IMPACT OF MINIBUS TAXI SCHEDULING ON ROUTE EFFICIENCY

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ABSTRACT

In 2007 the South African National Department of Transport commissioned the construction of Bus Rapid Transit (BRT) Networks in major metros. However, due to increased cost and dependence on subsidies, there have been questions about the need for and sustainability of BRT networks. This paper presents the scheduling of minibus taxi routes as an alternative solution to providing better public transport service. The investigation focussed on the Hammanskraal-Pretoria_CBD minibus taxi route in Tshwane. Scheduling resulted in shorter passenger waiting times, higher average daily trips per vehicle and reduced fleet size. This means a more reliable and efficient service can be provided without the cost of purchasing new vehicles and infrastructure upgrades related to BRT networks.

1 INTRODUCTION

In 2007 the South African National Department of Transport commissioned the construction of Bus Rapid Transit (BRT) Networks in major metros (Seedat, 2007). Ten years later, three BRT systems have begun operations and are estimated to carry 108 178 passengers daily (Brtdata.org, 2018). However, due to increased costs and high dependence on subsidies, there have been questions about the need for and feasibility of fully sustaining BRT networks (Venter, 2017). This highlights the need to consider other, more affordable, ways to improve public transport. One such alternative is to make existing operations more efficient without requiring high investments into new infrastructure, vehicles and buying out of current operators (Behrens et al, 2016). This paper will investigate the impact of changing minibus taxi routes from unscheduled to scheduled operation on fleet size, average daily trips per vehicle and passenger waiting time.

2 METHODOLOGY

Data was collected as part of route utilization survey for the Hammanskraal-Pretoria_CBD route in Tshwane. Data was collected between 04h00 and 20h00 on Monday, Wednesday, Friday, Saturday and Sunday on the week of the 14th to the 20th of September 2015. The survey point for the forward trip, Hammanskraal-to-Pretoria_CBD, was at the Douglas Rens Road-and-R101 intersection in Hammanskraal. For the reverse trip, Pretoria_CBD-to-

Hammanskraal, surveys were conducted at five minibus taxi facilities situated in Pretoria_CBD. Data was collected through field observations during which the following information was recorded: vehicle registration, number of passengers loaded, departure time and destination.

Total hour demand was calculated for the forward and reverse trips; from which peak hour demand, headway, fleet size and total trips were determined for each of the following time periods:

a. 04h00-09h00: Morning period. Commuters travelling to school or work;
b. 09h00-12h00: Midday period. People generally at work or at school;
c. 12h00-15h00: Afternoon period. Work lunch hour and end of school day;
d. 15h00-18h00: Evening period. Commuters travelling home from work; and
e. 18h00-20h00: Late trips

A maximum load factor of 0.9, 120 minutes cycle time, and 15-passenger vehicle capacity were used for scheduling. A high load factor was used to make scheduling more acceptable to operators who are used to fully loaded vehicles. 15-passenger capacity vehicles constitute the majority of the existing fleet, which reduces the need to purchase new vehicles. Headways and fleet size were determined to best serve the observed demand independent of the existing unscheduled headways or trips. Schedules were designed specific for the observed 2015 minibus taxi demand on the route and did not consider growth in demand or modal change from other transport services.

3 PUBLIC TRANSPORT SCHEDULING

Public transport schedules can be designed based on either even-headways or even-loads (Ceder, 2007). The latter aims to ensure that all vehicles have the same average maximum load, thus increasing trip revenue. However, this requires varied headways corresponding to fluctuations in passenger arrivals which makes the schedule difficult for passengers to understand or operators to implement (Ceder, 2007). The even-headway schedule assumes a constant passenger arrival rate and applies the same average headway for all departures. This results in low occupancy trips during low demand and early departures during high demand (Ceder, 2007). Even-headway scheduling was used for this research, which should be easier to understand for an industry that is new to scheduling.

4 CURRENT OPERATIONS

Operations on the Hammanskraal-Pretoria_CBD route include unscheduled fill-and-go loading at Pretoria_CBD facilities and mostly on-route pickup in Hammanskraal. Two main difference in the demand patterns between the forward and reverse trips (Figure 1) is that morning demand from Hammanskraal is higher and starts earlier (04:00-05:00) than demand from Pretoria_CBD. This is because most commuters have to make a second connecting trip from Pretoria_CBD to their final destination. Secondly, the reverse demand is approximately double the forward trip demand. The route is currently operated by 220 vehicles which make an average of 1.5 to 2.2 daily trips per vehicle (Figure 2).

