Modeling Travel Time with Travelers' Experience

Justine Kira (Corresponding author)
Mathematics, Humanities and Social Sciences, National Institute of Transport
P. O Box 705, Dar es Salaam, Tanzania
E-mail: sindato2005kira@gmail.com

Shabani Mohamed
Logistics and Transport Studies, National Institute of Transport
P. O Box 705, Dar es Salaam, Tanzania
E-mail: shaabankanou@gmail.com

Abstract
This paper presents results from analysis of travel time model of Bus Rapid Transit (BRT) system. It meant to consult BRT operators and other parties concerning vehicles scheduling and maintenance, customer care, customer service, and structural improvement in future with regards to travelers' perceptions. It used descriptive survey research design and survey questionnaire to collect data on the six routes of Dar es Salaam BRT system. It applied Microsoft Excel spreadsheet to organize and analyze the data. Analysis of travelers' responses shows that, travel demand volume is low on Sunday and is high on Monday and Friday. The travel time total calculated from these responses ranges from lowest travel time to highest travel time. Certainly, through Kimara - Kivukoni route, the travel time total ranges between 53 to 112 minutes, Kimara - Morocco 47 to 101 minutes, Kimara - Gerezani 49 to 103 minutes, Morocco - Kivukoni 40 to 87 minutes, Morocco - Gerezani 36 to 78 minutes, and Gerezani - Kivukoni 29 to 64 minutes. The time that a traveler should add to an average travel time when planning for a trip in a dense traffic in order to ensure on time arrival through any of these routes are as follows: Through Kimara - Kivukoni route, a traveler has to add at least 17 minutes, while through Kimara - Morocco 13 minutes. Likewise, through Kimara - Gerezani 16 minutes, Morocco - Kivukoni 11 minutes, and Morocco - Gerezani 9 minutes. The planning time a traveler should allow in a dense traffic to ensure on time arrival varies from one route to another and at a point in time. Through Kimara - Kivukoni route, a traveler has to plan at least 65 minutes, Kimara - Morocco 48 minutes, Kimara - Gerezani 61 minutes, Morocco - Kivukoni 41 minutes, and Morocco - Gerezani 34 minutes. Some underlying factors that influences high travel time variations and delays on the BRT system include inadequate number of express-articulated buses, inappropriate vehicles scheduling and maintenance plans, imbalance between travel demand volumes and availability of travel facilities, inadequate on/off-boarding systems, failure to adhere to set schedules, and other reckless behaviors by some drivers. Among the measures that the responsible parties should put on board to mitigate these underlying factors include having in place proper maintenance plan, introducing new buses with equitable carrying capacity, and developing flexible scheduling plans that comply with the changing travel demand volumes. Other measures are improving ticketing services even outsides the existing facilities and establishing direct routes that strategically connect all terminals on the system.
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1. Introduction

The 90^{th} or 95^{th} percentiles travel times are the most useful considerations to determine Buffer index and Planning time index to describe travel time reliability. Equations 1 and 2 represent the formulae for computing Buffer index and Buffer time, respectively.

$$Buffer\ Index = \frac{90th\ or\ 95th\ Travel\ Time - Average\ Travel\ Time}{Average\ Travel\ Time} \times 100\%, \quad (1)$$

$$Buffer\ Time = Buffer\ Index \times Average\ Travel\ Time \quad (2)$$

Buffer index means the size of the extra time given in percentage that indicates the additional time that a traveler must add to his/her average travel time when planning for a trip in order to ensure on time arrival. Buffer time measures the extra time that a traveler must add to the average travel time when planning for a trip. For example, a buffer index of 40% means that, in a trip that typically takes 20 minutes, a traveler in such a trip should budget additional 8 minutes to ensure on time arrival, which makes a travel time total of 20 minutes (Lyman K and Bertini, 2007).

