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Evaluating Perceived Travel Time and Travel Time Reliability in the Transit System of Tehran (Case Study: The First BRT Line)

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ABSTRACT: Crowding in public transportation in Tehran is a convenient problem, especially in the pick hours. Transferring in a crowded transit vehicle makes passengers feel discomfort during their trips. Another important thing is the idea of time which is a subjective issue which means that passengers experience their travel times differently in a specific time interval. The literature has confirmed this issue, so the idea of "perceived travel time" has been introduced for many years. It implies that a passenger travelling by a congested public transport vehicle feels like the time is passing slower compared to those who are traveling in uncongested vehicles. The idea of perceived travel time has led some researchers to the concept of "perceived travel time reliability". This paper is aimed at demonstrating the necessity of paying attention to these two concepts for the public transport system in Tehran. For this purpose, the first line of the BRT system of Tehran has been considered as a case study. Using Automated Fare Collection (AFC) and Automatic Vehicle Location (AVL) data in a pick hour of a work day back in the autumn of 2019 and before spreading the coronavirus, the perceived travel time and perceived travel time reliability are calculated. The results show that there is a significant difference between perceived and nominal. The differences show the necessity of reconsidering the analysis of public transport systems using the nominal travel time and travel time reliability. In fact, it seems that using the perceived will be more helpful and telling as well.

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1- Introduction

Depending on the situation, public transport users' travel time experiences may differ. Therefore, the concept of Perceived Travel Time has been introduced in the literature [1]. Based on [2] for a journey with waiting and in-vehicle travel times, the perceived travel time can be calculated using equation (1):

$$T^p = \beta^w T^w + \sum_{m=1}^{M} \beta_m^{sit} T_m^{sit} + \beta_m^{std} T_m^{std} \quad (1)$$

Where T is nominal waiting and in-vehicle travel times, m is the crowding level and βs are time coefficients. Also, travel time reliability is an essential parameter of decisions for both users and providers of public transport [3]. A reliability buffer time (RBT) measures travel time reliability by subtracting 50% of travel time from 90 or 95% of travel time. The Experienced Service Reliability Gap (ESRG) is based on the concept of RBT and takes into account perceived travel times instead of nominal ones [1]. ESRG has never been the focus of Iranian researchers, to the best of the author's knowledge. As a result, this paper seeks to achieve the following goals using the Automated Fare Collection (AFC) and Automatic Vehicle Location (AVL) data of the first line of Bus Rapid Transit (BRT) in Tehran:

- Calculating perceived travel time and comparing it with nominal travel time;
- Calculating the ESRG and comparing it with RBT.

2- Methodology

The calculations were made for December 1st in 2019, which is a workday in Iran. The data used in this study relate to the morning peak hour (7 a.m. to 8 a.m.) on the first BRT line in Tehran, which is the busiest BRT line in the city. The line connects the west and east parts of Tehran. The AFC data was preprocessed prior to estimating the travel times. It was not necessary to preprocess the AVL data since there were no missing values, anomalies, etc. Using the trip chain method, the destination of each transaction was estimated [4]. There were still some one-transaction trips for which the trip chain could not be applied. To estimate the destinations of these trips, they were distributed among different ODs based on the percentage of trips made by that particular OD

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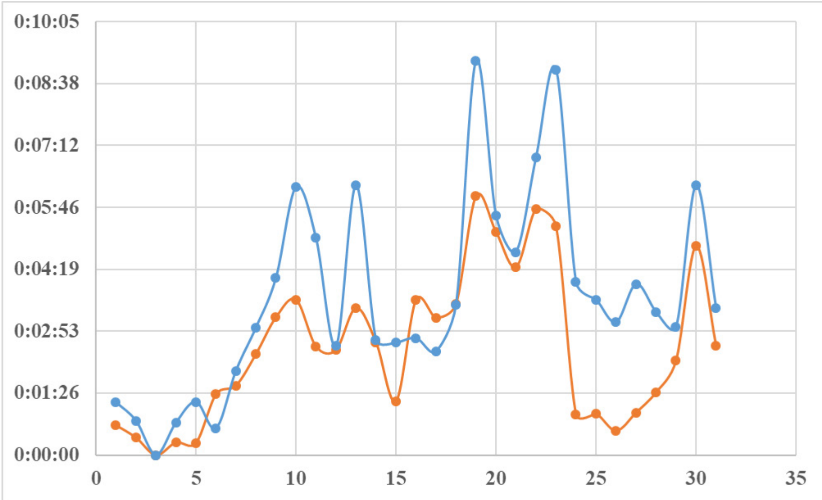

Fig. 1. Plotting ESRG (blue) and RBT (Orange) in 31 2-minute time windows

as determined by the trip chain method. It is necessary to determine the precise time at which each passenger enters the origin-destination in the next step. As the AFC system of Tehran provides time in one-hour intervals, it is impossible to determine the exact time. The exact time at which passengers are to be boarded in the buses with a precision of seconds is required since the precision of the AVL data is in seconds. For each stop, an assumption is made that there is a steady flow of passengers during each hour. As an example, if 7200 transactions take place at stop 1 between 7 a.m. and 8 a.m., then 2 (7200 passengers/3600 seconds) passengers enter the stop every second. Considering that the capacity of each bus is 150 passengers, based on [5], the in-vehicle time coefficients for each passenger in each block should be determined. According to [5] if a passenger has a seat and less than 50 percent of seats are occupied, then the time coefficient is 1, if more than 50 percent of the seats are occupied, then the time coefficient is 1.22, if the passenger stands and less than 50 percent of the standing capacity is occupied, the coefficient is 2.19, and finally if the passenger stands and more than 50% of the standing capacity is occupied, the coefficient is 3.01. The time coefficient for waiting time is considered to be 2 according to [1]. The westbound of the line was considered in this study. In total, 4445 nominal and perceived travel times were calculated.

3- Discussions and Results

The results of the study show that the difference between perceived and nominal travel times can reach up to 50 minutes for some passengers. The calculations were made for passengers whose origin and destination stops were 12 to 18 stops apart. Additionally, the average travel time for each block traveled (stop-to-stop) was calculated. The results indicate that the difference between perceived and nominal travel times per block is sometimes greater than bus headways. After that, both RBTs and ESRGs were calculated for 2-minute time interval windows. There is a visual representation of these two measures in figure1.

Figure 1 illustrates that in most time windows, ESRG is greater than RBT. There is a distinction between perceived and nominal travel times, as well as between the ESRG and RBT, which suggests that when it comes to both travel times and reliability, it is important to consider perceived ones.

4- Conclusions

This paper compares perceived and nominal travel times and reliability of travel times on the first BRT line of Tehran during weekdays and morning peak hours (7 a.m. to 8 a.m.) in the westbound direction. As should be noted, the data pertain to December 1st, 2019 when the COVID-19 pandemic had not yet occurred in Iran and the situation was actually normal. It has been found that in some cases the difference between perceived and nominal travel times reaches up to 50 minutes, and in some cases, on average the difference per block is greater than the bus headways. This paper's results and calculations indicate that for planning purposes and other areas of transportation related to public transportation, perceived times can be used instead of nominal times for studies and projects.

As part of future research, it is recommended that the perceived travel times and reliability for multi-modal public transportation journeys be calculated and compared. Also, to the best of the authors' knowledge, there are no time coefficients for the transfer time in multimodal public transportation journeys; therefore, obtaining this coefficient in places where it is necessary to transfer from one mode of public transportation to another may be helpful. Another suggestion would be to compare the ESRG before and after the COVID-19 pandemic.

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