POSSIBLE IMPACTS OF ICT BASED DEMAND-RESPONSIVE PUBLIC TRANSPORTATION SCHEMES IN THE FREE STATE

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ABSTRACT

Reliability and accessibility of public transportation are major concerns. ICT based demand responsive schemes can be the ultimate solution to these problems. Even though Demand Responsive Transportation solutions have always been conventional for cabs to meet individual traveller's needs, they have not been used for buses and mini-bus taxis in the Free State. Therefore, they can be considered to provide reliable and flexible transportation to meet the public's momentary transportation needs at affordable rates using taxis and buses. Current accessibility problems like long walking distance to bus stops and long waiting times can be solved using demand responsive schemes and cheaper demand based minibus taxi or bus services would reduce the use of expensive cabs. This would reduce public transportation reliability, accessibility, affordability and efficiency problems, but might not have the same impact on operators and public transportation users. The benefits they might have on public transportation users could lead to immediate or long-term consequences for the operators. This paper aims at evaluating the possible impacts of using ICT based technologies and applications for demand responsive public transportation in the Free State province and how they may impact public transportation operators and users in terms of dead mileage, travel times, intensity of demand in different areas and acceptance of these schemes by the public and operators.

KEYWORDS: Demand Responsive Transportation, ICT, public transportation

1. INTRODUCTION

Traditional public transportation methods (i.e. buses and mini-bus taxis) that operate routinely on time schedules and planned routes were thought to be most suitable to meet the demand for transportation at different times. As public transportation problems such as inaccessibility and congestion as well as population increase; these normal public transportation systems become less and less sufficient to provide services efficiently to the people. Considerations have to be made for alternative ways to meet the transportation demands of the public and Demand Responsive Transport (DRT) and ICT solutions should be considered. DRT services operate with no fixed routes and timetables as they have to be flexible to customer demands and ICT solutions makes it possible for virtual transfer of information between passengers, operators, and drivers.

1.1 Study Area

The Free State province consists of 4 district municipalities and one metropolitan municipality; with Bloemfontein as the capital city of the province, as well as major towns like Welkom, Botshabelo, Kroonstad, QwaQwa and smaller towns like Thaba-Nchu and villages/ rural settlements. The majority of the province's area has a population density of less than 100 people per square kilometre. Public transportation is more efficient in areas with denser populations (urban and metropolitan areas) as compared to rural areas. High population density means higher demand for transportation just as low density means that there is very low demand for transportation.

