Public Transport Service Reliability in Dar es Salaam City, Tanzania: A Case of Bus Rapid Transit (BRT)

***Msumanje, G.P[1] and A. Runyoro[2]**

[1]Department of Logistics and Transport Studies, National Institute of Transport
[2]Department of Computing and Communications Technology, National Institute of Transport

Correspondence: *gmsumanje2016@gmail.com*

Abstract

The main problems of BRT service users are delays and overcrowding at stations and in buses during peak hours. This situation causes low region productivity, accidents, insecurity, poor students' academic performance and increased health risks. The objective of the study was to analyze the satisfaction of passengers with BRT service reliability. Case study design with mixed approach for data collection and analysis was adopted. A total of 138 respondents represented the relevant study population. The study revealed that more than 70% of the respondents showed dissatisfaction on schedule adherence caused by inadequate bus supply, ineffective ticketing systems, ineffective bus scheduling, bus breakdowns and accident, poor passenger information, weather conditions, drivers' behavior and traffic interactions. It is recommended that the service provider (BRT) should supply sufficient buses, build staff capacity and implement Intelligent Transport Systems (ITS) for management of its services.

Keywords: Public Transport Services, Service Reliability, Bus Rapid Transit, Passenger Satisfaction.

Introduction

Public transport provides a shared passenger-transport service available for use by the general public. It encompasses transport service for reward carried on regular basis using vehicles that carry more than one person over a predetermined route(s) from one fixed point to another (Iles, 2005).

Iles (2005) reported that causes of public transport challenges in developing countries are rapid urban population growth, inadequate road infrastructure, free use of private transport, severe traffic congestion, insufficient and inefficient public transport systems. It is discussed in the Transport Research Board (2013) that in the United States of America, the motorists and motor carriers along metropolitan highways and travelers on intercity planes, trains and buses experience delays more routinely due to crashes and weather disruption. In major metropolitan areas, motorists take about 60 minutes to reach their destination for trips that would take only 20 minutes in lighter traffic (Transport Research Board, 2013).

According to Vasconcellos (2017), Brazilian cities experience public transport problems caused by low-quality infrastructure for non-motorized transport, unreliable public transport services, environmental pollution, congestion, safety and inequality in mobility and transportation access. Solanke (2013) reported that in Nigeria urban transport challenges such as traffic congestion, parking problems, accidents and environmental pollution are the main cause for unsatisfied public transport users.

In Tanzania, public transport challenges can be traced back to the period before independence in the 1960s, where several solutions were based on intervetions adopted by the Government. For example, in 1949 a British owned company named Dar es Salaam Motor Transport Company (DMT) started to provide public transport services in Tanzania Mainland (Kanyama *et al.,* 2004). Later after Independence in 1974

DMT Company was nationalized and formed "*Kampuni ya Mabasi ya Taifa (KAMATA)*" and "*Usafiri Dar es Salaam (UDA)*". While UDA was charged with the responsibilities to manage, set fares and provide urban public transport services in Dar es Salaam, "KAMATA" had the responsibility to serve inter-regional public transport services. UDA met only 60% of the demand leading to long queues at bus stops, thus causing inconvenience to the passengers (DART Agency, 2017). In 1983, Government of Tanzania (GoT) allowed the private sector to provide public transport services commercially and in 1985, light trucks locally called "*Chai Maharage*" were used to supplement (Kahama, 1995). As a result of further drop of UDA market share to 2% in 2000 the private sector became dominant leading to rapid increase of Para-transit (*Daladala*) buses (SUMATRA, 2011). The *Daladala* System had challenges because they were operated without control and that they had no transport schedules at all (African Development Bank Group, 2015). By 2010 the Government of Tanzania introduced the transport licensing Act for motorcycles Regulation of 2010 to allow tricycles and motorcycles (*bajaji and bodaboda*) to operate passenger services commercially.