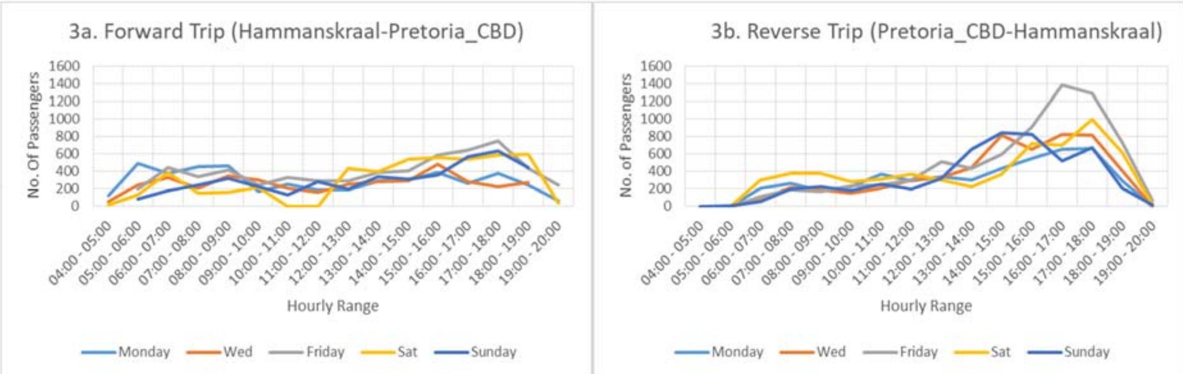

Figure 1: Passengers transported in forward and reverse trips

Minibus taxi facilities in Pretoria_CBD experience varying demands and activity (Figure 2). Only two of the five facilities generate more than 100 trips each day. Lavender Road & Onderspoort Road facility has the latest start of operations (14h00-15h00) but generates more daily trips than Belle Ombre (07h00-08h00) and Paul Kruger & Boom Street (07h00-08h00) facilities. These variations between facilities are mostly due to the facility’s location and the availability of community services in the surrounding area.

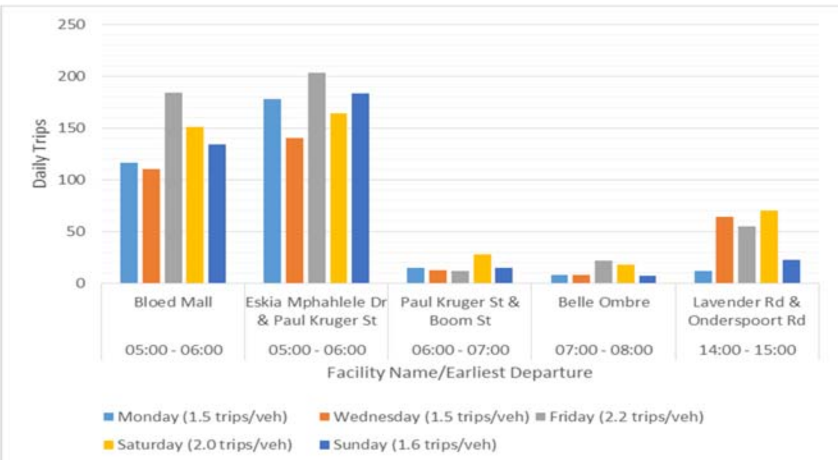

Figure 2: Daily trips and earliest departure times for unscheduled operation

5 PROPOSED SCHEDULED OPERATION

5.1 Passenger waiting time

While scheduling generally reduces the average headway, the level of reduction varies for each facility depending on the day and time period (Figure 3). For the Midday period, scheduling increases average headway at the Eskia Mphahlele but not at the Bloed Mall facility. For the late trips, both facilities get an increase in average headway but on different days. This is due to the variation in demand patterns between facilities (Figure 2).

