Evaluating Social and Economic Benefits of Public Transport Access: Evidence from Tehran, Iran

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Abstract
Public transportation Provision requires substantial organizational efforts, careful planning, financial contributions from the public, and coordination between millions of passengers and staff members in an extensive system. Efficient resource allocation is critical in its daily operations. Therefore, Public transport has been among the most popular subjects in transport economics since the infancy of this discipline. Proximity to public transport infrastructure increases the access of neighborhood residents. More access to public transportation allows residents of these areas to have more access to jobs and not be restricted in choosing jobs due to lack of access. So they can select higher-paying jobs, even if they are a long distance away. Therefore, demand for residence in the high access areas is more. This study evaluates the benefits of public transport based on residents' demand results.
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1-Introduction

The impact of access to public transportation on the quality of life and income of residents in different parts of the city is not hidden from anyone(Khodabandelu, Choi, et al., 2020). However, the severity of this effect varies in different regions(Arabi et al., 2015). Public transportation is one of the most popular modes of transportation due to lower fares and costs(Alimohammadirokni et al., 2021)(Mahmoudi, 2022).Therefore, it is necessary to ensure equity in access to public transport infrastructure when planning existing lines and stations(Ashrafi et al., 2019). It is necessary to determine what effect access to public transport infrastructure will have on residents' incomes(Mohaghegh& Valipour, 2020)(Mohaghegh & Valipour, 2021).Also, sometimes greater access to public transportation in an area will increase the demand and price of residential land(KHARAZMİ & JAHANGARD, 2020)(KHARAZMİ & JAHANGARD, 2020). This study has attempted to investigate this relationship and determine the correlation between these parameters(Norouzi et al., 2021)(Faghihinejad, 2021).

2-Literature review

Pricing decisions in public transit have welfare implications in absolute terms and distributional results. Social equity in transit pricing is usually a salient consideration of policymakers and public servants, with a more considerable relevance than the economic efficiency of the offered reform in several cases(Quinet, 2005), to the point that distributional issues can be an argument not to implement marginal cost pricing in public transport(Khodabandelu, Park, et al., 2020)(Shirkhanloo et al., 2021). Despite the relevance of social equity considerations, the distributional consequences of alternative pricing decisions are often overlooked in theoretical

models of optimal pricing models, either due to methodological complexness or because disparities in distributional consequences are considered not so relevant(Aghajanian et al., 2021). deletion of an equity analysis might have harmful consequences for the primary source of methodological difficulties is that complete distributional analyses need, User heterogeneity in the model and a general equilibrium approach(Nasr et al., 2021)(Park et al., 2018). Even if a model features multiple income levels, there is no direct way to assign operating costs to individual users of together served public transportation markets. There is a clear distinction between the average and marginal operating cost of a trip due to scale economies and cost inter-dependencies(Basso et al., 2011).

The average public transport subsidy per person is very similar foe all income groups except for the highest income quantile(Sobhan Nazari, Fereshteh Faghihinejad, 2012)(Mahmoudi & Ghaneei, 2022), concluding that subsides are not effective as a redistribution policy in Stockholm, where public transport is more uniformly used across income groups than in Barcelona and Santiago. Many equity analyses are driven by the spatial distribution of low and high-income households in cities. If lower income households are predominantly located in the outskirts, they experience the longest travel distances in public transport. This makes distance-based pricing rules unattractive from an equity point of view, despite their superiority in terms of economic efficiency. Due to differences in urban spatial structure, fares are shown as more equalitarian in Santiago(Linke et al., n.d.)

(fereshteh faghihinejad, 2022)Tried to model the relationship between rail access and economic growth. (Fereshteh Faghihinejad, 2013)provide a framework to evaluate the relationship between all modes of the transportation networks and the economic development of the regions(Shirkhanloo, n.d.).

Based on the literature review, regions' access to public transportation infrastructure prepare some benefits for habitats, such as access to jobs and income. Also, the access to employment causes increasing the residence demand of that region. This study evaluates the correlation of public transportation access and economic growth(income) of residents and the correlation between public transportation access and residence land price. In this research Tehran is selected as a case study.

3- Methodology

To achieve the aim of this study, first the access of the regions to public transportation should be calculate. The access of regions to public transportation is calculated by concept of connectivity power(Ricciardi et al., 2015)(Mishra et al., 2012a)(Foth et al., 2013)(Alizadeh et al., 2020).