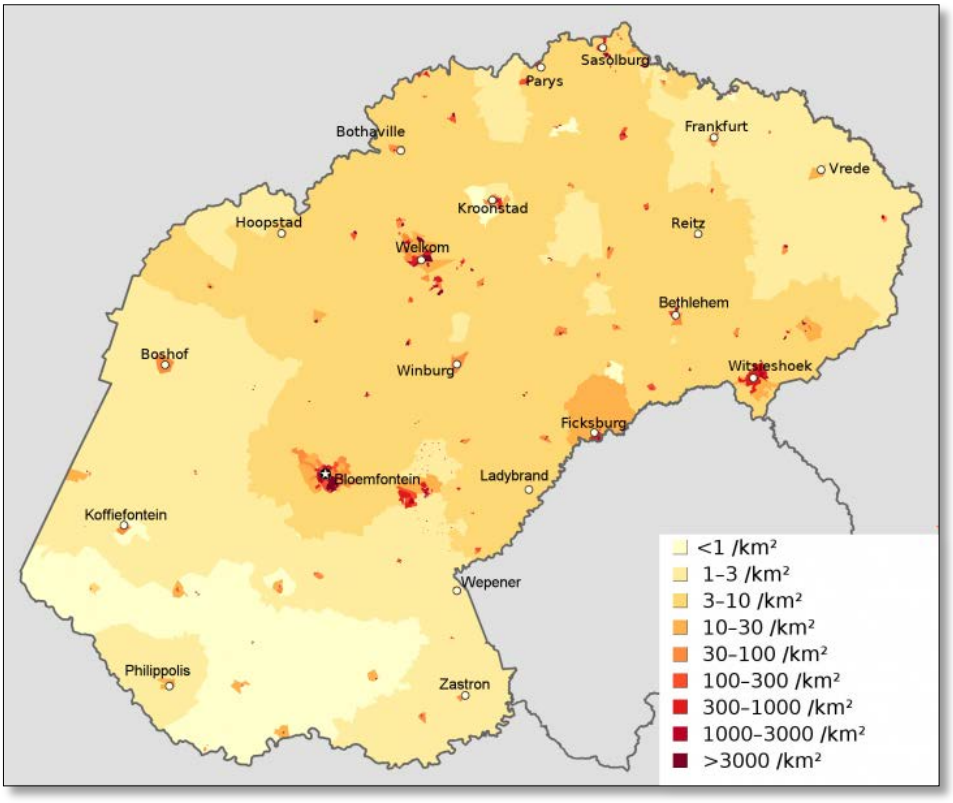

Figure 1: Population density Map of the Free State Province:
Source: Statistics South Africa, 2011

Public transportation service operations in the Free State province, especially taxis are not well organized to flexibly meet the demands of passengers. DRT schemes have been studied over the years in order to cater for different groups of people like disabled people, people commuting at specific times on pre-determined routes and in other cases on special orders in cases of events like sporting activities where it is known that a certain number of people will need transportation at a specific time from origin A to destination B and the transportation is usually booked well in advance. One example is the Big Sky bus service company in the Free State, which offers DRT but it is usually through bookings previously arranged for a large number of passengers for school trips, church travels, functions and sporting activities. These types of DRT services aren't conventional in a sense that they do not cater for the public or potential customers in need of transportation for trips that were not previously planned. Currently, there are no traveller information systems for public transportation users in the Free State to provide passengers with real-time traveller information about public transportation and enable them to request and plan trips

1.2 Demand responsive public transportation

The aim of DRT is to offer more sustainable, reliable and flexible transportation fulfilling the transportation needs and demands of users, thus improving mobility compared to traditional or conventional public transportation. Conventional public transportation services (buses) operate on fixed routes and schedules while mini-bus taxis operate on fixed routes but do not have schedules and therefore do not operate to the customers' convenience.

Demand Responsive public transportation in many countries has always been a common form of transportation for disabled people and elderly people but have in recent years been progressively shifting to accommodate any person in need of transportation. Cabs and taxis have also been widely used all over the world before invention of the earliest communication technologies after the telephone. Invention of cellphones and mobile applications, online mapping and tracking technologies have made it easier for DRT to be easily accessible in terms of response time. The existing demand responsive public transportation services are small scale vehicles, mini-bus taxis and buses would provide large-scale flexible public transportation services. Traditional DRT operators disperse vehicles i.e. buses and taxis to fulfil the customer (passenger's) request made via phone call. Lately with the advancement of technology, ICT platforms have been used to convey the need for transportation by customers to operators.

1.3 ICT based technologies aiding Demand Responsive Transportation

Xu and Huang, 2009, define DRT services as "planning computer systems in charge of the assignment and scheduling of client's traffic requests using different vehicles available for the purposes". Computer systems are the foundation of Information Communication Technologies, therefore, the relationship between DRT and ICT lies within the process of requesting for transportation services by a passenger or client using a phone, computer or application to the scheduling and responding by the operators and drivers using computers, online maps, tracking and mapping technologies as well as information databases.

Vast technologies have been developed over the years that have tremendously improved communication. Information Communication Technologies have also been advancing, therefore, there are basic technologies and more advanced technologies which can be used by transportation users to request transportation. Considering the spectrum of public transportation users: their location, literacy level, age and financial background, some may or may not be willing to use, have access or be able to afford the use of some ICTs.

Technologies such as Unstructured Supplementary Service Data (USSD), SMS and phone calls can be used on conventional or any type of phone are also suitable for use by most drivers and passengers regardless of location, internet connectivity cost and literacy rate. Transportation companies are also developing mobile applications to assist users to request and conveniently pay for services and track the dispatched vehicle online.