Planning time index means the total time a traveler should plan to ensure on time arrival, it comprises of Buffer time and the average travel time. Planning time index measures the magnitude of the travel time total from the average travel time. In the other words, it indicates the travel time total that is necessary for on time arrival. For example, a planning time index of 1.60 means that, for a trip that takes 15 minutes in a light traffic, a traveler should budget at least 24 minutes to ensure on time arrival in a dense traffic at 95^{th} percentile of travel time. Assume a free-flow average travel time of about 15 minutes and planning time index of 1.60, then the Planning time is obtained from multiplying 15 minutes by1.60, which is equal to 24 minutes (US Department of Transportation, 2019). Equations 3 and 4 represent the formulae for computing Planning time index and planning time, respectively.

$$Planning\ Time\ Index = \frac{90th\ or\ 95th\ Travel\ Time}{Average\ Travel\ Time} \times 100\% \quad (3)$$

$$Planning\ Time = Planning\ Time\ Index \times Average\ Travel\ Time \quad (4)$$

1.1 Bus Rapid Transit

Bus Rapid Transit (BRT) is a bus-based transit system characterized by high quality bus, fast delivery, comfortable, high carrying capacity, and cost effective service. BRT operates in dedicated lanes, with bus ways and iconic stations aligned to the center of the road, off-board fare collection, and frequent operations (Callagan & Vincent, 2007). The history of BRT went far back in the early of 1973 where the first system was introduced in Ottawa-Canada, called Ottawa-Carleton (OC Transpo) system characterized by dedicated lane through the center (Callagan & Vincent, 2007). The second BRT system in the world was the Rede Integrada de Transporte (RIT, integrated transportation network), implemented in Curitiba, Brazil, in 1974. Most of the elements that have become associated with BRT were innovations first suggested by Curitiba Mayor Architect Jaime Lerner (Robert, 2013). BRT is relatively new mode of transport; it currently found in 170 cities around the world and investigated to be an effective and viable solution for urban mobility challenges. It saves 33,356,087 passengers per day worldwide and it covers a total of 5,046km length around the world (Global BRT Data, 2018).

In African cities, Bus Rapid Transit is a relatively new phenomenon. The first system was opened in 2008 and since then, 6 others BRT systems has been inaugurated whereas in 2016 saw a record of three new BRTs on the continent. Currently, BRT systems operate in the following African cities; Lagos in Nigeria, Lagos BRT opened in March 2008, Johannesburg in South Africa, Rea Vaya opened in August 2009, and Cape Town in South Africa MyCiTi opened in May 2011. Others are George in South Africa, Go George BRT system opened in August 2015, Dar es Salaam in Tanzania, DART opened in May 2016, Marrakech in Morocco opened in November 2016, and Accra in Ghana opened in November 2016 (Matata F et al., 2017).

1.2 Dar es Salaam Rapid Transit

Dar es Salaam Rapid Transit (DART) is a bus based mass transit system connecting the suburbs of Dar es Salaam to the central business district, which began operations on May 2016. Phase I of the BRT system has a total length of 21km exclusive bus lanes that run from Kimara to Ubungo ending at Kivukoni, Morocco, and Gerezani. It consists 2 bus depots, 5 terminals, 27 centrally located bus stations, 3 pedestrian bridges at Kimara, Ubungo, and Morocco, pedestrian crossing facilities at each station, 4 feeder stations and able to carry about 406,000 passengers per day using 175 HCB and 300 FBs (Mchomvu Y, 2018).

Dart operational design comprises of 7 trunk, 2 express and 5 local services, 13 feeder routes and 4 stations, Average 33 trunk buses/hour – peak hour and 10buses/hour off peak, Average speed of 23km/hour for trunk and 17km/hour for feeder buses (Dar Rapid Transit Agency, 2014). The entire system operates by the Usafiri Dar es Salaam Rapid Transit (UDART) under the supervision of the Surface and Marine Transport Regulatory Authority (SUMATRA), now Land Transport Regulatory Authority (LATRA). It started transport operations in 2016 with almost 140 Chinese built Golden Dragon buses, providing express and local service for 18 hours daily from 05:00 am to 11:00 pm (Chengula D.H and Kombe K, 2017).

The first phase of Dar es Salaam BRT aimed to serve people living and/or working along Morogoro road and nearby places, Morocco and nearby places, Gerezani and nearby places, as well as Posta and nearby places. They depend much in the DART as the only mode that could save their travel time and related costs since other means such as Daladala have long and unreliable travel time while Bodaboda is highly costly. Introduction of DART in Dar es Salaam metropolitan city, meant to reduce the congestion problem by improving travel times reliability and variability in an exclusive curbed media bus lane.

