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(RESEARCH ARTICLE)

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Measuring willingness to pay for bus rapid transit in Cairo

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Abstract

Cairo's Bus Rapid Transit system (BRT) is a mode of transport recently proposed to provide a different approach to solving the city's transportation issues. The passenger's choice of transportation mode is thought to be significantly influenced by the cost of the trip. Willingness to pay (WTP) can guide authorities in structuring new public transportation and setting an appropriate fare structure policy. Data for this study was gathered through interviews with 250 passengers who were surveyed. The data collected is in the form of respondents' characteristics, travel characteristics, and pay perception. This study focuses on a progressive willingness to pay system for different levels of improvement in comfort and travel time. According to the findings of the study, the average value of willingness to pay is 30 Egyptian pounds per passenger, which has the potential to increase the ministry of transportation's revenue on the Ring Road by 40%. The trip characteristics show that passengers prefer reducing trip time, the presence of private car parking (park and ride facilities), reducing the waiting time, then the ticket price, and the availability of complementary transportation services. When comparing countries with BRT systems, Cairo's BRT system is among the longest in the world. The proposed ticket price is considered the average for the BRT systems.

Keywords: Willingness to pay; Bus Rapid Transit; Optimum Price; Public Transportation; Cairo passengers

1. Introduction

Cairo is one of the largest metropolitan urban areas in the world and the largest city in Egypt, with a population size of over 10 million residents within an area of 3,085 km2 (CAMPAS, 2022), so various transportation modes are utilized in its transportation network, such as private cars, buses, taxis, motorcycles, and metro lines, in addition to trucks transporting goods. Together with an aging transportation network, this creates crowding, unreliability, inconvenience, and safety problems in general and especially on the Cairo ring road. It is one of the major arterials connecting the various parts of the city, was constructed in 2005, and has a total length of about 100 kilometers. By enhancing public transportation infrastructure, the government aims to build a good transportation system those users will feel comfortable utilizing while also adhering to decreasing co2 emissions. Public transportation can help reduce congestion and harmful environmental effects; furthermore, it can also influence the economy in the long run (Pujiati,A., Nihayah, D., Bowo,P., Prastiwi,F., 2019).

Bus Rapid Transit (BRT) has evolved and surpassed all other modes of transportation, particularly in the past ten years since 2004, when BRT has expanded on a global scale. It began in 1972 in Curitiba, Brazil, with efficiency in terms of cost, high capacity, speed, and service quality. BRT must be designed with a few essential components in mind in order to function flawlessly, including segregated bus lanes, off-board fare collection, level boarding, bus priority at intersections, and other high-quality features such as technology and effective branding (BRT Planning Guide, 4th Edition).

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The Willingness to Pay (WTP) is an important component to take into account while creating a fare structure for the new public transportation mode; on the one hand, it should be acceptable to the majority of users. A person's willingness to pay indicates how willing they are to pay for the service they receive. Transportation productivity, quantity and quality, utility costs, income, and salary all affect WTP. The WTP analysis has a significant influence on the decision-making (Quevedo et al., 2009). Additionally, the willingness-to-pay principle is utilized to raise the standard of a bus service. Measuring WTP for fare policy changes is helpful for a fare scheme reform because fare schemes can have a significant impact on how travellers decide to use public transportation.

The purpose of this paper is to determine the appropriate BRT fare for the passengers by applying the WTP survey for a new public transport system in Cairo, Egypt. With regards to passenger transport in Egypt that is subsidized by 7.8 EGP billion, the authorities target to at least have any new mode of transport cover its operation and maintenance costs, and willingness to pay estimates can be used to inform public policy makers (Ministry of Planning and Economic Development, 2022).

2. Literature Review

Travel preferences in actual or fictitious markets can be examined, measurement and analysis issues that arise when forming WTP estimates and using them to inform public policy. Willingness to pay is the average highest fare that users of the system are willing to pay. This indicates a willingness to pay for service and time savings (McFadden, D., 1997).

WTP has been investigated in a number of studies to offer suggestions for transportation improvements or to determine the tariff of a new transport mode. The approach method relied on customers' willingness to pay or offer rewards in exchange for the services they receive per mile. Furthermore, the studies assess a person's ability to pay based on an ideal income-based assessment of his ability to pay for the services he received. In study of measuring LRT fare in Palembang, Indonesia, they used a household budget method; the total transportation budget for public transportation was calculated based on the total monthly travel distance and monthly income. Based on ATP (Ability to Pay) and WTP analyses, the optimal LRT rate was between 10,000 IDR and 13,300 IDR. The subsidized tariff scenario would result in up to 5,000 IDR and 93 percent more daily travellers. About 65 percent of the passengers, out of 93 percent, decided to use the LRT mode (Sarwandy M.,et al, 2019).

