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## Assessment of Factors that Influencing Operational Performance of Bus Rapid Transit: A case of Dar es Salaam Bus Rapid Transit-Tanzania

BY

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### Abstract

Despite of the efforts made by government for introducing BRT to ensuring the congestions situation can be improved in Dar es Salaam still commuters experience long waiting time at terminals, overcrowding of the passengers, and little adherence of schedule. The main objective of this study is to assess the factors that influence operational performance of Dar es Salaam Bus Rapid Transit. The data were collected in BRT main corridor of Phase one through questionnaires, interview, and observation. The collected data includes bus capacity, travel time, and bus availability. The study used 400 sample sizes for questionnaires and interview respectively where 334 (83.5%) respondents were accessed. The findings show that all predictor's variables are positively affecting operational performance of bus rapid transit (BRT) due to its influence with the positive correlation value and statistically significance. It's concluded that Dar es Salaam BRT suffer in operational underperformance resulted from inadequate number of the buses and it recommended that the agency and distinguished responsible authority should make sure the required buses and others operations requirement tools are found so as to meet the commuters' requirements and the project expectations.

### Article History

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### 1.0 Introduction

Bus Rapid Transit adopted to overcome problem of traffic congestion and mobility challenges in populated cities where there is high transport demands and mobility challenges (Feye et al., 2014). The BRT aiming moving people fast to different economic, social, and political angles without delay, in a comfortably as well as costly friend in time(intangible) and tangible fare. Despite of the government efforts and agency as well of making all necessary infrastructures available, the DBRT commuters are still experiencing chaos since are overcrowding in the buses, long waiting time at terminals and stops. There is ineffective of DBRT operationally resulted in inadequate capacity of their buses in term of numbers, travel time, lack of availability of that buses resulted from daily breakdowns, and less durability (Andrew et al., 2022).

The DBRT commuters has been subjected to severe discomfort because of frequently operational uncertainty, the buses are inadequate, scheduling not adhered, waiting time at terminals is too long, especially during peak hours, and availability of the buses sometimes are questionable by commuters due to long queues when waiting for buses at peak hours (Njau, 2020). However, the

question still remains that if the DBRT perform well in operation arena. The good operational performance of the DBRT needed to the good level that commuters will not experience the discomfort, overcrowded, and long waiting time at stops during peak hours (Swalehe, 2019).

To address the issue of dwell time, delays at terminals, inaccessibility, costs, and other mobility obstacles from the BRT in Dar es Salaam city, the DBRT needs to be effective in operational area particular to have adequate buses, reliability in timely travel (schedule adherence) and reliable availability of the buses so as to reduce travel time, waiting time, and overcrowding of commuters into the DBRT buses (Tengecha & Juma, 2021). From that scenarios, the bus capacity, travel time, and bus availability are the important components that are to meet operational hegemony of the DART agency so as to meet the commuters expectations.

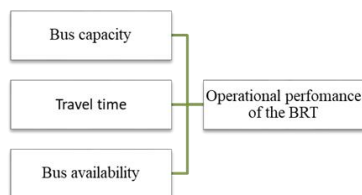
### 1.1 The Theory of Transportation

This is an old theory, developed by Charles Horton Cooley in 1894. According to this theory, the best transportation is the one that accomplishes the movement of things or items with the least force and in the shortest time (Cooley, 1894). The theory states that



the efficient transportation is one that is cheap and capacity and quick at the same time in accommodating mobility as per demands and time value as intangible facts. This theory can be linked to DBRT operational performance, whereas the operational performance of BRT system is regarded as one which provides travel services in a quick way (speed) and at reduced costs which triggered by enough capacity of the buses, travel time reliability, and buses availability as well. The reduced costs do not only include running costs of buses, but also include the time wasted by passengers in traveling (travel time), in waiting at station (waiting time), infrequency of services, etc. However, this should happen without increasing the costs of services to passengers (Nkurunziza, 2008). This theory is linked to the study as it emphasizes on the operational performance influential factors for DBRT. The theory emphasizes on speed, shortest time in traveling, short waiting time, optimum operation costs, vehicle carrying capacity, etc. These also are the chosen factors influencing operational performance of DBRT.