Furthermore, the Government of Tanzania took another significant measure to improve the public transport services in Dar es Salaam by introducing Bus Rapid Transit (BRT) system. BRT combines the efficiency and reliability of a rail service with the operating flexibility and lower cost of a conventional bus service. BRT services are increasingly utilized in Africa and India (Deng & Nelson, 2011 in Wenquan & Xiaojian *et al.,* 2014). Latin America, North America, Europe, Southeast Asia, Australia, and China have also implemented BRT systems. In Tanzania BRT service started operations in May 2016 with high expectations of mitigating public transport problems in Dar es Salaam city. It is unfortunate, however that, so far the performance of BRT has not yet satisfied the government and users expectations.

Dar es Salaam inhabitants perform approximately seven to eight million trips per day (Msigwa, 2013). It is estimated that about 5 million of the trips made per day are commuter trips (Bwire *et al.,* 2017). A majority of the commuter trips are made by using public transport like paratransit, commuter train, BRT, tri-cycles and motorcycles. According to Msigwa (2013), 61% of the commuters within the city rely on public transport. This dependence creates high demand for public transport, especially during the morning and evening peak periods.

Despite the various interventions of the Government of Tanzania to improve the public transport services in Dar es Salaam city, it still seems to be unreliable, insufficient, unsafe, uncomfortable and uncoordinated. The BRT transport service users are mainly suffering from long waiting time and overcrowding at bus stations and terminals. The delays have resulted into low region productivity, insecurity, poor students' academic performance and increased health risks due to overcrowding of passengers in buses and stations.This paper analyzes the public transport service reliability and passengers satisfaction in Dar es Salaam city.

Materials and methods

A survey was conducted between July and December 2018 from service providers, regulators as well as individual regular commuters who travelled to and from the city center using BRT services. The sample size was calculated using Kothari (2004) formula for sample estimation as follows:

$$n = \frac{Z^2 \times p \times q \times N}{e^2(N-1) + Z^2 \times p \times q} \quad \text{......................(1)}$$

Whereby N=number of BRT users per day (200,000/day) (UDART, 2018), Z=standard variant (Zscore) (1.96), p=population proportion (0.9), q=1-p, e=acceptable error (5%) and n is sample size.

A sample of 138 respondents was obtained to represent the relevant study population. Structured questionnaires, interview guide questions, observations and documentary review were tools used for data collection in this study. The analysis of descriptive statistics was performed and R^2 was determined to explain the strength of the relationships of the attributes. The objective of the survey was to analyze commuters' satisfaction towards the public transport mainly focusing on BRT service reliability performance. Service reliability describes the ability to perform the promised service dependably and accurately. It depicts consistent performance, free of non-compliance, in which the user can trust. It means that the supplier must comply with the promised service, without the need for rework (Parasuraman *et al.,* 1991).

Public transport service reliability presents a service that performs the service dependably and accurately regarding service punctuality, compliance to the timetable (including arrival at the destination, journey length, and communications) and routes (McKnight *et al.,* 1986). Arhin *et al.* (2014) point out that urban public transport operators' use schedule adherence, headway regularity and vehicle run-time to measure the reliability of their service.

This study measured public transport service reliability based on five variables, namely schedule adherence, headway regularity, vehicle run-time, waiting time and passenger travel time.

Schedule adherence: Schedule adherence was measured by considering on-time performance or punctuality of bus departure/arrival times based on passenger experience and observation. This mainly aimed to see if the service provider follows and maintains the scheduled departure times. In the execution of this activity, the departure time was categorized into three; (1) early departure, (2) on-time departure and (3) late departure times. A bus is considered to depart on-time if it departs at origin between one minute before and five minutes after the scheduled departure time. If a bus departs less than one minute before the scheduled departure time it is considered as early departure and when it departs later five minutes after the scheduled departure time is considered late departure. Commuters were asked by using questionnaire to rank their level of satisfaction regarding the service provider's adherence to the schedule. In addition, the observation check list was used to record events as they took place and the data obtained were useful to provide inputs for analysis of schedule adherence (timetable compliance) for the study.