The willingness of passengers to pay for bus service evaluated for raising quality levels. To develop a tool for assessing passenger willingness to pay that takes into account some qualitative service factors in addition to the more typical quantitative service factors, such as trip time and cost. The methodology that has been used is based on the calibration of behavioral models using user preferences. The WTP values are calculated using the marginal rates of substitution between certain service quality features and travel expenses when utility is constant. For this purpose, multinomial and mixed-logit models were developed. The models were calibrated using data gathered from a stated preference experiment in which each user was given the option to select between two alternatives, one of which represented a fictitious bus service and the other represented the current service. The willingness-to-pay in terms of service quality attributes is a quantitative indicator of the price a user is prepared to pay to enhance certain qualitative service elements, such as traveler comfort and safety. Due to the difficulties of evaluating and quantifying these service features in monetary terms, they are typically overlooked. The project revenues for investments in transportation services may be calculated using WTP values (Eboli, L., Mazzulla, G., 2008).

Public transportation fares need to be reviewed by the government to make people feel comfortable because passengers focus on comfort and the security of the transport mode. In order to determine the community's willingness to pay for switching from private to public transportation, research is required. (Permata, M.,2012) claims that the willingness to pay strategy uses consumer views of public transportation service prices, which take into account the amount and quality of transportation services, as well as user utilities and consumer income.

The public transportation users initially express their disapproval of the overall service quality changes until they are encouraged to take into account other factors that, at first, they were unaware of and which, in turn, have a significant impact on their assessment of the overall service quality (Dellolio,L., Ibeas,A., & Cecın, P., 2010). Finally, it will have an impact on how transportation preferences are used.

When using WTP and ATP (Ability to Pay) in Korat city, Thailand, passengers were given the option to select either the present mode or a high-quality bus (new public transport). A light rail or air-conditioned bus operating on a designated lane was briefly described to responders as the new method of transportation. The study used the Stated Preference tests to examine decision-making. It had three characteristics, including waiting time, in-vehicle travel expenses, and

journey time. The qualities were chosen based on an expected route taken to get from one place to another. It was shown that most travellers are willing to spend more money than they can afford. This is due to the fact that the ATP in this study is calculated using the current household's travel expenses on their current modes of transportation. They could be prepared to spend extra when given excellent service. However, this would raise all of their household's costs, which is likely to be an issue for those with low incomes (Jaensirisak,S., Luathep, P., and Paksarsawan,S.,2017).

In conclusion, the previous studies depend on the stated preference survey to measure WTP and ATP with different methods. One used multinomial and mixed logit models; others used the household budget method that was derived from the overall transportation allocation for public transportation from monthly income per total distance of travel for a month, as well as from the operational cost analysis and also from the purchasing power (Ansusanto,J., Christianto,A.,2018). Due to the lack of such data, this study relied on the WTP for Cairo's BRT, which is scheduled to begin operations in 2023, by applying the van Westendorp Pricing Model to data collected via face-to-face survey.

3. Methodology

Primary data was collected at the site where the route runs and stops are constructed, by doing the interview at the ring road where the route and stops for BRT will be constructed. The interview took place between February 23 - 26, 2022. The questionnaire covered economic and social characteristics, using the ring road generally and current means of transportation, travel patterns, and an analysis of the willingness and ability to pay of BRT users.

This study depended on primary data and was conducted in Cairo, which has a population of 10 million people. Analyze a minimum of 100 respondents using the *Slovin* formula, where N is the total population of Cairo and e is the error rate (10%).

$$S = \frac{N}{1+N(e)^2} = 100 \text{ respondents.}$$

By interviewing 250 passengers on Mwaslat Masr Buses, one of the competitive transportation means on the ring road. Then, coding the data used *Triangular Likert Scale* method that depends on putting weights on every question.

The van Westendorp Pricing Model, developed in 1976 by Dutch economist Peter van Westendorp, is a technique for determining how much customers value a service or good. This method also referred to as the Price Sensitivity Meter (PSM), assesses a variety of price points. The technique specifically aims to pinpoint the price at which consumer interest starts to decline. It is also employed by marketers who want to assess the effects of price adjustments or determine how customers perceive their prices in comparison to those of their rivals. **(**Westendorp, V., 1976).

Participants in the Van Westendorp study are questioned about what price point they consider the good or service to be a deal. Likewise, at what price do you believe the good or service is overpriced? And they can either provide open-ended replies or be given a pricing scale that represents both extremes of the price spectrum by marketers. Each question's responses are displayed on a graph known as a price map.