Figure 1.1.1 Conceptual Framework



## 2.0 Methodology

The study was conducted in Dar es Salaam city, the only city with Bus Rapid transit system and the most populated city in Tanzania where there is high traffic and mobility challenges than other cities in the country due to its economic position and mono-centric in nature with a single direction to enter and exit to Commercial District Business (CDB) (Nyaki et al., 2020). The study was quantitative and qualitative (mixed-method) approaches, using a case study design with a cross-sectional time frame (Saunders et al., 2007). Simple random and purposive sampling was used to reach three hundred and thirty four (334) both commuters BRT staffs. The expected sample size was 400 respondents but a total of three hundred and thirty-four (334) which was equal to 83.5% participated in the study. Primary data were collected using questionnaires, interview, and observation which contained a set of close and open-ended questions basing on demographic characteristics of the respondent. Also close-ended questions related to study variables (bus capacity, travel time, bus availability, and operational performance). Moreover open-ended questions were provided to DA-BRT staff. The reliability of quantitative data was computed and expressed by Cronbach Alfa Test (CAT) where all variables scored the value greater than 0.7 which is acceptable (Hinton et al., 2014). In the qualitative data, reliability was ensured by testing and re-testing the questions with several respondents and checking the answers corresponding to make sure that they do not contain obvious mistakes made during transcription (Creswell, 2014). Qualitatively, validity was ensured through the member check method where (5) participants in the

questionnaires were invited to check the findings and results and give feedback if they find themselves in or not (Muya & Tundui, 2021). Data analysis involved a number of activities including coding, transcribing interviews, typing up field notes into Microsoft word, familiarization with the data, as well as reading and re-reading of the data (Muya & Tundui, 2021). The mean, correlation and regression were the tools for analyzing the quantitative data through IBM SPSS version 20.0 software to generate descriptive and inferential statistical results. On the qualitative data analyzed thematically by thematic analysis which involved focusing on analyses of all data relevant to each potential theme (Muya & Tundui, 2021).

## 3.0 Analysis of the Study Variables (Quantitative data)

The analysis and presentation of findings of the study is described by mean, standard deviation, correlation, and multiple linear regression analysis. The reason was to show the existing relationship between independent and dependent variables. The independent variables are the operational performance selected determinants which are bus capacity, travel time, and bus availability. In that scenario, the analyses in both angles are shown as follows:

### 3.1 Mean and Standard Deviation

The analysis was done to show the variable as the study predictor with the highest influence among others in the dataset as well as the minimum level of dispersion in terms of respondent’s opinions. The analysis is being provided in Table 3.1 and it shows the findings on mean and standard deviation whereas among the predicting variables to the dependent variable bus capacity has highest influence than other independent variables because it has highest mean value than other variables (2.99). This implies that operational performance of the Dar es Salaam bus rapid transit is mostly determined by bus capacity than other determinants. These also supported by observational result by researcher that if the DBRT attain to have optimum number of the buses could reduce somehow the chaos inconveniences passengers due to inadequate of the buses at DART which hinder efficiency and effective operations to its level bests.

Table 3.1: Mean and Standard Deviation

Study Variable	Mean	Standard Deviation
Operation Performance	3.01	.656
Bus Capacity	2.99	.747
Travel time	2.88	.632
Bus Availability	2.31	.887

Source: Researcher Finding (2023)

### 3.2 Correlation and Multiple Regressions

Correlation and multiple regressions are conducted to indicate the existing relationship between study variables both independent and dependent ones. With that, before correlation and multiple

regression analyses being performed, model summary analysis is first conducted to indicate the overall contribution of the independent variables on dependent variable. Therefore, the model analysis is presented in Table 3.2.

**Table 3.2 Model Summary**

Model Standard of Estimate	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Error
1	.783	.613	.542	.645

Source: Researcher analysis (2023)

Independent Variables: Bus capacity, travel time, Bus availability.