The BRT Phase 1 system was expected to displace 1,800 Daladala existed. After introduction of BRT commuters mobility and satisfaction with public transport has improved by 32%, especially through Phase I corridor, though with some negative impacts to Urban poor who face access constraints to the service. These include rises of house rents along the Phase I corridor and high travel fares and other costs (Lwakatare R *et al*., 2018). Despite some improvements in travel time variations in urban areas brought by DART, still there are inconsistences of the total travel time per route occasionally on peak hours the average travel time of the DART become almost the same with the normal buses and mini-buses.

1.3 Purpose of the Study

The main objective of this study was to assess travel time reliability of an operating BRT system by using travel time model that base on travelers' experience.

The specific objective were to:

i) To calculate the average time a traveler spends in a queue to buy ticket and to wait for a bus at the terminal or station on an operating BRT system,

ii) To calculate the travel time total and travel time variations of an operating BRT system,

iii) To pinpoint the underlying factors that influences high travel time variations and delays on an operating BRT system.

1.4 Research Questions

The study responded to these six research questions:

i) How long does a traveler stay in a queue to buy ticket at a terminal or station?
ii) How long does a traveler wait for a bus at a terminal or station?
iii) How long does it take a traveler through any route on BRT system?
iv) How reliable it is to travel through any route on an operating BST system?
v) What are the underlying factors that influence high travel time variations and delays on BRT system?
vi) What should the responsible parties do to mitigate these underlying factors?

1.5 Significance of the Study

The significance of this study includes:

i) It will generate useful information to BRT operators management and users, hence improved quality of service,
ii) It will make useful resources for studies related to transport planning in metropolitan areas.

2. Materials and Methods

The study used an example of Dar es Salaam BRT system, which has a capacity of carrying about 400,000 travelers per day (World Bank Report, 2017) to 406, 000 travelers per day (Mchomvu Y, 2018). The population of the study consisted almost 180,000 travelers per day (Global BRT Data, 2018). A sample of 120 travelers comprised of 60 male and 60 female travelers was drawn through a simple random sampling technique in the selected terminals and stations. However, the actual sample included 90 travelers, 52 males and 48 females.

The descriptive survey research design was adopted to respond to the research questions. The survey questionnaire used for data collection was made up of three parts: Questions regarding demographic characteristics, travel time total and travel time variations. Others were the 4- point Likert scale survey questions concerning underlying factors that influences high travel time variations and delays, and measures to mitigate them.

The survey instrument was administered on face-to-face bases by the researcher after securing permission from UDART officials. The respondents were briefed on the purpose of the study; they were allowed to read the instruction, fill out questionnaires as directed, and then submit completed copies back to the researcher. Some

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travelers were unwillingness to respond on peak hours, and absence of sitting benches at stations and terminals limited travelers to fill out questionnaires while standing.

