International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

How Fatigue affect Public Transport Perception of Users?

Mahmut Esad Ergin

Istanbul Commerce University, Logistics Management, Istanbul, TURKIYE
meergin[at]ticaret.edu.tr

Abstract: ***One of the most vital components of daily life is transportation. As traffic congestion increases, the waiting time in traffic also increases. While this condition impacts both private automobile users and public transportation passengers, it also decreases travel satisfaction. The quality of the city's amenities has a direct impact on people' urban perceptions and, as a result, their quality of life. The binary logit model was used to investigate the effects of long trip times due to traffic congestion on users, how they evaluate fatigue during long trips, how they perceive the existing public transportation system within the context of fatigue, and how much they are willing to pay for a better public transportation system so that they will be less tired. Finally, the likelihood of switching to a new mode increases as the consumers' trip times grow. As people' ages rise, so does their need for a more pleasant and secure trip. Furthermore, female commuters demand better public transit more than male commuters.***

Keywords: Fatigue, Public transport performance, Quality of service, Perception

1. Introduction

Transportation is one of the most important aspects of daily living. The need for transportation is growing every day as a result of natural population expansion, migration from rural to urban regions, and economic and technological developments. When an increase in travel demand exceeds the capacity of current urban infrastructure, issues such as public transit vehicle congestion and traffic jams emerge. The metropolitan area, according to Rodrigue (2020), is the most active zone for passenger and freight transit. Because of the fast urbanization in many parts of the world, passenger and freight transportation inside cities has increased. Urban mobility is shaped by the technology that evolves on a daily basis.

Traffic congestion can be broadly divided into two groups. Koźlak and Wach (2018) classified congestion into two groups as recurrent (regular) congestion and non-recurrent congestion. Non-recurrent congestion refers to unpredictable events that cause a temporary increase in travel demand or a decrease in the capacity of a road segment as a result of everyday routine traffic. Recurrent congestion, on the other hand, refers to predictable events that cause an increase in travel demand and the usage of a road exceeds its capacity at a specific location and for a specific duration as a result of everyday routine traffic.

As traffic congestion increases, the waiting time in traffic also increases. While this situation affects even private vehicle users, it also reduces the travel satisfaction of public transport users. Especially for metropolitan cities, traffic management is a necessity; if traffic is not adequately controlled, traffic jams develop, affecting the city's quality of service. Quality of facilities served in the city directly affect on the urban perception of the residents and in the end quality of life of the residents.

When traffic congestion worsens, the negative impact of transportation-related impacts on public health worsens (Requia et al.2018; WHO, 2005), as does the population's exposure to air pollution (WHO, 2005) and other potential health problems related with the noise, stress, safety, and fatigue.

In this study, the effects of long trip times due to traffic congestion on users, how they evaluate the fatigue during long travels, how they perceive the existing public transportation system within the scope of fatigue and how much they can pay for a better public transportation system so that they will get less tired were investigated using the binary logit model. Thus, expectations of the users for the faster and more comfortable public transportation service, and what improvements should be made in the service quality at first are analyzed by this study.

In the next part of the study, firstly, previous studies will be mentioned. In the studies, it will be revealed how the perception of the public transport system is measured and what kind of results are obtained. In the following section, the methodology of the modeling study used in the study will be explained, and then information about the study area and data will be presented. Then, each variable used in the model will be interpreted by giving the model results. In the last part of the study, the whole study will be discussed and concluded.

2. Literature Review

Many developed cities are suffering increased traffic congestion. There is a rising awareness that public transportation networks must be created in order to provide a viable travel alternative (Curtis and Scheurer, 2015). This viable alternative should be affordable, reliable, and comfort. In other words, this alternative mode should attract new users and present private vehicle users. At this point, the perfomrance of the public transport system should be analyzed. There are ten different types of performance indicators defined in TCRP Report 88 (TCRP, 2003). The performance measures are:

- Availability
- Service delivery
- Community

- Travel time
- Safety and security
- Maintenance and construction
- Economic
- Capacity
- Paratransit
- Comfort

Public transport services should meet the expectations of the users in terms of the indicators above. Some of the indicators can be measured easily such as travel time, economic (travel cost), capacity, etc. However, some of them cannot be measured easily such as safety, comfort, feeling secure, etc. On the other hand, the public transport service quality is matters for users and the quality of the system is up to the perception of the users.

The quality of the public transportation system may be assessed by scoring service factors such as punctuality, system network size, line connections, and service frequency, and this scoring can also be asked of users over the public transportation system in general (Del Castillo ve Benitez, 2012). Another research found that public transport users considered the variables of waiting time, cleanliness and comfort the most important. They placed less value on variables such as driver courtesy, crowding, and travel time (Dell'Olio, vd., 2011). In the transportation mode selection, not only the criteria that can be measured, but also different factors that cannot be measured easily but perceived by the users play an important role.