2. LITERATURE REVIEW

DRT schemes have the potential to transform the public transportation system because of their ability to operate flexibly to the customer's needs. The concept of shared trips, where a vehicle can transport a number of passengers at once can also be beneficial in reducing congestion during peak hours (Thompson et al, 2011). DRT services are a way to efficiently use the existing public transportation infrastructure and vehicles while reducing public transportation problems (Jin, Itmi and Abdulrab, 2008; Xu and Huang, 2009).

DRT can be viewed from two different perspectives based on population density of an area. In urban areas with more population and demand, this form of transportation can be the answer to urban mobility problems such as congestion, long waiting times for transportation (Thompson et al, 2011). On the other hand, for less populated remote areas where there is limited movement and maybe less accessibility of public transportation vehicles, DRT, in this case, shared can be effective at peak hours when more people need transport services, this will relieve the conventional public transportation from taking scheduled trips only to find that there are no people to transport (Mulley and Nelson, 2009).

Platforms provided by improving technology and ICT solutions have made it possible for transportation services to be more accessible. They provide up to date, convenient, affordable real-time communication between passengers and operators. Companies offering transportation based on demand like Uber have been innovative enough to create mobile applications for their services. USSD technology is short code message or protocol which is typed on a cell phone starting with (*) and ending with a (#), it sends messages from a cell phone to mobile applications running on the same network. The technology enables prompt real-time communication and it is interactive, flexible and cost-effective (Sanganagouda, 2011). SMSes and calls are also other traditional and means of requesting transport services but they cost more than USSD technology.

Some factors that can have an impact and also determine the impact of Demand Responsive Public Transportation are:

2.1 Area/location

The locations (area, urban, rural, metro) and operational conditions of public transportation also have an impact on the success of DRT services. In urban areas where there is larger populations and frequent demand for travel, Demand responsive schemes would be more beneficial and successful. Countries like United Kingdom have DRT services in rural areas, but they operate as replacements for conventional buses (Ryley et al, 2014). This is done in a coordinated way such that pick up times and pick up points are organized in place of normal buses. Rural areas have demand for transportation at certain times of day (peak hour) and very low demand during the day, therefore the success of Demand Responsive public transportation is uncertain (Davison et al, 2014).Connectivity in rural areas in terms of network coverage and access to virtual platforms such as mobile applications can also be a constraint to the accessibility of DRT.

2.2 Accessibility

Due to the flexible nature of service provision offered by DRT services, public transportation will be easily accessible to users. The use of internet-based ICTs will also improve the accessibility of transportation based on real-time information, through computer and mobile phone applications. The use of USSD technology which could be more suitable for people with lower levels of literacy and rural areas can be potentially the ideal ICT tool for improved accessibility of public transportation for the disadvantaged communities (Maritz and Maponya, 2010).

2.3 Finances

DRT are often financially straining (Ryley et al, 2014) both to operators and passengers. Trip fees for the services have often been higher than those of fixed routes, but one effective way of reducing costs of trips by DRT services can be by means of ride sharing, splitting the trip cost by the number of passengers in a vehicle.

2.4 Vehicles

Commonly, in the Free State, vehicles used to flexibly serve customers are smaller taxis. Ideal vehicles used for DRT services in rural areas in the United Kingdom are 16-seater mini-buses in order to cater for possible low demands (Ryley et al., 2014). Buses are in a more favourable position to provide demand-responsive services if the main concern was to be profits; this is because buses are subsidized by the government. Through this, buses drive around even if they are empty and still get money from the government. For mini-bus taxis, however, the operators will lose a lot of money if they were to be flexible and instantly attend to every customers demands.

3. METHODOLOGY

Both quantitative and qualitative data gathering via questionnaires and interviews was used. Respondents to the questionnaire and interview questions included public transportation users, operators, drivers, academics and ICT experts. Questionnaires were used to assess the current accessibility of public transportation. The interviews examined whether DRT services will be necessary to improve accessibility of public transportation and source differing opinions on whether ICT based DRT services would help improve the system.

3.1 Research questions

1. How would ICT based DRT schemes affect the public transportation system in the Free State province?
2. Can the current accessibility and reliability problems of public transportation in the Free State province be solved by DRT schemes?