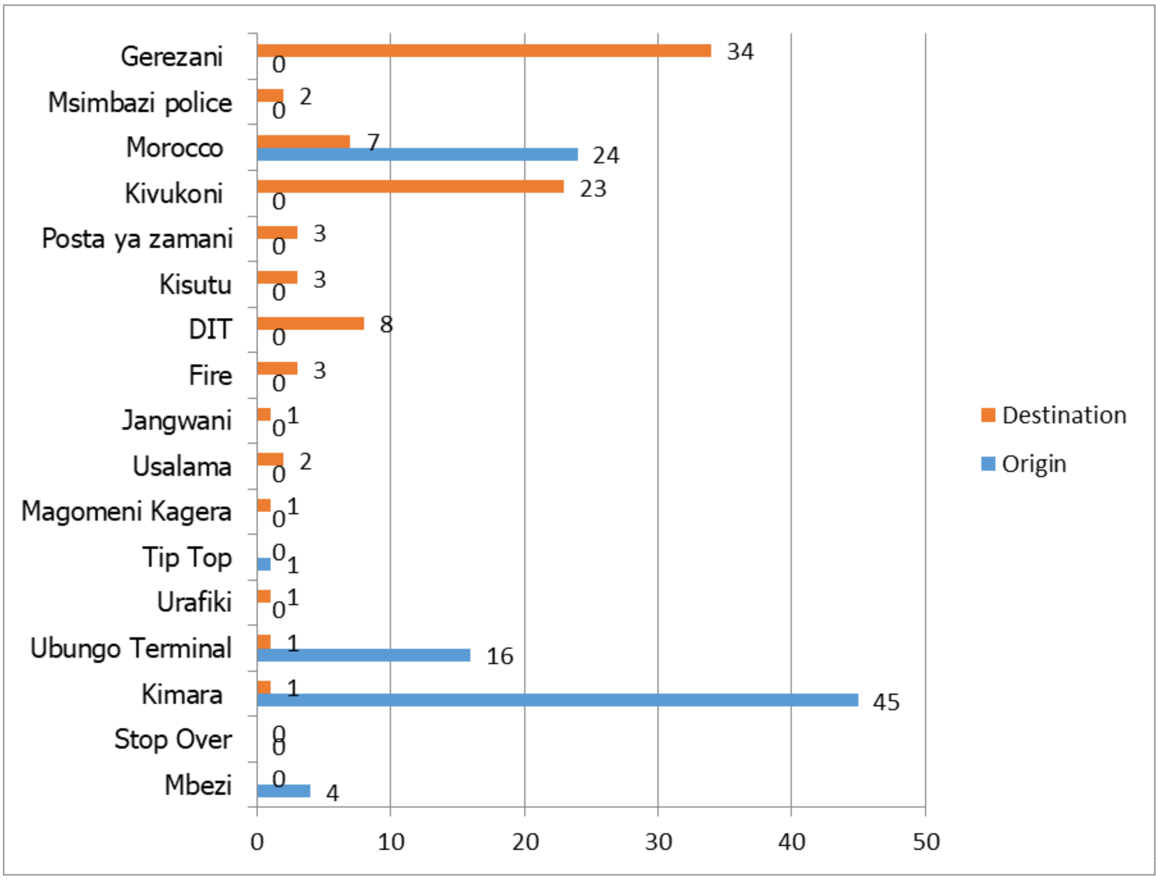
The data gathered were organized and analyzed by using Microsoft Excel spreadsheet. The research questions were answered using proportions and means. In answering research questions, any response proportion with at least scale proportion of 0.25 or response mean with at least scale mean of 2.50 was accepted while anything below these scales was rejected. The criterion for choosing the scale proportion of 0.25 based on small sample size used in the study, the reasoning being that, if 20 of 100 travelers show positive perceptions on an attribute, then that is it; however, the converse is not always the case.

3. Results

3.1 Demographic Characteristics

Of 90 travelers, (0.58) 52 were males and (0.42) 48 were females. The age groups distribution of the respondents dominated by the youth and few adult aged between 18 to 45 years old. Education of the respondents dominated by (0.74) 67 travelers who had either secondary, technician or vocational education while others (0.26) 33 travelers had either primary or undergraduate education. Of 90 travelers, (0.87) 78 travelers had experience of using DART service frequently, which means they might have clear sense of understanding of its business operations.

Most of the respondents' trips start at Kimara, Morocco and Ubungo; these trips mostly end at Gerezani, Kivukoni and Morocco, DIT and few of them end at Kisutu, Posta ya Zamani, Ubungo, Magomeni or Fire. This means most of travelers through these routes are businesspersons and public workers whose' activities are carried out in the City center. Figure 1 illustrates the origins and destinations of the trips.



Figu

re 1: Origins and Destinations of the Trips

3.2. Off the Board Travel Time

The average time a traveler spends in a queue to buy ticket ranges between 1 to 10 minutes based on almost (0.77) 69 travelers with experience of DART service. This time value varies from terminal - station, station – station, and station – terminal overtime.

The average time a traveler spends in a terminal or station to wait for a bus for on-boarding ranges between 16 to 20 minutes or over 20 minutes based on almost (0.60) 54 travelers with experience of DART service.