Tiznado-Aitken et al. (2021) studied on public transport level of service by establishing scores for level of public transport service in terms of travel speed, space within vehicle, share of dedicated rights-of-way, type of road, type of transit stop, density within vehicle, puntuality, headway. In another study, Barabino et al. (2020) assessed the sustainability level of public transport and its quality within the framework of the defined measures such as accessibility, information, time, attention given to passengers, comfort, safety and security, etc.

As it is seen that comfort is one of the common indicator that effects the perception of users of the public trasnport service quality. Comfort is strongly related with the travel time, the distance between transfer points, available seats, driver behavior, etc. Comfort is also associated with user fatigue. What ever effects on comfort, it also effects on user fatigue. Especially for commuters, a comfortable public transportation system is essential in order not to start a new working day tired or not to get tired on the road after a tiring working day.

3. Study Area and Data Analysis

Istanbul is one of the world's most crowded cities (Ergin, 2021) before the pandemic. According to traffic congestion values from TomTom's historical database for 2019, Istanbul is ranked 9th out of 416 cities (Tomtom, 2021). When compared to a free flow (uncongested) condition, Istanbul's average congestion level is 53%, implying a 53% increase in overall travel times. One of the main ideas, in order to cope with such great traffic congestion, is encouraging people to choose public transport instead of private vehicle.

A survey study was planned to analyze how the public transportation system is perceived by the users in terms of private vehicle users and new users preferring the public transportation system and thus managing the congested traffic in Istanbul. In this case, four mostly preferred district of the Istanbul is selected and 175 surveys are conducted with face to face method. The questionnaire consists of two parts: revealed preferences part and stated preferences part. The distribution of the surveys are given below in Table 1.

Table 1: Number of surveys by selected districts

Name of the district	Number of survey
Sisli	42
Besiktas	48
Kadikoy	48
Uskudar	37
Total	175

The selected districts also come to the fore as the intersections of the Istanbul transportation system. In particular, except for Sisli, the rest of the districts have a seaway connection, and they are one of the first and last points of bus lines. Sisli and Kadikoydistricts are also strongly connected to the transportation system by the metrobus line which is highly preferred BRT system and carry approximately 1 million passenger in a day for both direction in 2021.

The questions on the participants' socioeconomic status, gender, age, and income level were asked initially in the survey. In order to analyze the perceptions of private car users and public transportation users of the public transportation system were measured as part of the study. Fort his purpose, the respondents were asked to score their travel on a scale of 1 to 5 in terms of fatigue. The scoring scale indicates 1-very awful, 2-bad, 3-moderate, 4-good, 5-very good.

The average age of those conducted survey is 29.7 years old. Moreover, 33% of the people surveyed are female and 33% are married. Furthermore, the average household size was 3.09 people which is very close with the value stated in the Istanbul Transportation Master Plan (IUAP) 2006 Report that is 3.53. According to the survey analysis, 31% of respondents are unemployed, but 50% of them are homeowners, and 45% possess a private car. The average monthly household income, according to the survey is 5, 300 Turkish Liras.

4. Methodology

Mode selection models in transportation are one of the important pillars of transportation planning studies. These models, in addition to providing clues about the behavior of individuals using the current system, can also be used in studies such as forecasting and scenario analysis for the future. The mode selection is made under probabilities among the choice set. Ortuzar and Willumsen (2011) stated that the probability of choosing one of the given alternatives individually is a function that varies depending on the socio-economic characteristics of the individuals and the characteristics of the options. Moreover, Lancaster (1966) pointed out that while modeling transportation mode selection, the assumption is made that the user will try to maximize their utility or minimize their harm. However, alternatives do not produce untility. Utility is derived from characteristics of options and/or socio-economic characteristics of individuals. Which brings us to define the utility. In travel demand modelling studies, the users' utilities are defined by a function and this function is called the utility function. The utility function is usually a linearly expressed function which is written as Equaiton [1].

$$U = V + \varepsilon \quad (1)$$

In equation above, the U represents utility, the V part refers to the quantities that can be measured by observation such as age, travel time, travel cost, income, etc. This part constitutes the determining components of the model and is the part that the model can explain. On the other hand, ε is an alternative-specific error term. This section describes features that are not easy or possible to measure or observe, but have an impact on mode selection. This part is random part and also called as stochastic part of the model. It includes variables such as the person's perception, comfort and convenience. This part is based on the Random Utility Theory. According to Domencich and Mc Fadden (1975) and Williams (1977), the Random Utility Theory is the basis of the discrete mode choice model. In this case, the model result does not express certainty and it is assumed that people choose a mode within a probability. The distribution of error terms determines the model to be built. If the error terms are assumed to be normally distributed, the probit model is applied, and if it is assumed to have a Gumbel distribution, then the logit model is can bu chosen. In this study, it was decided to apply the logit model with the assumption of Gumbel-distributed error terms.

