

Evaluating the Impacts of Constructing Tehran Mall Trans-Regional Complex on Indicators of Tehran Urban Transportation System

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ABSTRACT

The interaction between urban land uses and the urban transportation system is one of the most critical issues in traffic policy and urban management. In order to investigate how these land uses interact with the transportation system, the construction effects of the “Tehran Mall” trans-regional complex on the general measures of the Tehran transportation system and District 22 were studied based on the 4-step modeling approach. In order to model the travel attraction of this complex, models of mixed trans-regional land uses were calibrated using volume counting and query information. Then, two scenarios were defined for Tehran in the year 1400. The first scenario was the status of the Tehran transportation system in the absence of Tehran Mall, and the second one was its status in the presence of Tehran Mall. After modeling both scenarios in EMME software, a comparison between the two scenarios was performed based on general measures of the transportation system, which include transportation network measures, auto, and public travel demand, air pollution emissions, and fuel consumption. Comparing the results of these two scenarios showed that in the case in which the Tehran Mall was constructed, important measures of the Tehran transportation system were improved. Therefore, it can be concluded that the construction of a trans-regional attractive land use in an area with unsaturated traffic capacity can attract part of the travel demand from other areas and thereby can improve the transportation system while reducing emissions.

KEYWORDS

Trans-regional land uses, Trip attraction model, Air pollution emissions, Sustainable development.

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Introduction

The relationship between factors affecting the increase in trip rates and emissions that are considered as sustainability and environmental issues has significant importance for managers and urban transportation planners. Thus, evaluating the interaction between the transportation system and major transport indicators is crucial. There are many trip-attractive complexes in big cities such as Tehran, which are considered as trans-regional land uses. These land uses have two major specifications. First, they have a greater trip attraction rate than neighbor areas, and second, they possess different patterns of trip attraction, including more trans-regional trips in comparison to other areas. In 2012, Odin et al. [1] studied the rate of trip attraction associated with commercial - recreational complexes. In this study, they used the analysis of the rate of travel to estimate the complexes' rate of trip attraction. For this purpose, six large complexes in Dhaka, India, were surveyed, and it was shown that there was a significant relationship between the available parking spaces, the occupant area, and the number of commercial and recreational units with the trip attraction rate of each complex. George et al. [2] suggested a polynomial regression model in order to estimate the attraction rate of the commercial land uses by factors such as the number of employees and business area. In 2016, the study of Akter et al. [3] demonstrated that the construction of a new commercial-recreational complex has a tangible effect on the travel pattern of people in adjacent areas and traffic parameters of the transportation system. Sabernezhad et al. [4] suggested models for estimating trip attraction of some shopping and healthcare centers in District 22, Tehran. In another study, Esfandi [5] analyzed the trip attraction rate of the Mega-Mall complex in Tehran as trans-regional land use. In 2020, Ismail et al. [6] introduced six trip attraction models according to a survey on three new great shopping centers in the city of Baghdad for large-scale trans-regional land uses. It was found that the large-scale complexes could have a significant impact on the distribution of travel demand in cities.

In order to model the travel attraction of the Mega-Mall complex in this study, models of mixed trans-regional land uses are calibrated using volume counting and query information. Then, two scenarios are defined for Tehran in the year 1400. The first scenario is the status of the Tehran transportation system in the absence of the Tehran Mall, and the second one is its status in the presence of the complex. After modeling both, a comparison between the two scenarios is performed based on general measures of the transportation system, which includes transportation network measures, auto, and public travel demand, air pollution emissions, and

fuel consumption. In this study, four trip attraction models based on the land use type will be introduced. These models will be calibrated by the volume count and query data. These models are a type of gravity models, which means that they include trip destination characteristics as origin ones. The origin characteristics may include socio-economic information such as population or car ownership, and on the other hand, the destination characteristics may include different parameters such as area. In addition, the effects of the construction of new trans-regional land use such as a mall will be investigated by these models in different aspects of transportation and environmental measures.

Methodology

In this research, trip attraction models were presented for each main type of commercial-recreational land uses (hyper, cinema campus, retail shops, and indoor recreational spaces), in which the number of daily trips attracted from the origin zone i to the destination zone j (where the land use is located) was predicted. In order to calibrate the trip attraction models related to trans-regional land use, a number of major trans-regional complexes by unique land use (e.g., commercial-only) were selected for modeling. These complexes include Bakeri Hyperstar (hyper land use), Milad Noor commercial complex (commercial land use), Mellat Cinema campus (cinema and amphitheater land use), and also Wonderland Amusement Park of Tirajeh complex (recreational land use). Then gravity models were constructed using STATA software to predict daily trip attraction to each of the aforementioned trans-regional land use types. Table 1 shows the results of calibrating the models for each type of land uses.