Table 1 (a) indicates the queuing time and waiting time at Dar es Salaam BRT terminals or stations.

Table 1 (a): Ticketing and Waiting Time at Stations or Terminals

Waiting Time in a Station				Time in a Queue for Ticketing			
Time	**Frequency**	**Proportion**	**Decision**	**Time**	**Frequency**	**Proportion**	**Decision**
1-5 minutes	5	0.06	Reject	1-5 minutes	46	0.51	Accept
6-10 minutes	22	0.24	Reject	6-10 minutes	23	0.26	Accept
11-15 minutes	9	0.10	Reject	11-15 minutes	13	0.14	Reject
16-20 minutes	29	0.32	Accept	16-20 minutes	4	0.04	Reject
Over 20 minutes	25	0.28	Accept	Over 20 minutes	4	0.04	Reject

3.3 On the Board Travel Time

This is the time a traveler takes while in a bus from when they on-board, taken from terminals or stations through some stops (traffic lights and zebra cross/lines) and off-boarding on the stations in between or at the destination terminal. Table 1 (b) indicates time spent by the travelers while in the bus.

The average time a bus takes to move from terminal - station, station - station, or station - terminal successively ranges between 1 to 2 minutes based on almost (0.90) 81 travelers with experience of DART service.

The average time a bus spends on the stops (traffic lights and zebra crosses) ranges between 31 to 60 seconds and even or over 60 seconds based on almost (0.62) 56 travelers with experience of DART service.

The average time a bus stop in a station to pick on or drop off the travelers ranges between 16 to 30 seconds based on almost (0.64) 58 travelers with experience of DART service.

Table 1 (b): Time Spent While in the Bus

Time Lapse between two Successive Nodes			Time in a Stops (Traffic Lights Zebra Crosses)			On/Off-Boarding Time	
Time	**Proportion**	**Decision**	**Time**	**Proportion**	**Decision**	**Proportion**	**Decision**
1-2 minutes	0.9	Accept	1-15 seconds	0.04	Reject	0.10	Reject
3-5 minutes	0.1	Reject	16-30 seconds	0.23	Reject	0.64	Accept
6-10 minutes	0	Reject	31-45 seconds	0.30	Accept	0.13	Reject
Over 10 minutes	0	Reject	46-60 seconds	0.02	Reject	0.01	Reject
			Over 60 seconds	0.32	Accept	0.07	Reject

3.4 Travel Time

Travel time total ranges between lowest travel time and highest travel time that a traveler may perhaps spends to complete a trip. Both, lowest travel time and highest travel time are the linear combinations of the time a traveler stay in a queue to buy ticket, to wait for a bus at stations or terminals, time a bus takes on stops (traffic lights and zebra crosses) through terminal - station, station - station, station - terminal, and time for on/off-boarding of passengers. Equation 5 is a mathematical representation that describes the phenomenon of this study.

$$TTT = TQ + TW + TI \times (NS - 1) + TS \times (NI) + TO \times (NS - 1) \quad (5)$$

The following are the definitions of the imbedded parameters and variables in equation 5:

i) TTT - Travel time total,
ii) TQ -Time on a queue for ticketing,
iii) TW -Time for waiting a bus in a station/terminal,
iv) TI -Time between two successive nodes: terminals - station, station - station, or station - terminal,
v) TS - Time on stops (traffic lights and zebra crosses),
vi) TO - Time for travelers on/off-boarding,
vii) NS - Number of stations on a specified route,
viii) NI - Number of intersections on a specified route.

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Table 2 indicates travel time total, both lowest travel time and highest travel time computed by using travel time model defined by equation 5.