Dependent Variable: Operational performance

The study findings in Table 3.2 above, the "R" the correlation coefficient, with value of 0.783 suggests a strong positive correlation between the independent Variables such as bus capacity, travel time, and bus availability to dependent variables (Dar Es Salaam Bus Rapid Transit operational performance). Also, it show the facts on the overall testing of all study independent variables on the dependent variable through the value of coefficient of determination (R<sup>2</sup>) which provides that operational performance of the Dar es salaam bus rapid transport (DBRT) is influenced by bus capacity, travel time, and bus availability by 61.3% and 38.7% is influence by other factors that was not included in the study. The computation implies that the assumptions as predicting variables to the dependent variable are positive and have been met the hypotheses of the study.

**3.3 Correlation Analysis**

Correlation analysis is performed specifically to show the variable among the predictors which correlate best than others in the dataset. In that case, Table 4.8 describes the study results.

**Table 3.3 Correlation Analysis**

	Operation Performance	Bus Capacity	Travel Time	Bus Availability
Operation Performance	1.00			
Bus Capacity	.514	1.00		
Travel Time	.412	.467	1.00	
Bus Availability	.331	.492	.496	1.00

ty

Source: Field Data Analysis (2023)

The Table 3.3 describes the values of correlation on the study variables and their implications. In that case, the highest correlation is on bus capacity because has the highest correlation which shows to influence dependent variable than other independent variables. This is attributed by the fact that bus capacity consists of the highest correlation (strong positive) value of 0.514 (51.4%) than others. The implication is that operational performance of the DBRT is influenced by bus capacity mostly than other variables. Travel time and bus availability correlates positively with the value of 0.412 (41.2%) and 0.331 (33.1%) respectively to dependent variable.

**3.4 Multiple Regression Analysis**

Multiple regressions were conducted to indicate the connection of every independent variable on the dependent variable such as bus capacity, travel time, and bus availability to operational performance as a dependent variable. The results found in Table 3.3.

From the equation stated that:

$$OP = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \mu \dots\dots\dots (3.1),$$

where

OP = Operational Performance

$\beta_1, \beta_2$  and  $\beta_3$  = are the beta values for independent variables one, two, and three respectively

$\beta_0$  = Constant factor

$x_1$  = Bus capacity

$x_2$  = Travel time

$x_3$  = Bus availability

$\mu$  = Random variable

$$OP = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \mu \dots\dots\dots (3.1),$$

becomes,

$$OP = 2.36 + 0.469x_1 + 0.315x_2 + 0.26x_3$$

The regression equation revealed that if all independent variable (factors) taken into account (bus capacity, travel time, and bus availability) constant at zero, the operational performance will be 2.36. The findings also presented that if taking all other autonomous factors at zero, a bus capacity will contribute to 0.449 on the upgrades of operational performance, a unit moderating in travel time will prompt to a 0.315 contribute the improvement of operational performance, and a unit increment in bus availability will go to 0.26 contributions in operational performance of the DBRT. This implies that bus capacity contributes most to operational performance of DBRT for 46.9% followed by travel time and bus availability for 31.5% and 26% respectively.

**Table 3.4: Multiple Regression Analysis**

Model	Unstandardized Coefficient		Standardized coefficient	T	P value
	B	Std. error	Beta		



(Constant)	2.360	.531		9.899	.000
Bus Capacity	.494	.380	.469	2.895	.010
Travel Time	.301	.249	.315	2.237	.042
Bus Availability	.272	.242	.260	1.591	.049

Source: Researcher findings (2023)

Additionally, the study in Table 3.4 shows the results on probability value (p-value or significance level). The results reveal that on the three predicting variables to the dependent variable, all found positive and statistically significant on the dependent variable. This implies that operation performance of the Dar es Salaam bus rapid transit (DBRT) is influenced by predictors' variable. This show the fact that operational performance of the DBRT is highly influenced by bus capacity, travel time, and bus availability in operation performance pattern for that matter, and statistically significance looking of the P value where is less than  $p < 0.05$ .

**3.4 Qualitative Analysis of the Findings**

**3.4.1 Interview findings**

Regarding to the various interview questions to staff who were dealing with the daily operation, the general findings were as follow.....