Through the Optimum Price Point (OPP) and the Indifference Price Point (IPP), the intersection of specific data points provides marketers with information about the respondent's opinion of price value. When an equal proportion of participants judge a price as either "too expensive" or "too cheap," this intersection is known as the OPP.

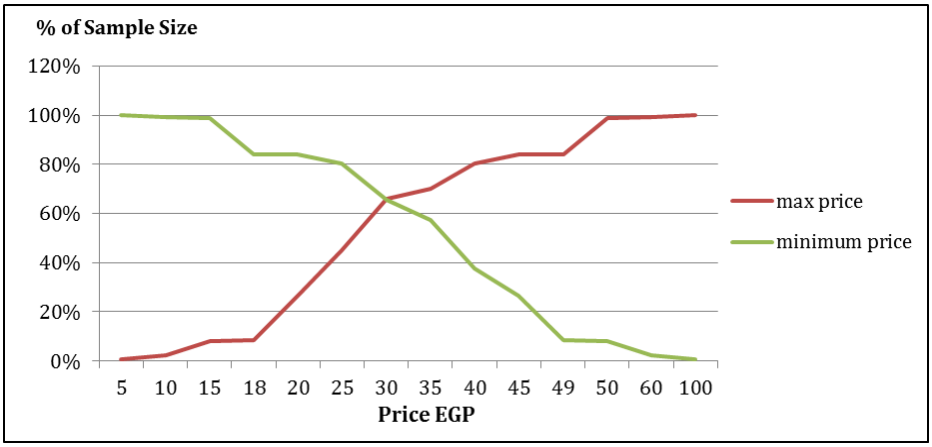
4. Results and discussion

One of the most significant obstacles any marketer must overcome is determining the price approach for a good or service. Pricing strategy has a more direct impact on bottom line profitability than other marketing mix components.

Based on the survey of ring road users, especially the questions related to willingness to pay to reduce the journey time and the question about ticket price that make them cancel the trip, and using the van Westendorp pricing rule, it is suggested that the optimum ticket price for BRT on the ring road is 30 EGP, as shown in Figure 1.

To compare the average willingness to pay on the ring road with the price that is needed to cover the marginal cost and the price that is needed to break even (cover both operation and maintenance costs), data was collected on the cost of operation and maintenance from the ministry of transport, which includes the following:

- Service Operation.
- Bus maintenance and the bus depot.
- Bus washing and refueling.
- Pre-operational activities.
- Facilities management: security and station cleaning, terminals, warehouses, and technical maintenance of the warehouse.



Source: Authors depend on survey data

Figure 1 BRT Respondent's Perception of Price-Value chart

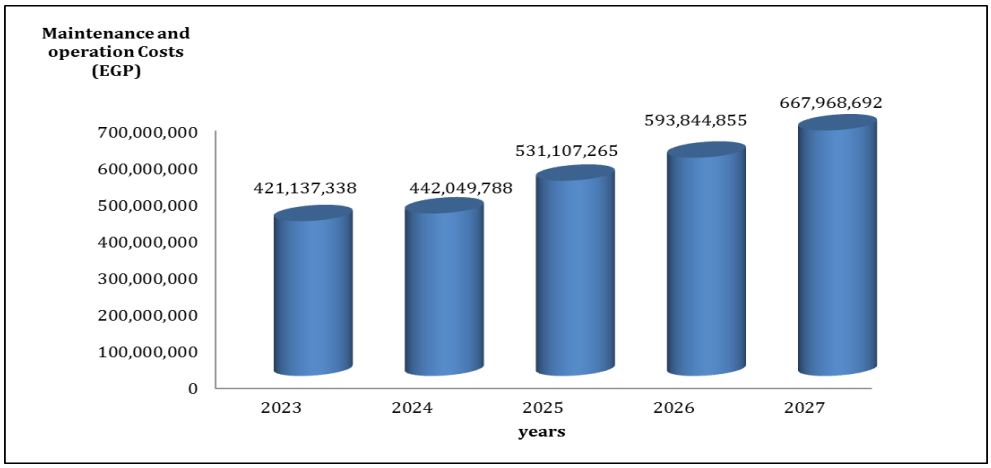
With respect to construction cost, available data estimates the cost of construction of 19 stations as shown in Table 1 (Ministry of Transportation, 2022).

Table 1 Capital Cost of BRT

Station	Estimated Cost (EGP)
Suez	85,520,787.94
10 Of Ramadan Station	39169258.07
Marg 1	36196961.07
Mustard	43175181.07
Alexandria Agricultural	46029431.07
Police Academy	27310233.6
Almushir	83439910.4
Bahteem	37497983.91
Cairo Festival	27470852.79
Alqalaj	42541685.07
Zakat Foundation	42540185.07
General Ibrahim El Orabi	42540685.07
Shubra Banha	42539585.07
Al-Saqali	42541385.07
Trolley	43610385.07
Rashah Alkhusus	43610385.07
Mintaa	43610385.07
Total	769,345,280.48

Source: Ministry of Transportation.