Headway regularity: Headway regularity defines the time interval (frequency) between two successive vehicles departing or passing through the same point traveling in the same direction on a given route. The study used headway of 5 minutes as applied to BRT services to obtain the required data. The study used questionnaire and observation methods to collect data from the respondents regarding maintenance of the headway throughout the vehicle trip. The data obtained was used to determine the variability of headway of bus services and its effect on service reliability.

Vehicle run-time: Run-time describes the time taken for a vehicle to travel from one terminal to the other (Iles, 2005). It is the time taken by a vehicle to make one trip along the whole length of the route (Firew, 2016). This study used structured questionnaire and observation check list to obtain the required data regarding the average actual time the vehicle takes to complete the trip from terminal to terminal. The vehicle runtime data was obtained by looking at vehicle departure time at original terminus and the time of arrival at destination (ending) terminus to determine the average vehicle run time in the particular route.

Passenger waiting time: Passenger waiting time describes the time it takes for a passenger to get the service from the time he/she arrives at a bus station. It is part of service reliability and one of the tools to measure the effect of unreliable service to passengers (Firew, 2016). During this study passengers were contacted through structured questionnaire to rank their level of satisfaction regarding the time they spend to get the bus service at the station. The study also used observation method to get experience and extract the actual information as bus activities went on.

Travel time: Passenger travel time is the complete journey that includes waiting time at the origin, access time, waiting at departure stop, in-vehicle time and egress time (time taken from final stop to destination) (Oort, 2011). This variable was measured by the amount of time a passenger spends to complete his/her trip using BRT bus services from ticket- purchasing point, waiting bay, and in-vehicle time to alighting time at the ending terminus. The questionnaires were distributed to passengers so that they could rank their level of satisfaction concerning time spent from the time of ticket purchase to the disembarking terminus. The observation method was also used to witness and record the events as they took place at BRT stations and terminals.

Critical analysis for measuring public transport service reliability based on the five variables was presented in a modified visual modal as detailed in figure 1.

peak periods (5:30-10:00 and 15:30-20:00); and for trunk route of KIMARA-KIVUKONI there are 30 buses which operate express services.

Customer satisfaction is a fundamental base for measuring service performance. Lushakuzi (2015) described customer satisfaction as a basic concept for activity monitoring and control in relationship marketing.

This section presents data analysis and interpretation whereby Tables 1, 2, 3, 4 and 5 present the frequency distribution of the opinion of respondents regarding the BRT public transport service reliability. Table 6 describes the relationships between public transport service reliability and passenger satisfaction.

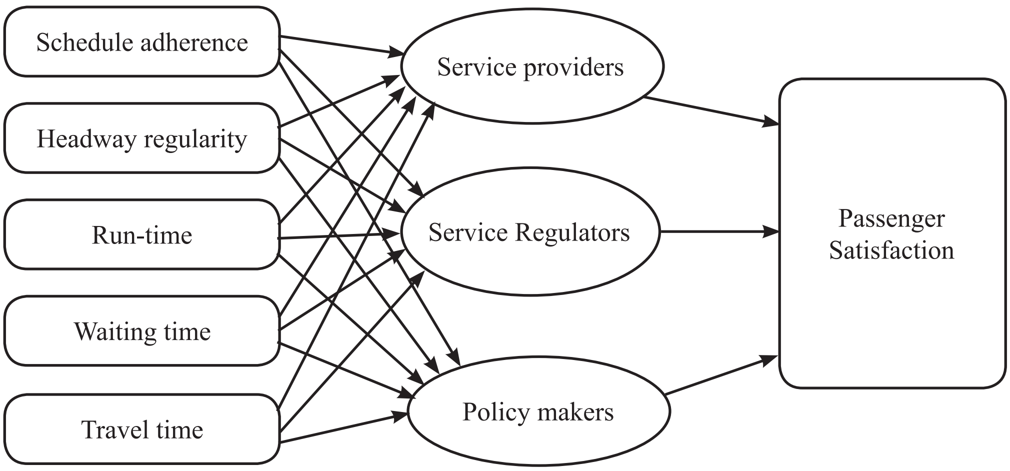

Figure 1: Visual model showing the relationship between public transport service reliability and passengers' satisfaction

Source: Firew (2016)