The benefits obtained from public transport are accessibility and mobility. In this study, to combine these two indices, the connectivity power index has been used. The station is the bridge linking the citizens and the public transit system. Accordingly, (Mishra et al., 2012a)(Faghihinejad, 2022) defined the concept of input and output power for every station and each passing line. The amount of connectivity power in every station involves the quality of the public transportation services in that station, including the fleet volume, frequency, line capacity, and average speed. The values of input power $P_{l.n}^{i}$ and output power $P_{l.n}^{o}$ of station n resulting from connection to line L are obtained according to Equations 1 and 2, respectively(Mishra et al., 2012b).

$$P_{l.n}^{i} = \alpha * C_l * f_l * H_l * D_{l.n}^{i} * V_l \quad (1)$$

$$P_{l.n}^{o} = \alpha * C_l * f_l * H_l * D_{l.n}^{o} * V_l \quad (2)$$

In these equations, C_l represents every vehicle's capacity, f_l is the frequency, H_l shows the hours of providing services throughout 24 hours, V_l indicates the line speed, $D_{l.n}^{o}$ and $D_{l.n}^{i}$ denote the distance up to the last station in the first station of the line, respectively. Coefficient α is equal to the inverse multiplication of the urban average of power relation variables. It has been included for standardizing and non-dimensionalizing the power in the

equation. The connectivity power of every station for each $P_{l.n}^{t}$line is equal to its average input and output power(Mishra et al., 2012b).

$$P_{l.n}^{t} = (P_{l.n}^{i} + P_{l.n}^{o})/2 \quad (3)$$

Every station's total power is equal to the sum of the power of lines passing through it.

$$P_{n}^{t} = \sum_{l.n \in l} P_{l.n}^{t} \quad (4)$$

After defining regions' access, the average income of regions and residential land prices should be collected. Finally, the correlation between these parameters can be calculated by SPSS software. A case study is done to use this methodology, and the results are presented in the next part.

4- Case study

Tehran is a case study of this research, and data of public transportation stations, lines of BRT, and metro are collected for three recent years(Fereshteh Faghihinejad, 2018). The average access of regions to public transportation is presented in Table 1. Also, data of citizens' income and residence land prices in different regions is collected for three recent years. The access of regions to public transportation is calculated by concept of connectivity power. Average income of residents in Tehran regions are collected for the recent three years (from the statistic office). The residents land price and population during the recent three years is collected too. This data is presented in table 1.

Region number	Access	Employment rate	Resident land price	population
1	1,317,389	88	689087	487,000
2	165,870	86	498220	701,000
3	85,573	88	649711	330,000
4	54,333	88	337257	919,000
5	150,112	87	376231	856,000
6	316,270	87	460440	251,000
7	189,330	89	285376	312,000
8	307,664	88	282895	425,000
9	17,335	87	227908	174,000
10	117,786	88	206052	117,000
11	433,787	90	216890	289,000
12	34,943	92	182222	240,000
13	39,346	88	299024	276,000
14	217,952	90	228807	512,000
15	370,998	91	164846	625,000
16	137,580	89	164249	288,000
17	20,388	90	163126	278,000
18	0	90	150315	420,000
19	0	90	180970	275,000
20	38,833	90	157831	423,000
21	0	86	225554	185,000
22	0	86	296463	141,000

Table1. Public transportation access and statistical data of Tehran city

Table 2. Correlation of public transport access and employment rate

		Public transportation access	Employment rate
Public transportation access	Pearson Correlation	1	0.000
	Sig. (2-tailed)		0.999
	N	22	22

The Sig parameter is a criterion for determining the significance level of the obtained results. If the significance level is very low, the correlation is considerable, and the two variables are linearly dependent(Abar et al., 2017)(Khodabandelu & Park, 2021). On the other hand, if this value is relatively large, then the correlation is not significant, and the two variables are not linearly interdependent(Tavana et al., 2021)(Gujarati, 2009).

Based on the results obtained from analyzing the correlation of public transport access of regions with the parameters of average employment rate, it is found that since the sig value in them is more than 0.05; thus the relationship is insignificant. So, there is no close relationship between the region's access and employment rate in Tehran city.

The correlation between public transport access and residential land price is evaluated too. The results are presented in Table 3. Based on the results, since the sig value is more than 0.05; thus the relationship is insignificant. So, there is no close relationship between the region's access and employment rate in Tehran city.

The correlation between Public transportation access and population is equal to 0.496, considering the sig that is 0.01 and is less than 0.05 in this table, so the results are valued. Therefore, there is a considerable correlation between population and public transport access in Tehran city.

Table 3. Correlation of public transport access and residential land price

		Public transportation access	residential land price
Public transportation access	Pearson Correlation	1	0.396
	Sig. (2-tailed)		0.068
	N	22	22

Table 4. Correlation of public transport access and population

		Public transportation access	Population
Public transportation access	Pearson Correlation	1	0.496
	Sig. (2-tailed)		0.019
	N	22	22

4- Conclusion

Access to public transport infrastructure is always considered an influential parameter on residents' income and employment rate(Karan et al., n.d.). In this study, an evaluation of the correlation between public transport access

and the employment rate in Tehran is done. Results showed that the correlation between the employment rate and public transportation access is not considerable. There is no close relationship between public transportation access and residential land price. But a substantial connection between the population of regions and their access to public transportation is seen. These results can be different in other cities. The method presented in this research is usable for other cities.

5-References

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