The total construction cost of the stations amounts to 769,345,280.48 EGP, which was divided over five years. The cost of maintenance and operation is 421,137,338 EGP, with a 5% increase every year, as illustrated in Figure 2.



Source: Ministry of Transportation.

Figure 2 Maintenance and operation costs of BRT stations

The minimum price for a BRT ticket is 43 pounds in the case of covering the cost of operation and maintenance and 124 pounds in the case of covering the total cost. The optimum ticket price for BRT on the ring road was found to be 30 EGP.

4.1. The effect of income and journey frequency on Willingness to Pay

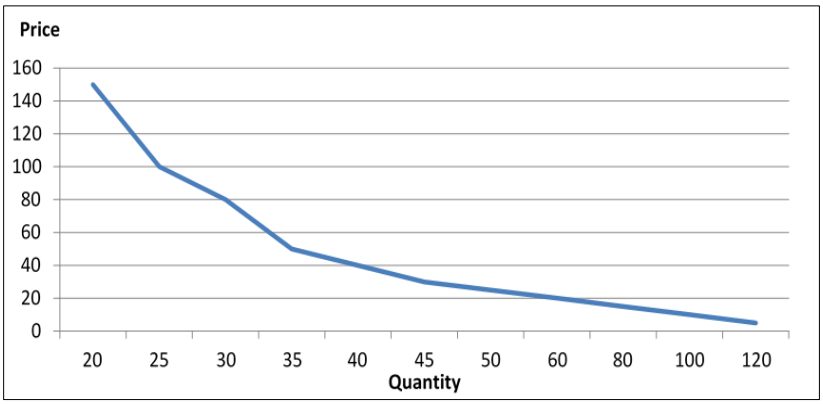
Correlation tests indicated a strong correlation between income and willingness to pay. Furthermore, there is a negative relation between journey frequency and WTP, as the number of passenger journeys increase; they are less willing to pay a higher fare for their journey as illustrated Table2.

Table 2 Correlations

		Income	**Trip Frequency**
Willingness to Pay	Pearson Correlation	0.72287	-0.20633
	Sig.(2-tailed)	.	0.000
	N	250	250

** Correlation is Significant at the 0.01 level (2-tailed); Source: Authors depend on survey data.

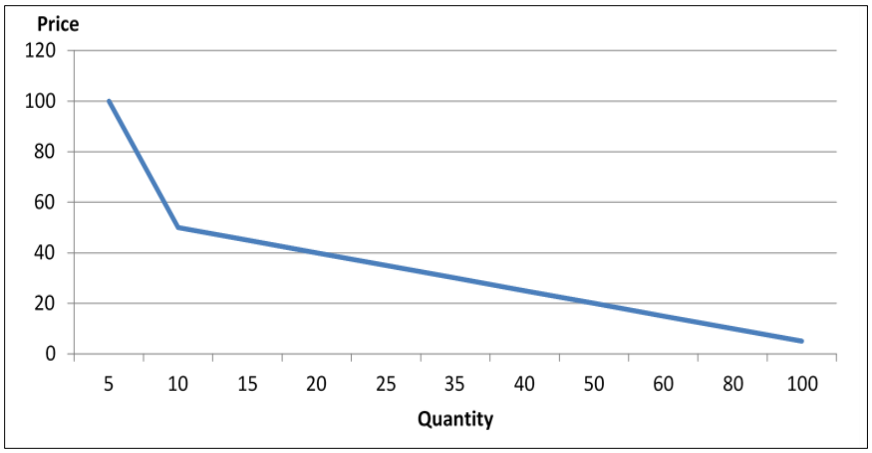
4.2. Effect of WTP on Revenue



Source: Authors depend on survey data

Figure 3 Current Demand Curve

The total current revenue is 9705 EGP for the sample size of 250 passengers, while the expected total revenue based on the WTP approach is 13554 EGP (see figures 3 and 4). This indicates an increase in revenue of 40% and an average fare of 0.1539 EGP per passenger km.



Source: Authors depend on survey data.