3.2 Study sample and Respondents

A sample of 186 respondents participated in the questionnaire survey while 15 respondents participated in the interview survey. All the respondents were stakeholders in the public transportation system and ICT sector.

3.3 Purpose of study

The study aims at assessing the possible impacts of Demand Responsive public transportation on the passengers, operators and all stakeholders including the public transportation system environment in general.

4. RESULTS AND DISCUSSION

4.1 Accessibility of public transportation

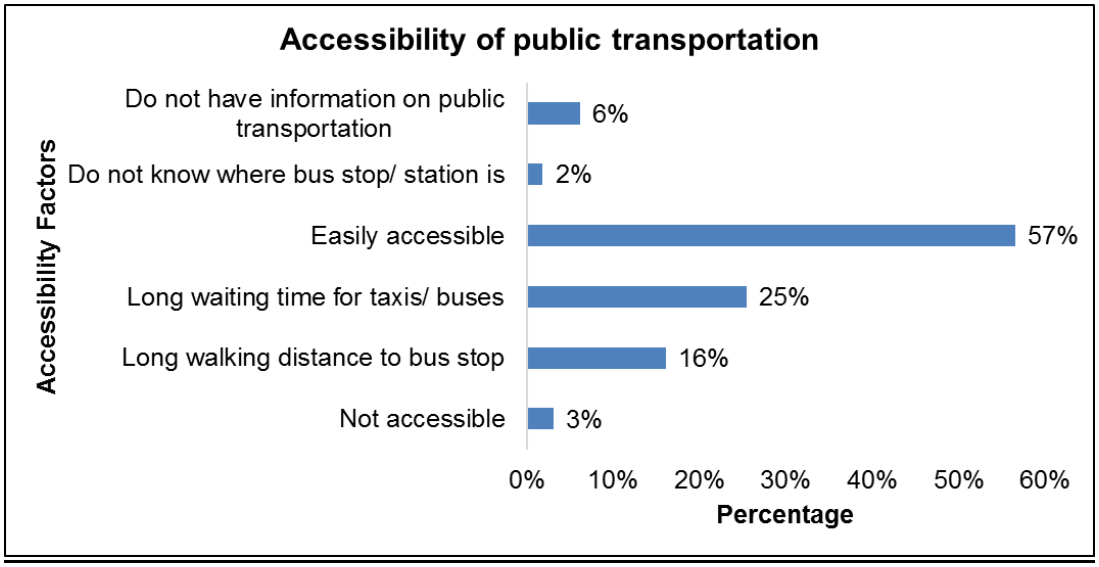

Figure 2: Factors determining accessibility of public transportation

Figure 2, shows accessibility factors to which the respondents responded. 57% of the respondents easily access public transportation; 25% wait for a long time to taxi and bus stops and ranks; 16% walk long distances to the bus stops and stations; 6% do not have information on public transportation, 3% responded that public transportation is not accessible and 2% does not know where bus stops or stations are located.

DRT have a potentially great ability of solving accessibility problems such as not knowing the location of bus stops and stations and long walking distances to these stops and stations. Demand Responsive public transportation vehicles would pick up and drop users exactly where they need to be dropped or picked. This also applies to users who wait very long times for buses and taxis without knowing when they are coming. With Demand Responsive public transportation, the person waiting will know when they will be picked up, this gives passengers a sense of assurance and trust in the public transportation system. The use of Automatic Vehicle Location technologies, as well as mobile applications, make it possible to track, locate and share the location of a vehicle amongst the drivers, the customers, and the companies. Lack of information on public transportation contributes to inaccessibility problems and DRT and ICT solutions could be used as viable tools to deliver the information.

In areas where the current public transportation vehicles are easily accessible, Demand Responsive public transportation can be considered to simultaneously operate with the existing public transportation to solve other transportation problems such as congestion and waiting times.