Table 2: Total Travel Time in Minutes

BRT Route	Travel Time	TQ	TW	NS	TI*(NS-1)	NI	TS*NI	TO*(NS-1)	Travel Time Total
Kimara - Kivukoni	Lowest	1	16	25	24	12	6	6	53
	Highest	10	30		48		12	12	112
Kimara - Morocco	Lowest	1	16	22	21	8	4	5	47
	Highest	10	30		42		8	11	101
Kimara - Gerezani	Lowest	1	16	21	20	13	7	5	49
	Highest	10	30		40		13	10	103
Morocco - Kivukoni	Lowest	1	16	16	15	9	5	4	41
	Highest	10	30		30		9	8	87
Morocco - Gerezani	Lowest	1	16	12	11	10	5	3	36
	Highest	10	30		22		10	6	78
Gerezani - Kivukoni	Lowest	1	16	8	7	6	3	2	29
	Highest	10	30		14		6	4	64

3.5. Travel Time Reliability

The most effective tools of measuring travel time reliability by using 90th or 95th percentile travel time are Buffer index and planning time index (U.S Department of Transport, 2017). Buffer index and planning time index are the naive schemes for measuring travel time reliability. Buffer index estimates how much delay on specified route will be on the day with high travel demand volumes. In this study, the highest travel time repealed the 90th or 95th percentile travel time. Equation 6 repeals equation 1 after substituting the 90th or 95th percentile travel time by the highest travel time, and the average travel time by the arithmetic mean of the highest travel time and lowest travel time. As well, equation 7 repeals equation 3.

$$Buffer\ Index\ = \frac{Highest\ Travel\ Time - Lowest\ Travel\ Time}{Highest\ Travel\ Time + Lowest\ Travel\ Time} \times 100\% \quad (6)$$

$$Planning\ Time\ Index\ = 2 \times \frac{Highest\ Travel\ Time}{Highest\ Travel\ Time + Lowest\ Travel\ Time} \times 100\% \quad (7)$$

In the other words, it is possible to estimate Buffer index and Planning time index by using the formulae given by equations 8 and 9, respectively,

$$Buffer\ Index\ = \frac{90th\ or\ 95th\ Percentile\ Travel\ Time - 10th\ or\ 5th\ Percetile\ Travel\ Time}{90th\ or\ 95th\ Percentile\ Travel\ Time + 10th\ or\ 5th\ Percetile\ Travel\ Time} \times 100\% \quad (8)$$

$$Planning\ Time\ Index\ = 2 \times \frac{90th\ or\ 95th\ Percentile\ Travel\ Time}{90th\ or\ 95th\ Percentile\ Travel\ Time + 10th\ or\ 5th\ Percetile\ Travel\ Time} \times 100\% \quad (9)$$

Table 3 indicates the days with high and low travel demand volumes.

Table 3: Days with High and Low Travel Demand Volume

BRT Route	Day with Low Travel Demand Volume	Lowest Travel Time (Minutes)	Day with High Travel Demand Volume	Highest Travel Time (Minutes)	Highest Travel Time minus Lowest Travel Time (Minutes)
Kimara - Kivukoni	Sunday	53	Monday	112	59
Kimara - Morocco	Sunday	47	Monday	101	54
Kimara - Gerezani	Sunday	49	Monday	103	54
Morocco - Kivukoni	Sunday	41	Friday	87	46
Morocco - Gerezani	Sunday	36	Monday	78	42
Gerezani - Kivukoni	Sunday	29	Friday	64	35
Difference Mean = 49, Difference Standard Deviation = 9					

3.5.1 Buffer Index and Planning Time Index

Table 4 indicates Buffer index and planning time index estimated by using equations 6 and 7, respectively.

Table 4: Buffer Index and Planning Time Index

BRT Route	Buffer Index	Planning time index
Kimara - Kivukoni	36%	136%
Kimara - Morocco	36%	136%
Kimara - Gerezani	36%	136%
Morocco - Kivukoni	36%	136%
Morocco - Gerezani	37%	137%
Gerezani - Kivukoni	38%	138%

3.5.2 Buffer Time and Planning Time

Table 5 indicates data extracted from the study by (Matata F, Kitali A.K, Sando T, and Bwire H, 2017); entitled Operational Characteristics of the Newly Introduced Bus Rapid Transit in Dar es Salaam, Tanzania). The following two empirical examples demonstrate valid applications of the travel time model defined by equation 5.