Figure 4 Expected Demand Curve

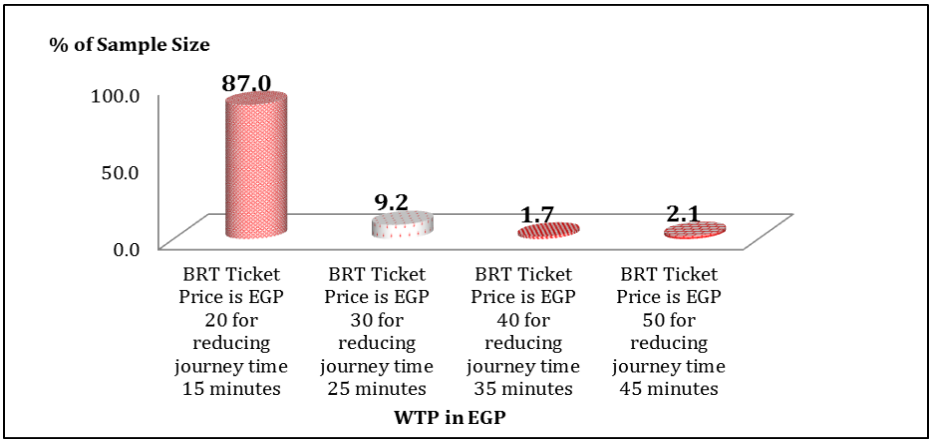
4.3. Effect of WTP on level of service

According to the study sample, trip characteristics were ranked Where 17% of the passengers indicated that reducing trip time is the most important level of service and this motivates them to use BRT buses, 13% believe that the presence of private car parking is the second most important trip characteristic to encourage using BRT buses, followed by reducing the waiting time of the transport mode and the availability of suitable waiting places (stations) by 11% for each, then the ticket price by 10%, and the availability of complementary transportation services by 9%. This rank explains the reason behind passengers' WTP being higher for reducing the waiting time of the transport mode.

Estimation of the importance of various levels of service variables passengers traveling on the ring road rank levels of service variables as follows:

4.3.1. Journey Time

The Value of Travel Time (VTT) is the amount of money spent to save 1 minute of journey time. The advantages brought about by shorter travel times are referred to as the Value of Travel Time Savings (VTTS).



Source: Authors depend on survey data

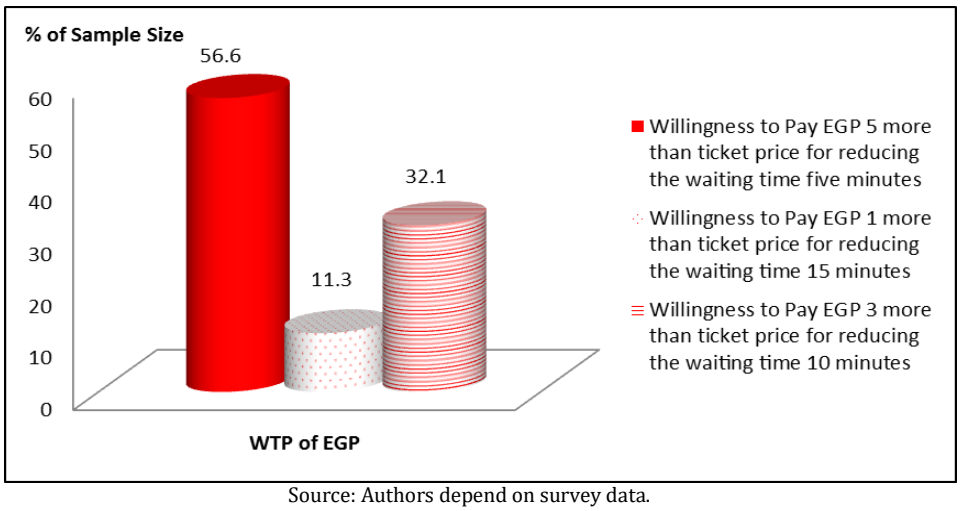
Figure 5 Willingness to pay for proposed reduction journey time

Mobility considerations include distance, speed, and travel time. For instance, quicker travel speeds can either shorten travel times or enable individuals to cover greater distances in a given amount of time. Higher speeds typically result in longer travel distances rather than time savings over the long haul since consumers typically retain set travel time budgets (Victoria Transport Policy Institute, 2022).

Research demonstrates that the values of journey time vary according to socioeconomic classes and modes of transportation. The difference is also most likely caused by (1) different estimation techniques, (2) values that have risen over time (as a result of rising income and congestion levels), and (3) distinct SP experiments with varying study objectives, options available, characteristics included, and attribute levels. This comes after a lengthy discussion on how the technique of selecting affects time values (Jaensirisak, S., Luathep, P., and Paksarsawan, S., 2017). Figure 5 shows that 87% of the sample is willing to pay 20 EGP for a 15-minute reduction in travel time, and 9.2% is willing to pay 30 EGP for a 25-minute reduction in travel time.