If the choice set consists of two alternatives, the binomial logit model is used and is not different from the multinomial logit model. That is, there are Alternative 1 and Alternative 2 in the choice set. According to this situation, the probability of choosing Alternative 1 is formulated as Equation 2.

$$P_r(1) = \frac{1}{1 + e^{(V_2 - V_1)}} \quad (2)$$

P_r (1) represents the probability of being chosen for alternative 1. On the other hand, V_1 and V_2 represent the deterministic parts of alternative 1 and alternative 2, respectively. As it can easily be deduced that the probability of being chosen of Alternative 1 depends on the increase on the deterministic part of alternative 1, and/or decrease on the deterministic part of alternative 2 (Horowitz et al, 1986).

5. Modelling and Results

According to the survey data, survey participants stated that they do not want to pay extra money for a more comfortable transportation service and this rate is 37.7% on average. In the survey, no definite amount was asked to the people and the users themselves determined the maximum amount of payment they could pay. Considering the distribution of the maximum additional payments they can pay for a better public transport system according to the answers given, it is observed that the specified additional payments are concentrated around 1 TL, 2 TL and 5 TL. These rates are 11%, 16% and 9%, respectively. The remaining approximately 26% of the answers is distributed to intermediate values. For these reasons, the dummy variables are determined as 1 TL, 2 TL and 5 TL as the monetary amounts that users can give in addition to the current transportation cost for better public transportation system service conditions. While obtaining the model data, it has been examined whether each individual will stay in the current mode or switch to the fictitious mode according to the price they specify against the accepted extra payment amounts. In the modeling study, a binary logit model was established, and it was investigated whether people would switch to the fictitious mode over the values they were willing to give. In addition, it has been tried to explain which independent variables play a more active role in the selection of modes by the model.

Variables used in the model:

- Socio-economic variables such as income, age, gender and marital status. Here, income is not defined as a stand-alone variable, the ratio of travel cost over income is taken into account. It is considered as the most reasonable way for the comparison of the allocated extra payment of the respondents.
- The travelis tried to be defined in the model by using the variables of travel cost, travel time and private vehicle use.
- Users' perceptions are also included in the model as an average (AVG) variable. The AVG variable takes a value of 1 if people score the current public transport system more than 3 in terms of fatigue, and 0 otherwise.
- Finally, the additional payment variable is used in the model. This variable expresses the maximum additional payment that people can give for a public transport system that will tire them less.

6. Results

In modelling study, only one model is established which represents that whether the current mode user shift to the fictitious mode or not. The model is linear regression that the dependent variable is fictitious mode and independent variables are metioned above. The model is predicted for private vehicle user group, public transport system user group and the overall sample. The result of the model is represented in Table 2 below.

Table 2: The results of the models

	Overall Sample		Private Car Users		Public Transport Users	
Variables	Coefficient	t-stat.	Coefficient	t-stat.	Coefficient	t-stat.
Travel time	0.016	4.063 (a)	0.019	2.260 (a)	0.021	3.951 (a)
Travel cost/Income	3.015	0.554	17.669	1.250	-2.788	-0.407
Additional payment	-0.458	-7.237 (a)	-0.198	-1.789 (b)	-0.600	-7.230 (a)
Age	0.024	1.736 (b)	0.056	2.205 (a)	0.018	0.907
Gender	0.138	0.622	-1.118	-2.059 (a)	0.456	1.739 (b)
Marriage status	-0.368	-1.254	0.116	0.220	-0.651	-1.689 (b)
Private car usage	0.465	1.802 (b)	-	-	-	-
Home – Work trips	-0.041	-0.181	-0.125	-0.264	-0.216	-0.764
Average score	-1.056	-3.716 (a)	-1.196	-2.455 (a)	-1.127	-3.136 (a)
Constant	-0.702	-1.516	-1.606	-1.518	-0.359	-0.633
No. of observations	525		138		387	
LL ()	301.157		83.270		207.280	
LL (M)	356.321		95.596		258.836	
-2LL	110.328		24.651		103.113	
ρ^2	0.155		0.129		0.199	

(a) *significant at 95% (1, 960),*
(b) *significant at 90% (1, 645), significant are written in* ***bold.***