Results and interpretations

BRT system is managed and maintained by DART while UDART Company provides operational services. The system has nine (9) bus routes in which seven (7) are trunk routes and two (2) are feeder routes. During peak period a total of 127 buses are scheduled for operation; whereby 100 buses operates in trunk route and 27 in feeder routes. There are thirteen (13) buses which remain parked at the depot as a reserve to supplement in case of mechanical breakdown, repair, accidents or any other disruption of buses en-route. BRT service operates daily from 4:30 to 00:00hours at scheduled headway of 5 minutes on workday

Frequency distribution of respondents on satisfaction with the bus departure/arrival times at BRT station/terminal

The results in Table 1 reveal that 56 (40.6%) respondents strongly disagreed and 54(39.1%) disagreed that BRT buses depart or arrive at station on time. These results indicate that majority of the BRT bus service users are not satisfied with service reliability of BRT buses. The table further indicates that 12(8.7%) respondents agreed and 11(8%) strongly agreed that BRT buses arrive or departs at station on time. The results imply that 23 (16.7%) respondents were satisfied with the service reliability concerning bus arrival or departure times at the station. Only 5 (3.6%) of the respondents showed a neutral attitude that BRT buses arrive or depart at the station on time. This result implies that public transport service reliability was neither satisfactory nor unsatisfactory as they could not indicate in favor or against.

Table 1: Frequency distribution of respondents on satisfaction with the bus departure times at BRT stations

Responses	Frequency	Percent
Strongly Agree	11	8
Agree	12	8.7
Neutral	5	3.6
Disagree	54	39.1
Strongly disagree	56	40.6
Total	**138**	**100**

Source: Survey data (2018)

Frequency distribution of respondents on headway regularity

Table 2 indicates that 59(42.8%) disagreed and 57(41.3%) strongly disagreed that the successive interval between BRT buses was well maintained such that there were no bunching experience stations. These results portray that most of the passengers are not satisfied with service reliability regarding maintenance of successive interval between buses. The table further shows that 11(8%) respondents agreed and 8(5.8%) strongly agreed that the successive interval between BRT buses was well maintained without bunching experience at stations. This result showed that few passengers were satisfied with the service reliability in regard to headway variations. Also, 3(2.2%) respondents showed a neutral attitude that the successive interval between BRT buses was well maintained without bunching experience at the bus station. These results imply that the public transport service reliability was neither satisfactory nor unsatisfactory as was unable to rank in favor or against.

Table 2: Frequency distribution of respondents on headway regularity

Responses	Frequency	Percent
Strongly Agree	8	5.8
Agree	11	8.0
Neutral	3	2.2
Disagree	59	42.8
Strongly disagree	57	41.3
Total	**138**	**100**

Source: Survey data (2018)

Frequency distribution of respondents on bus run-time in the entire route

Table 3 points out that out of 138 respondents 64(46.4%) agreed and 38(27.5%) strongly agreed that the bus journey time from the original terminus to the ending terminus is well maintained. This result showed that on average, after boarding a bus, the passenger is sure to arrive at the ending terminus within the expected time. The results imply that large percentages of passengers were satisfied with the service reliability regarding bus journey time. On the other hand, the table further shows that 18(13%) respondents disagreed and 11(8%) strongly disagreed that the bus journey time from the original terminus to the ending terminus was well maintained within the expected time. This means that some passengers were not satisfied with bus services reliability about the maintenance of the journey time between the origin and ending terminus. Furthermore, 7(5.1%) respondents showed a neutral attitude that the bus journey time from the original terminus to the ending terminus was well maintained.