4.3.2. Waiting Time

Figure 6 shows that 56.6% of the sample is willing to pay 5 EGP more than the ticket price for reducing the waiting time by five minutes, and 32.1% are willing to pay 3 EGP more than the ticket price for reducing the waiting time by 10 minutes.



Source: Authors depend on survey data.

Figure 6 Willingness to pay for proposed reduction in trip and waiting time

4.4. Comparison between different BRT systems

It is possible to make a comparison between different Bus Rapid Transit systems in the world, as shown in the following section. For these cost and ticket price comparisons on scientific grounds between various countries, the authors calculated the inflation rate in each country because the BRT system was established in a different year by using World Bank statistics to standardize the base year to 2021.

The BRT system in Cairo is one of the longest, as shown in Figure 7. It is the sixth system in terms of length. The longest BRT system is in the city of Jakarta, Indonesia, followed by the city of Mexico, and the shortest BRT system is located in Gothenburg, Sweden. Figure 8 exhibits that the highest capital cost for BRT systems is in Castellón, Spain, followed by Cleveland, United States of America, and the lowest capital cost for BRT systems is in New York City.

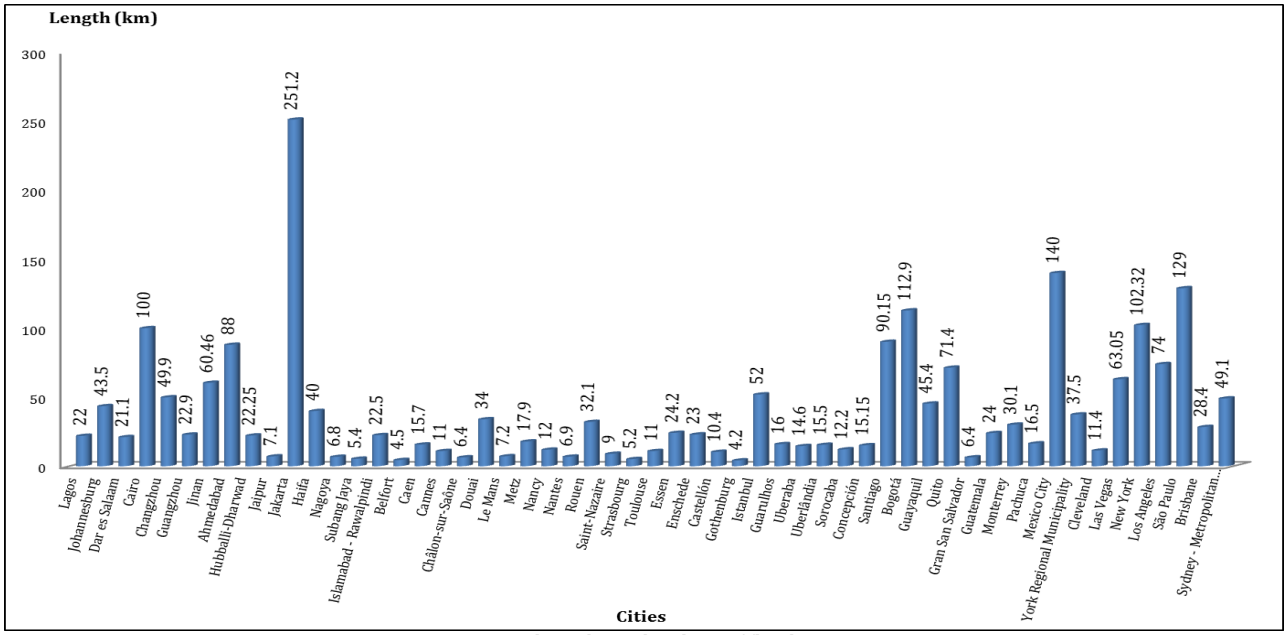


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Figure 7 Length of BRT systems according to different cities