Table 1. Results of calibrating the models for each type of land uses.

Land use	Unit	Model
Hyper	hectare	$T_{ij} = 55.388(d_{ij})^{-0.869} \cdot VP_i \cdot P_i$
Commercial	retails	$T_{ij} = 3.068(d_{ij})^{-0.466} \cdot VP_i \cdot P_i$
Cinema	seats	$T_{ij} = 1.677(d_{ij})^{-0.622} \cdot VP_i \cdot P_i$
Recreational	hectare	$T_{ij} = 0.085(d_{ij})^{-1.353} \cdot VP_i \cdot P_i$

T_{ij} : Number of trips attracted from origin i to destination j ,
 d_{ij} : Air distance from origin i to destination j ,
 VP_i : Car ownership of origin zone i ,
 P_i : Population of origin zone i .

One of the land uses with the trans-regional approach that is under construction in Tehran is the Tehran Mall commercial-recreational complex. In this section, using trans-regional trip attraction models presented in Table 1, the scenario of construction of the Tehran Mall trans-

regional complex for the planning year of 1400 was modeled and analyzed. To model the construction of this land use and investigate its effects on the transportation system, the latest revision of the 4-step transportation model in Tehran [7] (including travel demand prediction and traffic assignment models), implemented in EMME software [8], was used. Two scenarios were defined for Tehran in the year 1400. The first scenario was the status of the Tehran transportation system in the absence of Tehran Mall, and the second one was the status in the presence of Tehran Mall. After modeling both scenarios in EMME software, a comparison between the two scenarios was performed based on the general measures of the transportation system, which include transportation network measures, auto, and public travel demand, air pollution emissions, and fuel consumption.

Discussion and Results

Tables 2 and 3 show the general measures of the transportation network for scenarios 1 and 2 in the city of Tehran and within District 22 (construction site of Tehran Mall), respectively.

Table 2. Measures of the transportation network in Tehran after the construction of the Tehran Mall complex

Measure	Scenario 1	Scenario 2	Percentage of changes
Total origin-destination trips	1690180	1691147	+0.05
Total travel distance (veh-km)	9166966	9242139	+0.82
Total travel time (veh-hr)	459827	454072	-1.27
Average speed (km/hr)	19.6	19.8	+1.02

Table 3. Measures of the transportation network in District 22 after the construction of the Tehran Mall complex

Measure	Scenario 1	Scenario 2	Percentage of changes
Total trip produced (person)	28041	29200	+4.13
Total trip attracted (person)	54013	59222	+9.64
Total travel (veh-km) distance	910772	944651	+3.72
Total travel time (veh-hr)	36723	37441	+1.95
Average speed (km/hr)	24.6	24.3	-1.22

Table 4 also shows the travel demand for public and private transportation for scenarios 1 and 2 in Tehran and District 22.

Table 4. Changes in travel demand by the public and private transportation after the construction of the Tehran Mall complex

Measure	Scenario 1	Scenario 2	Percentage of changes
Public transportation demand in Tehran (person)	440773	442732	+0.44
Private transportation demand in Tehran (person)	1229407	1228415	-0.08
Total walking distance in Tehran (person-km)	742650	749991	+0.98
Private transportation demand in district 22 (person)	10324	11469	+11.09
Public transportation demand in district 22 (person)	32080	30966	-3.47
Total walking distance in district 22 (person-km)	159394	168248	+5.55

Fuel consumption and air pollutants' emissions are the most important factors affecting the environment. Table 5 shows fuel consumption for scenarios 1 and 2 in Tehran.

Table 5. Changes in fossil fuel consumption in Tehran after the construction of the Tehran Mall complex

Measure	Scenario 1	Scenario 2	Percentage of changes
Petrol consumption (lit)	1696011	1678961	-1.00
Gasoline consumption (lit)	164568	165361	+0.26

Table 6 also shows the amount of CO, HC, NO_x emissions for scenarios 1 and 2 in Tehran.

Table 6. Changes in air pollutants' emissions in Tehran after the construction of Tehran Mall

Measure	Scenario 1	Scenario 2	Percentage of changes
CO pollutant production (kg)	611813	607889	-0.64
HC pollutant production (kg)	70344	69601	-1.05
NO _x pollutant production (kg)	11191	11319	+1.13

Conclusions

Comparing the results of these two scenarios shows that if the Tehran Mall complex is constructed, the demand for travel by public transportation will be increased by 0.44% in the whole city of Tehran and 11.09% in District 22. Also, the average speed in the whole network will be increased by 1.02%, and gasoline consumption and CO emissions will be decreased by 1.00% and 0.64%, respectively. These results show that the construction of a trans-regional attractive complex in

an area with unsaturated traffic capacity is able to improve the measures of the urban transportation system by attracting a part of travel demand from other regions.

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