Table 3: Frequency distribution of respondents on bus run-time in the entire route

Responses	Frequency	Percent
Strongly Agree	38	27.5
Agree	64	46.4
Neutral	7	5.1
Disagree	18	13.0
Strongly disagree	11	8.0
Total	**138**	**100**

Source: Survey data (2018)

Frequency distribution of respondents on Passenger wait time at BRT stations

Passengers were also asked to rate the time they spend at BRT stations waiting for actual bus service. Table 4 indicates that the majority of respondents, about 67(48.6%) disagree and 49(35.5%) strongly disagree that passengers spend considerable (5-10minutes) time waiting for actual bus service at the station. These results indicate passenger dissatisfaction with service reliability regarding the time they spend at the station waiting for the bus. The table further shows that 13(9.4%) agreed and 8(5.8%) strongly agreed that passengers spend considerable time waiting for actual bus service at station and or terminal. These results show that some passengers are satisfied with the service reliability concerning the time they spend waiting for actual bus service. On the other hand, 1(0.7%) respondent showed a neutral attitude that passengers spend considerable time waiting for actual bus service at a station/terminal. These results further indicate that public service reliability is neither satisfactory nor unsatisfactory to other users.

Table 4: Frequency distribution of respondents on Passenger wait time at BRT stations

Responses	Frequency	Percent
Strongly Agree	8	5.8
Agree	13	9.4
Neutral	1	0.7
Disagree	67	48.6
Strongly disagree	49	35.5
Total	**138**	**100.0**

Source: Survey data (2018)

Frequency distribution of respondents on Passenger travel time

Table 5 shows that 57(41.3%) strongly disagreed and 56(40.6%) disagreed that time taken by passengers to commute between point of departure and destination (including time spent for ticketing purchase, waiting bay and in-vehicle time) using BRT buses is considerable. The results imply that majority of the passengers are not satisfied with the service reliability concerning the travel time to commute to and from the Central Business District (CBD) using public transport. On the other hand, 14 (10.1%) agreed and 7(5.1%) strongly agreed that time taken by a passenger to commute between point of departure and destination (from ticket purchasing, waiting bay and in-vehicle time) using BRT buses is considerable. It means that few passengers are satisfied with the service reliability concerning travel time. It is further shown that 4(2.9%) respondents showed a neutral attitude that; passengers spend considerable time waiting for actual bus service at a station/terminal.

Table 5: Frequency distribution of respondents on Passenger travel time

Responses	Frequency	Percent
Strongly Agree	7	5.1
Agree	14	10.1
Neutral	4	2.9
Disagree	56	40.6
Strongly disagree	57	41.3
Total	**138**	**100.0**

Source: Survey data (2018)

Pearson correlation coefficient between public transport service reliability attributes and passenger satisfaction

The formula

$$R_{xyz} = \sqrt{\frac{r_{xy}^2 + r_{xz}^2 - 2r_{xy}r_{xz}r_{yz}}{1 - r_{yz}^2}}$$

was also a useful guide for calculating multiple correlation coefficients as applied by Tailor (2017) of Indira Gandi National University. Table 6 describes the relationship between public transport service reliability attributes and passenger satisfaction. The response in the first item in the table indicates a higher degree of correlation than other items which imply that passengers will be satisfied when the schedule is well adhered to. The second, fourth and fifth items indicate a moderate degree of correlation between public transport service reliability attributes and passenger satisfaction. This implies that passengers will be satisfied when the service is reliable. The third item indicates a weak negative relationship. The coefficient of determination (R^2) of these attributes ranges from 26.01% to 37.82%, implying that, the variability of passenger satisfaction values will be explained by those attributes. The Pearson coefficient of correlation indicates a statistically significant linear relationship between public transport service reliability attributes and passenger satisfaction.

Discussion of the findings

This study found that the service provider has not been able to follow the time table. It was also observed that in the morning and evening peak hours, the average schedule adherence showed a decline compared to over the off-peak periods. However, this has been very common since during these periods there is a higher passenger activity which increases bus dwell time and causes delays.

Table 6: Pearson correlation coefficient between public transport service reliability attributes and passenger satisfaction

Attributes	Correlation Coefficient	Coefficient of Determination (R^2)
Schedule adherence	0.615	37.82%
Headway regularity	0.556	30.91%
Bus run-time	-0.113	1.28%
Passenger wait time	0.510	26.01%
Passenger travel time	0.600	36.00%

Correlation is significant at the 0.01 level (2-tailed)

Plate 1: Passengers at Kimara terminal forcing to board the bus through windows
Source: Kamala, Daily news (Thursday, October 11, 2018).