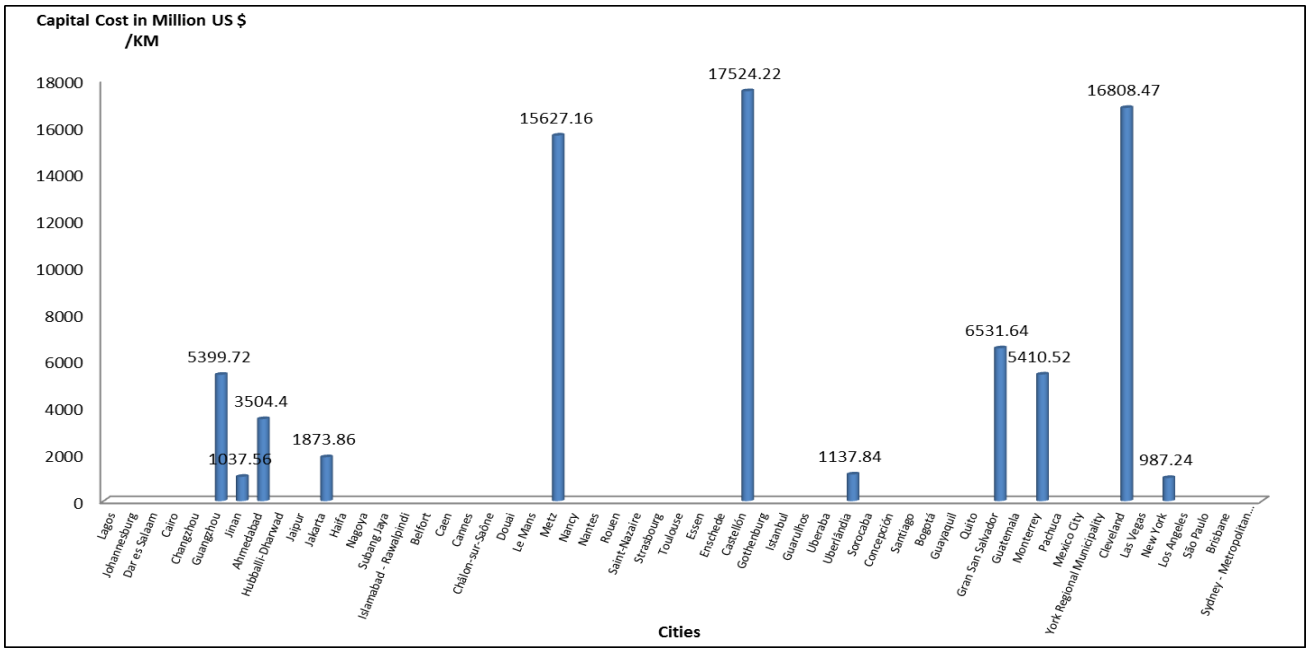

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Figure 8 Capital Cost of BRT systems according to different cities

Figure 9 shows that the highest total cost of BRT systems is in Brisbane, Australia, followed by Caen in France, and the lowest is Sorocaba, followed by Uberlândia in Brazil, and the BRT system in New York City. Figure 10 illustrates the proposed tariff in Egypt, which considered the average tariff for the BRT system, where the ride tariff in Egypt is 2.7$, while the highest tariff is 6.83$ in Las Vegas in the United States of America, followed by Brisbane in Australia at 5.52$. The lowest tariff system is 0.16$ in Guatemala.

