basis with the flexibility to design, specify and schedule the service provided they meet certain minimum standards. The concessionaire would receive the fare box and a possible subsidy at the discretion of the Contracting Authority. This would allow VOCs to harness their flexibility and their commercial and operational experience to provide more competitive and sustainable services. The concession approach will also allow VOCs to sub-contract and regularise[4] MBTs where appropriate, with the Operating Licence being in the hands of the VOC, not individual MBT operators, thus overcoming the problems associated with reinstating MBTs to areas for which they have received compensation in the past.

This approach would also allow commercial entities or business area partnerships to contract with VOCs to provide specific feeder and distributor services on cost recovery basis, particularly for staff transport but perhaps also to facilitate improved access for customers.

For new areas of BRT roll-out, the assumption is that the ordinary operation of market forces will ensure that MBTs or other bus services with the necessary route authorisations will provide feeder services to the BRT services, thus becoming more integral to the overall

[4] In consultation with the relevant MBT Association, issue operating licences to illegal operators whose services are deemed warranted on a route.

IPTN. To improve passenger convenience and information, MBT operators may be incentivised to adopt an integrated ticketing technology compatible with the BRT system provider. The incentives may be provided to encourage MBT operator and driver adoption of the appropriate AFC platform and could be supported by passenger transfer discounts on their fare when transferring to or from the BRT system. A necessary precondition for such an incentivised feeder service is the provision of an affordable and functional integrated ticketing technology that is practical to implement in different modes. Such systems do exist and are in quite common use in Europe, relying almost exclusively on phone apps. The appropriate AFC system will also facilitate an MBT industry opportunity to accommodate multiple fare payment mechanisms for their other business.

4.3 Elements of Proposal or Versions Thereof Implemented or Planned

Cities across South Africa have implemented or planned elements of the proposed approach or versions thereof either by choice or force of circumstances.

Cape Town is an example of a City that is planning on implementing a version of the proposed model. Initial supply of Phase 2A MyCiTi services is below projected demand, and conventional bus and MBTs will be allowed to operate parallel services (City of Cape Town: Urban Mobility Directorate, 2024). The intention noted in the MyCiTi Business Plan Update 2024 to 2038 is that conventional bus services initially operating may be replaced where largely parallel MyCiTi routes are introduced, but this is dependent on an agreement for the reallocation of the Public Transport Operating Grant (PTOG) to MyCiTi for replaced services. The Business Plan further notes that parallel MBTs will be compensated for passengers lost to MyCiTi with a reduction in operating licences in line with a sustained shift of passengers between the two modes. Feeding of the MyCiTi services is intended to be largely via MBTs, although transfers at integration points with conventional buses is possible.

Lack of availability of BRT type buses for trunk route services forced Rustenburg to contract with MBT operators to provide additional capacity with what is referred to as a “mop up” services (Chetty et al., 2024). These unscheduled services permeate deeper into communities and function more as direct than trunk services but still form part of the integrated services. The extent to which MBTs feed the 12m BRT buses operating is not published, but with the “mop up” services operating it is likely to be limited if at all.

5. CONCLUSIONS

The delivery of IRPTNs in South Africa has been slow and costly and has, in only a very few cases, resulted in effective public transport. It is argued that the reason for this limited outcome is an over-application of the BRT concept to public transport service delivery, especially to areas where alternatives are more effective and even in relatively high-demand corridors where there is a high diversity of origin destination pairs at the ends of the corridor.

Recognising that some adaptation in planning and organisation structures may be required, it is proposed that the BRT concept be trimmed back to focus on a limited level of service along selected but connected corridors in a manner that maximises the utilisation of assets and relies on other existing services to continue, for the most part, doing as they are now. This approach introduces all-day, universally accessible services across the network with a contribution to congestion management and the core of a truly integrated public transport network, which is one in which all modes play their optimal role in the socio-economic sustainability of the city.

Observations of actual operations by the authors indicate that fleets of 40% or less of that required to satisfy all peak demand can still accommodate around 70% of the weekly demand on the same corridor, offering maximum cost efficiency. This approach allows for much wider coverage at significantly lower unit costs and minimises the negative impacts and may in fact enhance the businesses of existing service providers through making public transport in general more attractive.

6. REFERENCES

Chetty, A, Venter, C, Angurini, M, Muhanguzi, D & Moleele, O. 2024. *Incorporating Contracted Minibus-Taxis into Traditional Integrated Public Transport Networks: The Case of Rustenburg.* Tshwane, s.n.

City of Cape Town: Urban Mobility Directorate, 2024. *MyCiTi Business Plan Update 2024 to 2038,* Cape Town: s.n.

Hugo, M, Bhanye, J & Matamanda, A. 2024. *Urban Planning and Public Transportation: An Historical Overview or South Africa.* Tshwane, s.n.

National Department of Transport. 2007. *Public Transport Strategy,* Tshwane: National Department of Transport.

National Department of Transport. 2021. *Revised Strategic Plan for the Fiscal Years 2020/21 to 2024/25,* Tshwane: s.n.

Schalekamp, H & Klopp, JM. 2018. *Beyond BRT: Innovation in Minibus-Taxi Reform in South African Cities.* Pretoria, s.n.

Vuchic, VR. 2007. *Urban Transit Systems and Technology.* New Jersey: John Wiley & Sons.

Wright, L & Hook, W. 2007. *Bus Rapid Transit Planning Guide,* New York: Institute for Transportation and Development Policy.