Headway regularity

The findings of this study show that the public transport service provider for the BRT system has failed to maintain headways as scheduled. According to DART Agency and UDART LTD the scheduled headway for trunk route (*KIMARA-KIVUKONI*) during peak period is 5minutes. The study observed several bunching of buses at stations for morning and evening periods as more than seven buses were seen moving in one direction. This means that for the 5 minutes' headway if a passenger misses either of the bunched buses, he/she has to stay at the station for more than 35 minutes waiting for the next bus. The headway deviation has an adverse effect on passengers because it causes overcrowding and scramble for service, which makes them feel unsafe/unsecured, uncomfortable and disregarded. Plate 1 shows the effect of bunching and the way passengers struggle to get the bus service.

The most affected people by this situation are special groups (elders, children, pregnant women, sick people and disabled) who are generally unable to scramble to embark onto the bus hence stay longer at the stations.

Vehicle run-time

Vehicle trip time constitutes drive, dwell and stop time. Variability in any of these elements leads to poor service reliability (Firew, 2016). The study observed that, regardless of the available challenges, there is a more considerable time-saving when using BRT buses than "*daladala*" or private cars. The findings of this study affirm that on average the bus run-time (from origin terminus to the ending terminus) along the BRT system was excellent and passengers argued that they prefer BRT services because once they manage to board a bus it takes them less time than the time taken by the other modes. Bwire *et al.,* (2017) explained that, during peak hours, morning and evening, many passengers prioritize the use of BRT as it has exclusive lanes hence more time-saving. In this case Bwire *et al.,* (2017) suggests more buses should be allocated and the drivers be closely monitored in order to maintain the bus run-time.

Passenger waiting time

According to the study, the waiting time is measured by considering the time the passenger spends to get service at BRT ticketing point and waiting bay. Basing on the 5minutes scheduled headway of peak period the average waiting time of a passenger is expected to be not more than 10 minutes. However it was observed that during morning and evening peaks, passengers spend more than 30minutes at the BRT stations

Plate 2: A crowd of passengers at BRT Kimara terminal waiting for a bus
Source: Field (October Friday 12, 2018 08:26 AM)

waiting for bus service which also when it arrives it is overloaded and crowded posing safety and health risks to the users. Plates 2 show the crowd of passengers standing haphazardly at kimara terminal waiting for the bus service during the morning peak period.

Passenger travel time

The travel time of passengers was measured by assessing the time respondent spent to commute to the destination from the point he/ she accesses the BRT station to the point he/ she leaves the BRT station/terminal of the entire journey.

The study observed acute queuing at ticketing point and at ticket scanning machines and that the ticket scanning machines were not properly working hence replaced by people who receive the ticket from the passengers and tear them to indicate that it has been used. These practices create loopholes for revenue losses, increase operation cost and lower profitability of the company.

Conclusion and recommendations

The sustainability of the BRT transport services will highly depend on its reliability performance which satisfies its users. When BRT services are reliably delivered, the users will be satisfied with their services, as a result they will be ready to leave their private cars and other alternative means of transport and opt to use BRT as their best mobility option for their daily trips. This is due to the fact that BRT service is perceived to be cost effective, environmental friendly, reduce city congestion, and time saving as well as civilized means of travel. So, when this perception fails to be witnessed by users the consequence is that the customers would shift to other means of transport such as private car, para-transit (*daladala*), tricycles/motorcycles (*bajaji/ bodaboda*) etc. This will also lead to a negative outcome to the company by experiencing increased operational costs, revenue losses and reduced profit. The most affected group with unreliability of public transport services however remains to be elderly people, children, pregnant women and sick people.

The study recommends the service provider to supply sufficient buses, build staff capacity, emphasize on safety management, improve ticketing system and implement Intelligent Transport Systems (ITS) which involve Automated Passenger Counter (APC), Automated Vehicle Location (AVL) and Passenger Information Displays (PID) applications for effective management of BRT services. The study also suggests further research to be conducted to the BRT performance analysis and its sustainability.

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