Table 5: Average Travel Time

BRT Route	Average Travel Time (Minutes)
Kimara - Kivukoni	48
Kimara - Morocco	35
Kimara - Gerezani	45
Morocco - Kivukoni	30
Morocco - Gerezani	25
Gerezani - Kivukoni	unknown

Source: F.Matata, A.K Kitali, T.Sando, and H.Bwire, 2017

Example 1: In average, a traveler takes 48 minutes to travel from Kimara to Kivukoni in a light traffic. At a Buffer index of 35%. What additional minutes would a traveler plan in a dense traffic? Use Buffer index given in Table 4, average travel time given in Table 5, and the formula given by equation 2; calculate Buffer time for each route on the Dar es Salaam BRT system.

Solution: Through Kimara – Kivukoni route, given average travel time of 48 minutes with the Buffer index of 35% (0.35), a traveler through this route should add at least 48×0.35 equals to 17 minutes in order to ensure on time arrival. Likewise, a traveler through Kimara - Morocco route should add at least 13 minutes, Kimara-Gerezani at least 16 minutes, Morocco - Kivukoni 11 at least minutes, and Morocco - Gerezani 9 minutes in order to ensure on time arrivals.

Example 2: How would the traveler in Example 1 plan his/her journey, if all factors remain unchanged?

Solution: Similarly, through Kimara - Kivukoni, the average travel time is 48 minutes and the Planning time index is 135% (1.35), a traveler through this route should plan at least 48×1.35 equals to 65 minutes in order to ensure on time arrival. Similarly, a traveler through Kimara - Morocco route should plan at least 48 minutes, Kimara - Gerezani at least 61 minutes, Morocco - Kivukoni at least 41 minutes, and Morocco - Gerezani at least 34 minutes in order to ensure on- time arrivals. Scrutinizing the results it was learnt that planning time is approximately one-third of the average travel time plus average travel time of each specified route of the study. Table 6 summarizes the results from Examples 1 and 2.

Table 6: Buffer Time and Planning Time in Minutes

BRT Route	Average Travel Time	Buffer Time	Planning Time	Validation
Kimara - Kivukoni	48	17	65	$t \geq 65 \in (53,112)$
Kimara - Morocco	35	13	48	$t \geq 48 \in (47,101)$
Kimara - Gerezani	45	16	61	$t \geq 61 \in (49,103)$
Morocco - Kivukoni	30	11	41	$t > 41 \in (41,87)$
Morocco - Gerezani	25	9	34	$t > 34 \in (36,78)$
Gerezani - Kivukoni	unknown	unknown	unknown	$t = ? \in (29,64)$

3.6 Underlying Factors of High Travel Time Variations and Delays

Table 6 indicates that all underlying factors 1-9 were accepted as causes of high travel time variations and delays on the Dar es Salaam BRT system because they had response mean greater than scale mean of 2.50. In addition, the grand mean of 3.20 is higher than scale mean, which suggests high perception of those underlying factors as causes of high travel time variations and delays among travelers.

Table 6: Underlying Factors of High Travel Time Variations and Delays

S/N	Underling Factors	Response Mean	Standard Deviation	Decision
1	Inadequate infrastructure such as stations and terminals along the existing BRT system	3.12	0.020	Accept
2	Inadequate number of express articulated buses	3.33	0.003	Accept
3	Inequitable carrying capacity of buses	2.98	0.035	Accept
4	Inappropriate maintenances plan	3.32	0.001	Accept
5	Inappropriate scheduling plan	3.36	0.005	Accept
6	Imbalance between demand of the services and availability of facilities	3.30	0.001	Accept
7	Existence of too many intersections	3.16	0.016	Accept
8	Interruptions of BRT system by other roads users	3.16	0.016	Accept
9	Frequent mechanical failure of vehicles	3.07	0.026	Accept
Scale Mean=2.5, Grand Mean =3.20				

Other underlying factors: The respondents also lamented on the following as additional underlying factors of high travel time variations and delays:

i) Inadequate on/off-boarding system on the terminals and stations (i.e. scrambling system),
ii) Inadequate supervision of BRT operations,
iii) Some drivers keep on waiting for travelers at terminals or stations,
iv) Dishonest of some drivers,

v) Flood on heavy rainfall seasons as consequence of climatic changes and environmental pollutions.

