# Could dedicated infrastructure boost minibus taxi performance?

Over the last 15 years South Africa has invested heavily in the upgrading of public transport. However, issues such as slow deployment, limited impacts, and financial underperformance of our budding Bus Rapid Transit (BRT) systems have raised questions about whether we should continue on the current path.

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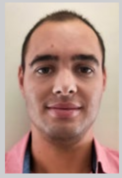

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It is clear that our inability to effectively deal with the dominant informal minibus taxi (MBT) mode of public transport, both as a complement to formal services and in its own right, has severely constrained our achievements to date.

Initiatives aimed at the incremental improvement of MBT vehicle standards, rank infrastructure, service quality, and driver capabilities have undoubtedly helped. We also have a few examples of the use of dedicated road infrastructure for public transport. The bus and MBT lane on the N2 inbound in Cape Town carries almost ten times as many passengers in the morning peak hour as a comparable general-purpose lane. This article argues that there is a case to be made for the much more widespread use of priority road space for MBTs, to leverage the already significant contribution that this mode is making to urban mobility.


**Figure 1** Minibus taxi creating its own informal priority

It has been suggested, for instance, that dedicated public transport lanes should be provided on Class 2 and 3 arterials, as many of these routes have the available road reserve and sufficient public transport volumes to justify such investments. Key questions that arise include: Are there smaller-scale infrastructure interventions that might be captured as low-hanging fruit? How would these affect the rest of the road network? And how might MBT operators respond?

Researchers at the Centre for Transport Development at the University of Pretoria have been using traffic observation, simulation, and mathematical modelling approaches to examine such questions. We started by noting that MBT drivers already use road infrastructure in illegal ways to try to gain a travel time advantage in congested traffic.

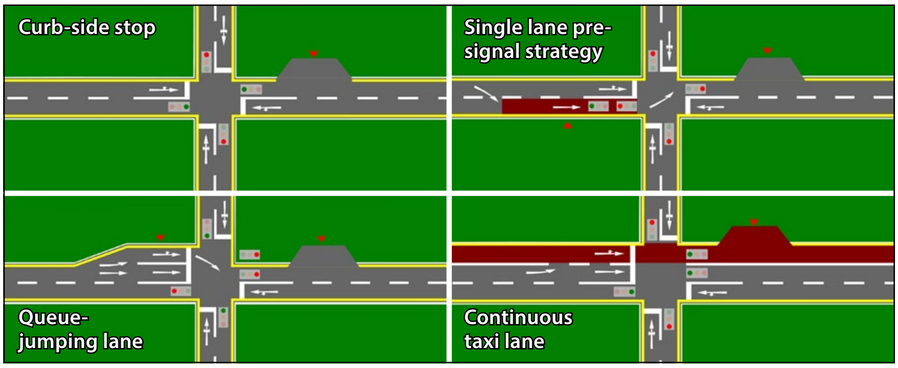


**Figure 2** Four alternatives for MBT priority at intersections

We used drones to observe driver behaviour during peak traffic times and found instances of drivers using turning lanes and shoulders to bypass long queues at intersections. For instance, Figure 1 illustrates a MBT on a through-movement driving in the right-turn lane, which has a shorter queue than the through lanes. After the traffic signal turns green, the taxi is seen cutting back into the adjacent lane, thereby effectively skipping eight vehicles in the queue and saving about 24 seconds of delay.

Such driving is of course problematic from the perspectives of safety and orderly road use, but it illustrates the pressure on drivers to increase operating speeds in order to reduce route cycle times and attract more passengers. Can we use dedicated infrastructure to formalise this behaviour and help achieve the same benefits while reducing the downsides? We conducted three simulation experiments to start exploring this question.

## SIMULATIONS

### 1. Minibus taxi priority: Is there a case for priority infrastructure for informal vehicles only?

In this study, a macroscopic traffic model was developed of a hypothetical intersection with four potential priority treatments: a regular curbside stop (as the base case), a queue-jumping lane for MBTs only, a single lane pre-signal strategy, and a continuous taxi lane (Figure 2).

Queue-jumping lanes are short lanes that allow MBTs to bypass queues at congested intersections; single-lane pre-signal strategies do the same but use the oncoming traffic lane temporarily in the reverse direction for this purpose. We estimated the costs and benefits of each treatment to taxis, other vehicles, and the road agency under a range of conditions including various flow rates under typical urban conditions.

The findings showed that:

- While costs and benefits vary substantially across the different treatments, all of these priority measures offer the possibility of substantial reductions in social (total) costs.
- Both taxi operators and passengers benefit substantially: estimated savings for operators (in fuel reductions and efficiency gains) are between R1 100 and R9 000 per month (Table 1), which translates into an implicit subsidy to the MBT sector that can promote sustainability and affordability in the industry.
- At low to medium volumes of general traffic, there is little impact on car users.
- Queue-jumping lanes are the most preferred solution due to their relatively low implementation cost.

### 2. Hybrid lanes: Can we use BRT lanes better as multi-class public transport lanes?

This study explored the question of whether we should rethink the exclusive use of BRT lanes by BRT buses. The logic is that some BRT trunk routes in South African cities have such low bus volumes that they are completely underutilised. Could excess capacity in bus lanes be used to accommodate informal vehicles in a hybrid system, without substantially degrading the service offered to either bus or minibus passengers?

We developed a detailed micro-simulation model of a 1 200 m-long section of the A Re Yeng BRT corridor along Nana Sita Street in Tshwane, asking what would happen if MBTs were allowed to use the BRT lane (Figure 3).