According to the model results, the longer travel time, the more likely all users are to switch to the fictitutiosmode. Travel time is statistically significant for each user at the 95% confidence interval. It is predicted that the travel cost/income variable is not statistically significant for any of the user group. Additional Payment is statistically significant in the 95% confidence interval for the overall sample and public transport users, and at the 90% confidence interval for private vehicle users. The higher the value that users tend to pay more for reducing fatigue, the more likely they tend to stay with the current mode. The age variable has no statistical significance for public transport users. It is statistically significant at the 95% confidence interval for private vehicle users and at the 90% confidence interval for the sample in general. Moreover, it is estiamted that as the age of private vehicle users increases, the probability of shifting to the fictitutiosmode also increases. Although the gender variable is not significant for the overall sample, it is statistically significant in the 95% confidence interval for private vehicle users and 90% confidence interval for public transport users. As a result, malesthose who use private vehicle are more likely to stay with the current mode and for public transport users to switch to the new mode. Marriage status was statistically significant only for public transport users at the 90% confidence interval. The increase in the use of private vehicles by private vehicle users increases the probabilities of users to switch to a fictitutiousmode. This situation can be evaluated as an indicator of the fatigue that caused by the long travel time on the road users in the present traffic conditions. Finally, as the AVG (Average score) increases, users tend to stay with the currentmode.

7. Discussion and Conclusion

Within the scope of the study, in summary, as the travel times of the users increase, the probability of switching to a new mode increases. As the ages of the users increase, their desire to have a more comfortable and safe trip emerges. Female users want to get improved public transportation service more than male users. First of all, a quality public transportation system should be offered for individuals who have no choice but to use public transportation and to attract private vehicle users to the public transportation system in order to have a well-managed traffic condition. Possible improvements can be reflected in ticket prices. However, the amount of the increase in the ticket price can be determined by the same method that is used in this study. In order to reduce the fatigue of the passengers during the travel, the transfer points should be close to each other, the walking distance should be at a minimum level and transfer points should be planned accordingly. In addition, it will not be expected for private vehicle users to shift to a crowded public transportation system where there is no available seat. As a result, an affordable and high quality public transportation system should be offered by local authority fort he sake of the people in the city in terms of quality of life.

References

[1] Barabino, B., Cabras, N. A., Conversano, C., and Olivo, A. (2020). An integrated approach to select key quality indicators in transit services. Soc. Indic. Res, 149, 1045–1080.

[2] Curtis, C., and Scheurer, J. (2015). Performance Measures for Public Transport Accessibility: Learning from International Practice, Journal of Transport and Landuse, 10 (1). https: //doi. org/10.5198/jtlu.2015.683

[3] Del Castillo, J. M. ve Benitez, F. G. (2012). "A methodology for modeling and identifying users satisfaction issues in public transport systems based on users surveys", Procedia-Social and Behavioral Sciences, 54, 1104-1114.

[4] Dell'Olio, L., Ibeas, A. veCecin, P. (2011). "The quality of service desired by public transport user", Transport Policy, 18, Sf.217-227.

[5] Domencich, T. A. ve McFadden, D. (1975). "Urban travel demand: A behavioral analysis", North-Holland Publishing Company.

[6] Horowitz, J. L., Koppelman, F. S. veLerman, S. R. (1986). "A self – instructing course in disaggregate mode choice modelling", Washington, Federal Transit Administration.

[7] Lancaster, K. J. (1966). "A new approach to consumer theory", Journal of Political Economy, 14 (2), 132-57.

[8] Ortuzar, J. D. veWillumsen, L. G. (2011). "Modelling transport: 4th Edition", ISBN: 9781119993315. BirleşikKrallık. John Wiley & Sons, Ltd.

[9] Requia, W. J. Higgins, C. D., Adams, M. D., Mohamed, M., and Koutrakis, P. (2018). The health impacts of weekday traffic: A health risk assessment of PM2.5 emissions during congested periods. *Environment International, 111*, 164-176.

[10] Rodrigue, J. (2020). *The Geography of Transport Systems*. Routledge, New York. ISBN 978-0-367-36463-2.

[11] Tiznado-Aitken, I., Muñoz, J. C., and Hurtubia, R. (2021). Public transport accessibility accounting for level of service and competition for urban opportunities: An equity analysis for education in Santiago de Chile. J. Transp. Geography, 90, 102919.

[12] Tomtom. (2021). Traffic Index Report. Accessed date: 10.04.2021. https: //www.tomtom. com/en_gb/trafficindex/

[13] Transit Cooperative Research Program (TCRP) Report 88. (2003). A Guidebook for Developing a Transit Performance-Measurement System, Transportation Research Board, Washington, D. C.

[14] Williams, H. C. W. L. (1977). "On the formation of travel demand models and economic evaluation measures of user benefit", Environment and Planning A, 9 (3), 285-344.

[15] World Health Organization (WHO). (2005). *World Health Organization, Health effects of transport-related air pollution: Summary for policy-makers.* WHO Regional Office for Europe, Copenhagen, Denmark.