3.7 Measures to Mitigate High Travel Time Variations and Delays

Table 7 indicates that measures 1-7 all had response mean greater than scale mean of 2.50. In addition, the grand mean of 3.30 is higher than the scale mean. Based on this result, all were accepted as measures to mitigate high travel time variations and delays.

Table 7: Measures to Mitigate High Travel Time Variations and delays

S/N	Measures	Response Mean	Standard Deviation	Decision
1	Discourage interruption of BRT system by enforcing rules and regulations governing BRT operations	3.20	0.007	Accept
2	Have proper maintenance plan based on time or distance travelled by a vehicle	3.50	0.017	Accept
3	Have in place flexible scheduling plan that could comply with the changing travel demand volume	3.40	0.014	Accept
4	Improve ticketing facilities to reduce the length of the queues on the stations and terminals	3.30	0.003	Accept
5	Add new vehicles with reasonable carrying capacity	3.00	0.030	Accept
6	Expand the BRT system to create multiple choice of routes for commuters	3.40	0.006	Accept
7	Improve other modes of transport like railway to reduce pressure on the BRT system	3.30	0.002	Accept
Scale Mean=2.5, Grand Mean =3.30				

Other measures: The respondents also pointed out the following as measures to mitigate high travel time variations and delays:

i) Modification of the management,
ii) Allow competitors to enter the business,
iii) Establish direct routes that connect all terminals (e.g. Mbezi to other terminals especially Gerezani),
iv) Introduce proper arrangement of on/off-boarding system,
v) Improve communication system on the stations and terminals,
vi) Carrying only fixed number of travelers in a vehicle,
vii) Allow Daladala to co-operate in the same route (e.g. Morogoro Road to Kimara and Mbezi),
viii) Introduce infrastructures and vehicles that can withstand the climatic changes,
ix) Introduce ticketing agencies outside the stations,
x) Considering the validity time of tickets,
xi) Improve management system,
xii) Improve customer care and customer services.

4. Conclusion and Recommendations

4.1 Conclusion

This paper models travel time basing on passengers experience and analyzes travel time reliability of an operating BRT system. The findings from the analysis of the travelers' responses indicate that, travelers spend a lot of time on stations or terminals to buy tickets and waiting for buses, a tendency that varies overtime. In some cases, the time travelers spend in stations or terminals to buy tickets and waiting for buses is slightly longer than the on the board travel time, particularly at Kimara and Gerezani terminals. The weekdays (e.g. Monday and Friday) had high travel demand volumes compared to weekends, besides on weekdays, the travel time total is relatively high than on the weekends (e.g. Sunday). Travel time variation in each route as determined by the differences between the highest travel time and lowest travel time ranges between 35 to 59 minutes. The average difference is 49 minutes and the standard deviation of the differences is 9 minutes. In general, travel time total on the existing BRT system is dubious because travelers are certain to add extra minutes approximately equal to one-third of the average travel time of a particular route on the system to ensure on time arrivals to destinations.

4.2 Recommendations

Based on the travelers' perceptions, the following recommendations were established:

i) BRT operators should;
  - Prepare proper maintenance plan on basis of time or distance travelled by a vehicle,
  - Have in place flexible scheduling plan that comply with changing travel demand volumes,
  - Improve ticketing facilities to reduce the length of the queues,
  - Add new vehicles with reasonable carrying capacity (e.g. articulated buses),
  - Establish direct routes that connect all terminals (e.g. Mbezi to other terminals especially Gerezani),
  - Introduce proper arrangement of on/off-boarding and encourage a fixed number of passengers in a vehicle,
  - Improve communication system in the stations and terminals (e.g. announcing the vehicles arriving as well as dispatching.

ii) Traffic police force should tightly discourage interruption of BRT system by enforcing the laws governing vehicle operations on the BRT system,

iii) The government should;
  - Expand BRT system to create multiple choices of routes for commuters,
  - Improve other transport services like commuter train (e.g. City Center-Ubungo commuter train, if improved will serve to reduce the pressure on the DART system),
  - Allow competitors to enter the business to compete with existing operators (i.e. particularly when new Tanzanian BRT systems will be established in future,

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