The advantage of scheduling is that all facilities can operate on uniform headways by serving the aggregated demand. This is mostly beneficial to passengers on on-route pickup points who often have longer waiting periods due to vehicles passing by already fully loaded. The reduction in headway means a reduction in the maximum possible in-vehicle waiting time (assuming first passenger arrives immediately when vehicle starts loading). Scheduling reduces the maximum waiting time to 7.5 minutes (Table 1).

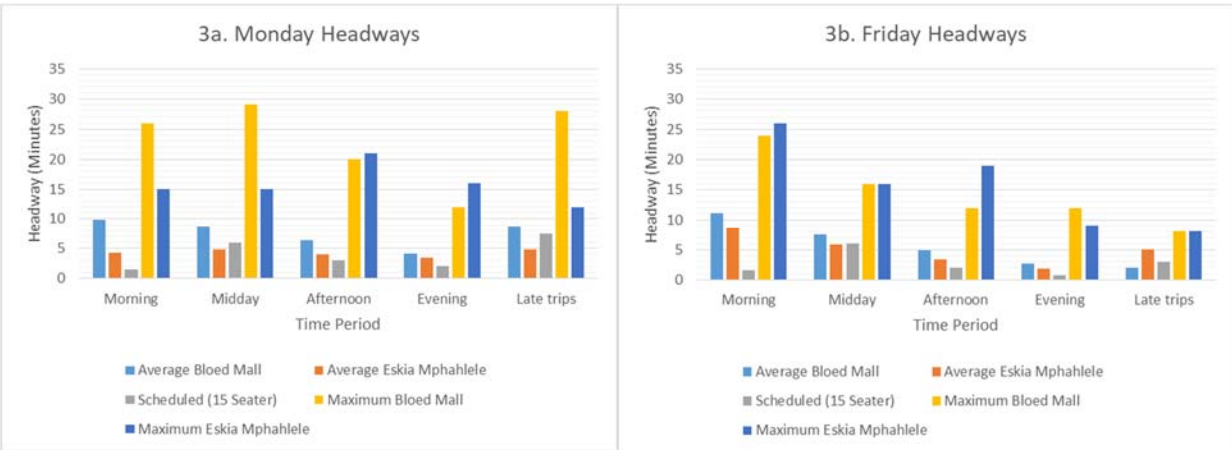

Figure 3: Scheduled and unscheduled headways

5.2 Fleet requirements and utilization

Table 1 shows that the maximum fleet required for scheduled operation is 160 vehicles, which is 60 (27%) less than the current fleet. However, 50% of vehicles (fleet size greater than 80) are only used two days during the week, Friday and Saturday. Scheduling also has a higher average daily trips per vehicle (4.75 – 5.85) than unscheduled operation (1.5 – 2.0, Figure 2). This means than scheduling more than doubles vehicle utilization and while avoiding route oversupply. The reduction in fleet size means no new vehicles are required. This reduction in fleet can be achieved through a change from the current individual ownership structure, in which each operator depends on the performance of his/her vehicles for a profit, into a corporate structure in which all vehicles, costs and profits are shared between operators. This has been successfully negotiated for BRT routes (Aboo & Robertson, 2016; Venter, 2013) and protects exisiting operators from loss of business.

Table 1: Daily operation summary for scheduled operation

Day	Monday	Wednesday	Friday	Saturday	Sunday	Units
Maximum Headway	7.5	6	6	6	7.5	Minutes
Minimum Headway	1.5	1.5	0.75	1	1.5	Minutes
Minimum Fleet Size	16	20	20	20	16	Vehicles
Maximum Fleet Size	80	80	160	120	80	Vehicles
Total Daily Trips	456	524	760	610	468	Trips
Average Daily Trips/Vehicle	5.7	6.55	4.75	5.08	5.85	Trips

6 CONCLUSION AND RECOMMENDATIONS

For the Hammanskraal-Pretoria_CBD route scheduling reduces the required fleet size, increases the average daily trips per vehicle, and reduces expected and maximum passenger waiting times. This means that route efficiency, service reliability and vehicle utilisation can be improved without the cost of purchasing new vehicles.

Before scheduling is implemented, its financial impact for individual and group of operators; and acceptability to commuters, should be determined. Similar research should also be conducted on other routes and areas to give an indication of the conditions for which scheduling is beneficial and when it is not.

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