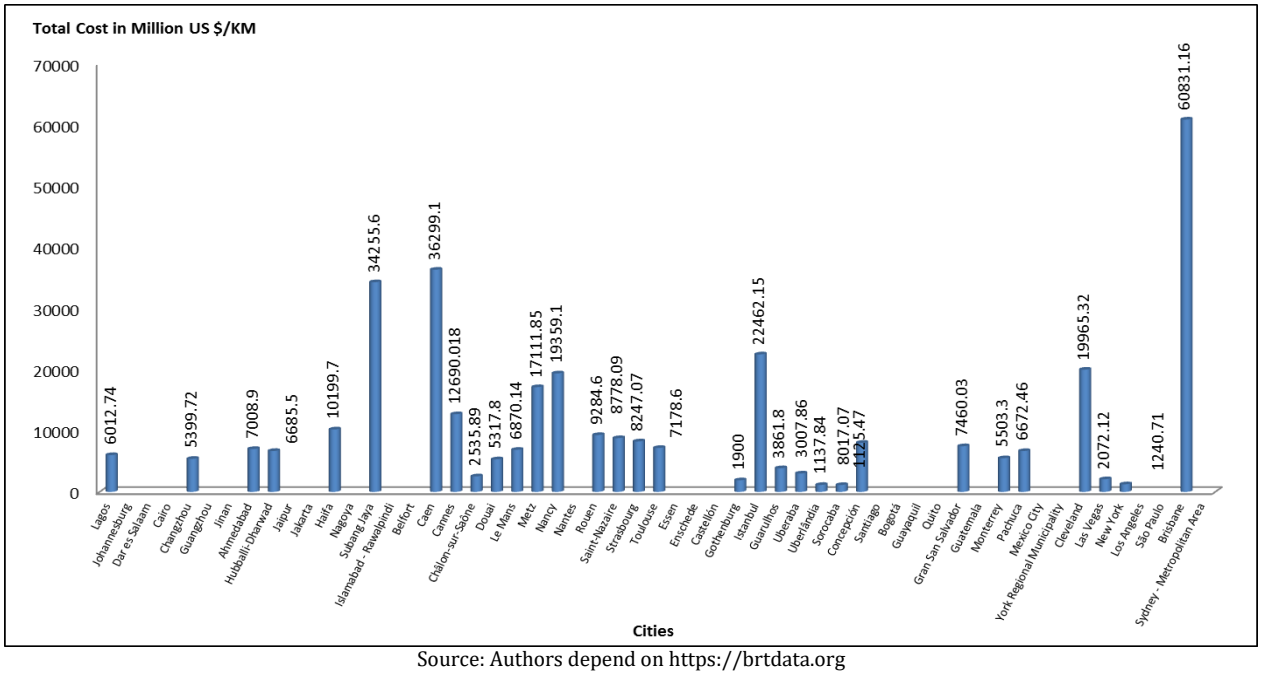

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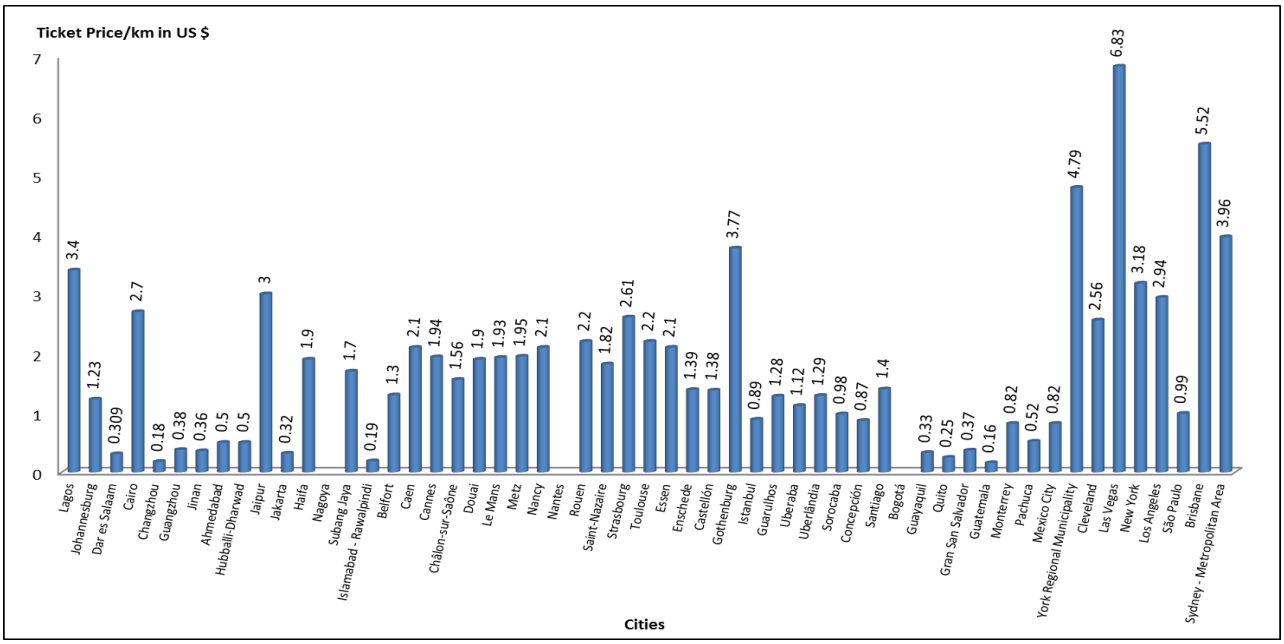
Figure 9 Total Cost of BRT systems according to different cities



Source: Authors depend on https://brtdata.org

Figure 10 Ticket Price of BRT systems according to different cities

5. Conclusion

The BRT system in Cairo is among the longest systems in the world. It is the sixth system in terms of length. The establishment of BRT can increase the percentage of public transportation users, especially when connected with park and ride facilities. Upon applying the Van Westendorp pricing rule, it was found that the optimum ticket price is 30 EGP for the proposed BRT facility. This has the potential to increase the ministry of transportation's revenues by 40% on the ring road, keeping in consideration the importance of applying a graduated fare on the ring road, where the greater the distance, the higher the assigned fare. With regards to trip characteristics, the study shows that passengers prefer reducing trip time, the presence of private car parking facilities, and reducing the waiting time of the transport mode. 56.6% are willing to pay 5 EGP more than the ticket price for reducing the waiting time by five minutes, followed by the

ticket price and the availability of complementary transportation services, respectively. The study concluded that there is 87% willingness to pay 20 EGP for reducing journey time by 15 minutes and 9.2% willingness to pay 30 EGP for reducing journey time by 25 minutes of the total journey time, which is 60 minutes on average.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of informed consent

Informed consent was obtained from all participants in survey that data will be used for the purpose of research.

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