The results show that, under uncongested conditions, there is little benefit gained from such hybrid operations. However, as congestion sets in during peak hours, a clear case can be made for allowing MBTs to share bus lanes under specific conditions. Even at the modest MBT volumes currently seen in this corridor (up to 94 vehicles per hour per direction), MBTs contribute significantly to congestion in general lanes, and shifting them to bus lanes reduces demand to below capacity, leading to significant savings for private vehicle users.

Taxi passengers benefit from an up to 50% reduction in travel time, with minimal impact on buses. The bus lane, which currently carries between two and nine buses per hour per direction, can accommodate an additional 87 buses per hour or 334 MBTs per hour before service deteriorates to unacceptable levels at stations or intersections. These results persist even when taxi and bus volumes are increased to take account of modest demand growth and latent demand, although the rules of sharing infrastructure become critical.

These results are not necessarily generalisable as they depend on the specific taxi stopping patterns and the geometric conditions (specifically the presence of overtaking lanes) in this corridor. We do not advocate turning existing BRT lanes into hybrid lanes without carefully considering issues of station design, enforcement, and passenger safety. But, the results do illustrate that cases exist where dedicated infrastructure may work better as multi-class public transport lanes, rather than exclusive bus lanes.

We might have to think of a stepwise approach where, for a period of

**Table 1** Example of financial impacts of priority infrastructure on MBT operators

| Infrastructure | Hourly taxi operating cost | Operating cost savings/taxi | Minimum monthly savings/taxi | Maximum monthly savings/taxi |
|---|---|---|---|---|
| Curb-side taxi stop | R133 | – | – | – |
| Queue-jumping lane | R105 | R28 | R1 232 | R4 928 |
| Single lane pre-signal strategy | R108 | R25 | R1 100 | R4 400 |
| Dedicated taxi lane | R82 | R51 | R2 244 | R8 976 |

**Figure 3** VISSIM model (left) of the Nana Sita BRT corridor (right), Tshwane

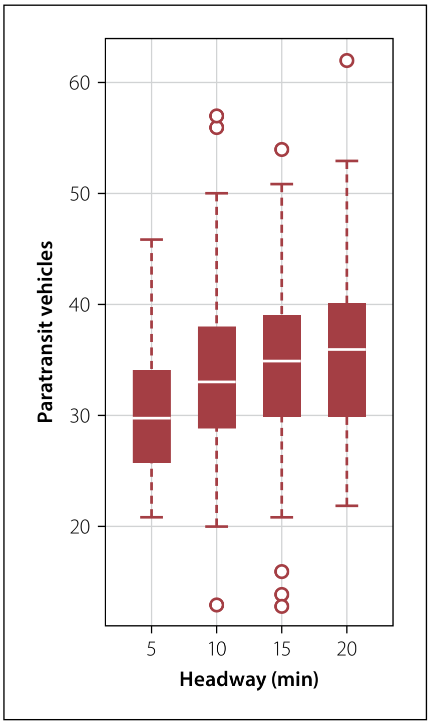


**Figure 4** Box plot showing range of MBT fleet size adjustments as BRT headway rises

time, dedicated infrastructure is shared between all qualifying public transport operators (formal and informal) in order to spread the benefits of dedicated road space more widely. In the longer run, as passenger volumes grow and the network evolves, shared lanes may graduate to full bus lanes.

### 3. Market behaviour: How would informal operators respond to shared infrastructure?

The third study acknowledges that our ability to implement shared infrastructure is hampered by the fact that government actually has little control over the behaviour of MBT operators, making it difficult to predict how they might use shared lanes. Questions arise as to whether MBT drivers want to migrate to shared lanes, and, if so, whether they complement or compete with the formal BRT service.

To start answering such questions, we developed a tool to capture the dynamic behaviour of MBT operators using an agent-based simulation model within the Multi-Agent Transport Simulation (MATSim) framework. For a specified scenario including shared lanes along a hypothetical BRT line, MBT operators can modify their service parameters such as fleet size, routes, and frequencies in pursuit of optimal ridership and profitability. The passenger demand is fixed in terms of total trips, but passengers can choose between BRT and MBT services to minimise their time and cost expenditure. In this way we can predict the evolution of MBT service patterns over time in response to realistic passenger preferences and network conditions.

Initial results showed that MBT operators are indeed sensitive to the decisions made by system planners. Their sensitivity is highest to the service frequency or headway of the BRT: as headways increase (i.e. fewer BRT buses per hour), MBT operators capitalise by adding more vehicles to the route and competing more strongly with the BRT (Figure 4). This might indicate the emergence of scavenging behaviour from the MBT drivers who could use their high flexibility to adjust their schedules to serve the same stops just *before* the arrival of BRT buses.

Efforts like these to better understand interactions between informal and formal parts of the system are needed to avoid unintended consequences and devise appropriate incentives and regulatory tools of a hybrid system.

## WHERE TO FROM HERE?

While these cases start to illustrate the potential for prioritising road space for bus and MBT vehicles in an integrated multimodal network, they also point to many uncertainties and knowledge gaps. Perhaps the most useful way forward will be the implementation of some small-scale pilot projects to start getting real-world results under carefully chosen conditions. These will become the basis of further development of planning approaches, design warrants, and operational strategies. It is key that these efforts involve the MBT industry as knowledge partners that can help steer them in a mutually beneficial direction.

## ACKNOWLEDGMENTS

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A comprehensive paper on this topic, titled *Priority infrastructure for minibus-taxis: an analytical model of potential benefits and impacts*, was also published in the **December 2021** (Vol.63, No.4) issue of the SAICE Journal.

Other references are available on request from the authors. The research is partly sponsored by the Volvo Research and Educational Foundations through the BRT+ Centre of Excellence. ☐