The numbers of the buses are not enough to accommodate the daily demands of 500000 estimated commuters at first BRT corridor and its feeder roots. The available buses were 200 and only 145 were working and the remained buses are grounded due to breakdowns while the needed buses to accommodate 500000 commuters are at least 316 for both rigid and articulated buses. The capacity of serving passengers currently is less than 190000 passengers per day as per DART records. Additionally, interviewee provides that the commuters waiting at terminal and stops for the maximum time of 15 minutes during peak hours due to larger number of passengers compared to available buses.

**3.4.2 Observation findings**

It was observed by researcher that, the numbers of buses are few compared to the peak demands, the buses are carrying to many commuters than their capacity during the morning peak -time and the evening, peak-time resulted from scarcity number of the buses. The buses with capacity of carrying 155 passengers including standees and sitting are carrying up to 190 commuters per trip. Also, it was observed that the passenger waiting for a long time at a queues waiting to boarding into the buses, the situation is triggered by the inability of the DBRT to accommodate the whole demand at once due to lack of buses. The passengers waiting up to 45 minutes at Kimara terminal during morning peak time, and up to one hour at Gerezani terminal during evening peak time. Moreover the headway and frequencies of the buses was good as observed where there is almost 15 buses passes at terminal and stops per hour. This implies that the headway and frequencies of

the DBRT buses are good to the standard of 1 to 3 minutes bus are arriving and leaving to the stops.

**4.0 DISCUSSION OF THE RESULTS**

**4.1 Bus Capacity and Operation Performance**

With regard to the influence of bus capacity on operational performance, three indicators (measures of bus capacity) which was considered as well as three questions to bus capacity as the first independent variable. Those indicators (measures) are size of the buses, number of buses, and number of passengers that are carried by the buses at once journey.

Quantitatively, in the mean and standard deviation analysis, the study results revealed that the bus capacity as independent variable constitute most than travel time and bus availability in operational performance as the predicting variable since the results found that the bus capacity scoring a highest mean of 2.998 which means that the bus capacity as the among predictors variables has a highest influence on operational performance of the DBRT. Also, the variable correlates more than other predictors since it has the correlation value of 0.603 which is positive strongly relationship and it means the variable influence the operational performance for 60.3%. To the regression, the variable constitutes 54.1% when other variables omitted. Moreover, in probability value (p-value) the variable has positive and statistically significant on operational performance as the dependent variable whereas probability (p) value of 0.015 which is less than 0.05 ( $p < 0.05$ ) a recommended P value for the variable to be significant important to the study (Hinton et al., 2014). The implication is that operational performance of the Dar es Salaam bus rapid transport (BRT) is not performing well in operations area due to inadequate number of the buses that DBRT have.

*Qualitatively, it was witnessed in the field observation by a researcher that there is a high demand during the morning and evening between 6:30 a.m. to 9:00 a.m. and at 16:30 p.m. to 20:30 and 21:00 respectively. The observation took place at Kimara terminal at morning hours and Gerezani terminal at evening hours from 10 day of July to 23 day of July respectively. The other days the observation took place in outbound direction that is from Gerezani terminal to Kimara terminal during the morning and the inversely during the evening and at noon hours so as to explore the situation as observed previously if is the same. The results shows that the operation of the DBRT is inbound and outbound single direction, to mean that during the morning the commuter concentration is from out of city centre and the evening is from the city centre to outward. So, the discomfort faced by DBRT commuters are seasonally and few hours during the morning when they going to town centre and evening few hours when they back to their home places.*

*Additionally, regarding to the bus capacity as the independent variable, a respondents were quoted saying:.....There are few buses, passengers are overcrowding during morning and evening hours particular from 06:30 a.m. to 09:00 a.m. at Kimara terminal and at evening from 16:30 p.m. to 21:00 p.m. at Gerezani terminal*





due to the few number of buses which fails to accommodating the mass number of commuters congregated in the terminals during that hours.

Also, the interview findings from DART staffs dealing with operation unit provides that the DBRT buses are not enough to accommodate the current needs where the approximated demands is 500000 trips, but now DBRT accommodates only an average of 190000 ridership. This is because there are total numbers of 200 buses and on that number, it is only 145 buses are current working while the needed buses are 316 for both rigid and articulated.