4.2 How ICT Based Demand-Responsive Bus and Taxi Schemes Would Help the Operators and the Public

The question attempted to determine whether ICT based demand-responsive schemes for buses and taxis would help the passengers and operators of the public transportation system. Respondents had differing views on the ways demand-based scheme would affect the main stakeholders, being the passengers and the transportation service providers. Respondent 1 indicated that demand-responsive schemes would be viable for smaller vehicles like taxis. Respondent 2 and 11 indicated that these schemes would eliminate the low occupancy of vehicles and dead mileage, leading to better customer service. Respondents 1, 5 and 13 indicated that these schemes will not be profitable for operators, but would maybe work in areas of high demand. Respondent 9 indicated that there would be satisfies passengers and a more reliable public transportation system. Respondent 10 indicated that it would give an indication of the current state and allow for prediction. Respondents 12 and 14 indicated that it would allow operators to allocate enough vehicles for certain times and allow the public to plan their daily trips. Respondent 13 indicated demand based schemes are far-fetched for the province and can help in exclusive cases like events and accidents. Respondent 15 indicated that these schemes would lead to less waiting time by passengers and a more effective public transportation system.

ICT based demand responsive schemes for taxis and buses as a solution to dead mileage and long waiting times are a viable solution to consider, but they may not be

suitable for the Free State. With the current subsidized buses, to eliminate the dead mileage accumulated by buses travelling on scheduled times even though they are not carrying any passengers or when they only have a few people onboard Demand Responsive schemes might be able to address this situation. Mini-bus taxis only leave their respective ranks when full or with a certain minimum number of passengers (long distance mini-bus taxis), and are not greatly affected by dead mileage, but dispersing taxis to meet every passenger's demand may be a financial burden to the operators.

Demand responsive schemes may either increase or decrease dead mileage. If a vehicle is dispersed due to a few people who showed demand, it will still record less occupancy, meanwhile, when vehicles are dispersed only due to passengers' indication of demand, it will prevent vehicles driving around and going back to the station without any passengers. These schemes may help operators in managing their fleet, dispensing vehicles and allocating them to routes according to demand indicated by the public.

These schemes seem more likely to benefit passengers than operators. There may be financial implications for operators especially small scale mini-bus taxi operators with a few taxis. Large transportation enterprises with a larger number of vehicles to cover densely populated areas with higher demand may be less financially implicated, their operations are likely to be more profitable compared to those with less fleet. Passengers will have the advantage of having vehicles made available to them whenever they want to take a trip. The flexibility of DRT schemes will be beneficial to public transportation users in terms of reliability and accessibility of the services offered.

Even though some respondents thought of DRT schemes as a far-fetched concept for the province, the success of the schemes in both rural and urban areas in other countries indicate that they may be a solution to many transportation problems in the Free State.

5. CONCLUSION

Even though demand responsive public transportation services have proven to be efficient where they are already being used, it is difficult to predict the expected success in the Free State. Impacts of DRT on the stakeholders are likely to be similar or in a way relate to those encountered in other parts of the world, considering the varying operation circumstances, type of vehicles used, the financing and subsidising of DRT in other places.

Demand Responsive public transportation should be able to provide travel options to users other than the fixed routes and scheduled traditional buses and mini-bus taxis and traditional cabs and taxis to be able to create a balance between mobility and cost without negatively impacting the existing forms of public transportation. The use of such Demand Responsive public transportation services would also potentially assist in the shift from using private vehicles to increased use of public transportation.

ICT based DRT public transportation services will be able to offer integrated, inclusive and flexible transportation to public transportation users. The technologies used In DRT in the Free State should also fit the environment, considering the digital divide, accessibility, and usability of such technologies. Basic technologies such as phone calls, SMS, and USSD are affordable, usable by the majority of the people and accessible to many while more advanced technologies like computer and mobile phone applications may only be affordable and usable to certain demographics of the Free State province population.

The question now will be whether the conventional public transportation system should be replaced with Demand Responsive public transportation system. The viable options would be to totally replace the current public transportation system with a Demand Responsive public transportation system or aiming for co-existence of the current system with an integrated Demand Responsive system. This can be determined by the population density of the area, the rate of transportation demand and the design of the DRT schemes. It is possible for some areas to have either only DRT or the conventional public transportation and co-existence of both in some areas of the province.

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