#### 4.2 Travel Time and Operation Performance

Quantitative findings on this variable revealed that the travel time as the independent variable is positive and statistically significant on operational performance as the dependent variable whereas  $p < 0.05$ . It constitutes 30.1% in operational performance from the linear with the moderate positive correlation against dependent variable with correlation value of 0.431(43.1%). The implication is that operation performance of DBRT is also not well attained and among constraints leading the chaos to commuters is long waiting time at terminals where during the peak hour the dwell time taking at terminal is up to 30 minutes rather than 5 to 10 minutes as a BRT international and DBRT recommended standard waiting time as well (ITDP, 2016). This is supported by (Njau, 2020) on her study "Effects of Service Quality on Customer Satisfaction in Tanzania: A case of Dare es salaam Bus rapid Transit" by arguing that the operation of the DBRT is still not well because it was experienced that there is long waiting time of the passengers at terminals during the peak hours in morning and evening hours.

Also, the qualitative findings from respondents on their level of agreement on the statement that there is long waiting time of passengers at terminal quoted saying:

..... The waiting time taken by passengers at terminal during the morning is up to 30 minutes during morning at Kimara terminal and up to 40 minutes as the time spends by passengers waiting for boarding at evening at Gerezani terminal. "We experience long queue and competitions to on boarding" some respondents add. The statements that made by some respondents does not differ from the observation witnessed by the researcher at the field on both terminals such as Kimara and Gerezani where there is a passengers congestions waiting the buses on queue.

Conclusively, it was observed that the commuters spend too long waiting for buses at terminal during the pick hours. In the morning from 06:30 a.m. to 09:00 a.m. at Kimara terminal where is the origin of the trip, passengers wait up to thirty (30) minutes, and at Gerezani during evening from 16:30 p.m. to 20:30 p.m. commuters spend up to 45minutes waiting for buses.

#### 4.3 Bus Availability and Operation Performance

The study results also showed that bus availability as the independent variable is found positive but statistically significant on operation performance as the dependent variable whereas  $p < 0.05$ . This implies that operation performance of the DBRT is

not well observed due to less adherence of schedule, Punctuality and availability of buses in the time of needed. The study findings by (Swalehe, 2019) suggests that Dar es salaam bus rapid transport (DBRT) in Tanzania is far from expected performance since the availability of the buses has been poor with lots of delays among passengers which has been chaotic to a great scale. (Mwatawala, 2019) also provides that the transportation system as it started with higher performance then as days went on, it has been diminishing to the extent that passengers experience delays but the buses with several passing the stations empty with no passengers and only few operate in a slow pace affecting the entire aim of overcoming traffic mobility challenges since passengers are highly delayed in the course since the buses are not reliable in schedule as well as an availability. Additionally, the buses run idle (dead kilometers) during the noon hours and the time of distribution at the morning because depot is located to the place where the strip is not originally oriented.

Qualitatively, it was observed that the frequencies of the buses are 15 buses per hour to mean there is a headway of 4 minutes which is allowed but due to inadequacy of the buses which cause passengers to waiting at the queue and even to witnessing the five buses are arriving and departing without boarding to queue length. For the case of availability in headway and frequency it was observed that the problem geared by inadequacy number of the buses, the dislocated of depot which leads the dead kilometer journey of the buses when they start their picking.

## 5.0 CONCLUSION AND RECOMMENDATIONS

It is reality that Dar es Salaam bus rapid transit (DBRT) operation performance has challenges and its objectives have not been well attained as it is both not reliable and inefficient because all three attributes of operation performance found significance which directly influences the pattern of operational performance. This entails that the DBRT has not attained the required performance which hinder the services and hence creates other new problems which cause great chaos to the customers for taking long time waiting for the buses at terminal during peak hours. This is something, which must be severely address to overcome the challenges since taking long waiting time at terminal hinder mobility. This is evident with the fact that in reality the services are far from the required performance because the buses have been delaying and become an obstacle to the passengers reaching various destinations. Also, the buses are rarely accessible such that the buses sometimes are not enough and available for the operation, which makes people to seek for other forms of transportation besides the DBRT. Therefore, the problem of operations performance is geared by in adequate number of the buses. If the buses will be increased it could improve the travel time and hence reduce waiting time at terminals for the passengers and utilize their time space in profitable.



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