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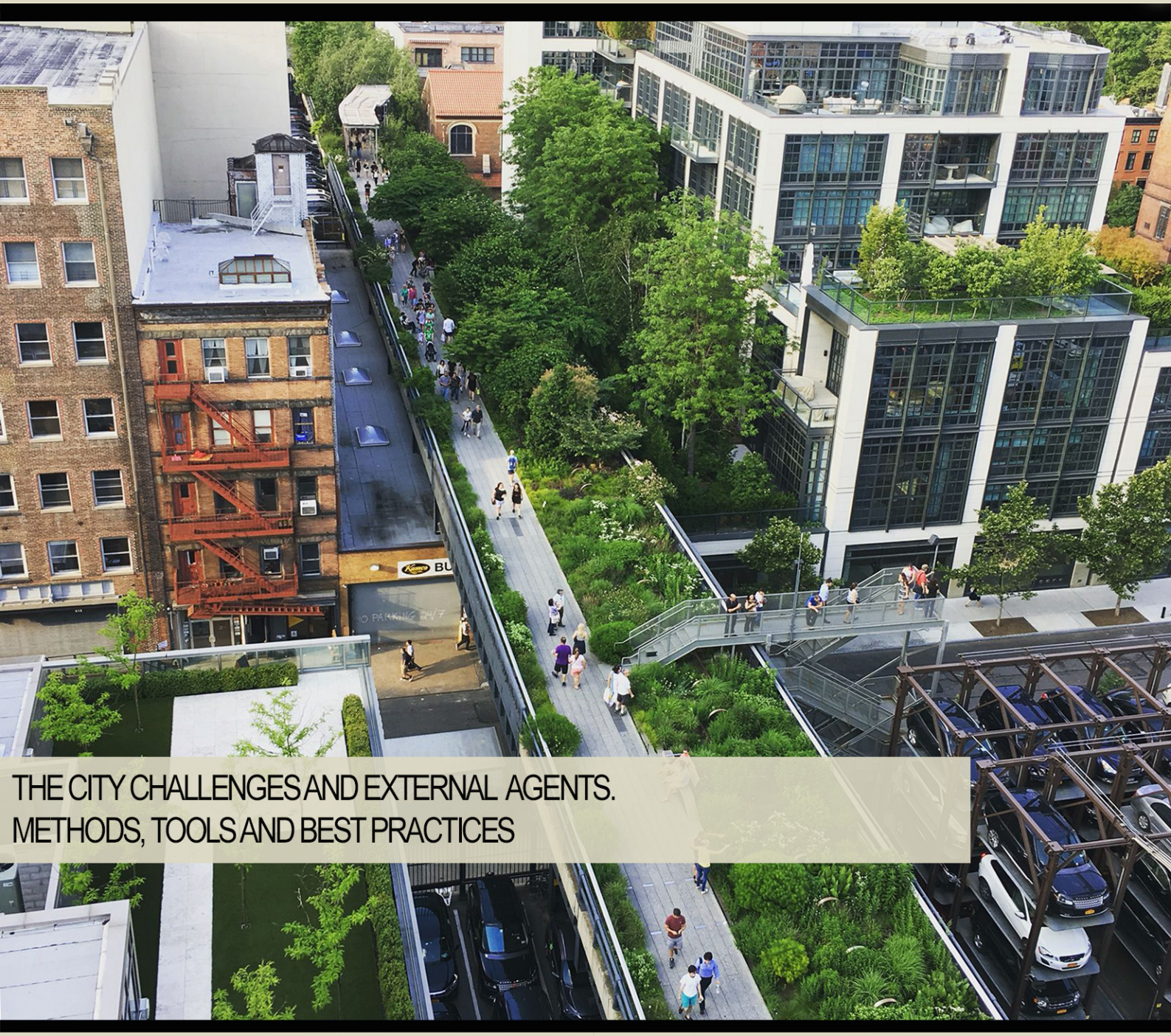

THE CITY CHALLENGES AND EXTERNAL AGENTS. METHODS, TOOLS AND BEST PRACTICES

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Congestion toll pricing and commercial land-use: clients' and vendors' perspective

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Abstract
This study outlines the effects of congestion toll pricing on commercial land-uses (CLUs) through studying the temporary and permanent impacts of client behavior on the CLUs. In the case study of Tehran metropolis, Iran's capital, which has experienced congestion pricing for more than four decades, both clients and vendors' viewpoints were modeled using discrete choice models. Two types of questionnaires were provided to evaluate clients' and vendors' behavior in response to the traffic congestion zone charges. The clients of three businesses, including garments, electronics, and home appliances, were more sensitive to toll price changes. A 20-percent increase in toll prices led to a substantial client loss in the above businesses in the long run due to accessibility decrease in their utility function. Consequently, the vendors preferred to change their approach and sell different goods; then, they gradually tended to migrate outside of the congestion zone.

Keywords
Congestion toll pricing; Commercial land use; Discrete choice models.

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1. Introduction

Urban population growth has created numerous issues in large cities. One of the most prominent of the high number of vehicles on the highways within the central parts of cities has created adverse effects, such as various contamination types, commute disruptions, and public disquiet. Travel demand management (TDM) policies can be adopted to relieve transport systems that suffer from low levels of service (LOS) and mitigate mobility-related issues. Among these policies, congestion pricing is a measure that allows linking road transport externalities directly to travelers producing them (Cipriani et al., 2019). One of the most practical approaches to control travel demand in a particular area or route to reduce congestion and provide additional financial resources is congestion toll pricing (CTP) (Afandizadeh Zargari et al., 2016). In recent years many European cities have introduced congestion toll pricing strategies to control transport demand (Mariano et al., 2011). The social and environmental benefits of toll fees on private vehicles as a shape of the urban traffic management system are considerable and considered an essential sustainable mobility policy (Marins et al., 2014). Therefore, road pricing can be a beneficial tool to control traffic, reduce air pollution, and earn money for urban management organizations. However, the effects of this Travel demand Management (TDM) policy are not limited to the mentioned in the long-term. Economic influences of CTP could be further than the transport system by disturbing workers' spatial allocation (Vandyck & Rutherford, 2018).

In addition to the confident effects, does CTP have adverse effects? Can CTP affect people's daily transactions and change people's purchase behavior? Can congestion toll pricing affect the region's economic activities and change the region's spatial land use? Are these effects the same for all economic activities? How much should the toll cost change to affect the buying behavior of the people of Tehran from this area? To what extent do these preventive policies affect people's buying behavior and business activities? These are the questions that will be answered in this study.

The results from cordon pricing in the Oslo show that the population may tend to live, work, and purchase inside or outside of the cordon in the long run. While some researchers believe that proper pricing leads to more dense and populated cities, others consider congestion pricing as a centrifugal force in urban growth. Neither theoretical studies nor the research on executive actions on the relationship between transport costs and urban development provides convincing evidence to support whether road pricing and congestion have a centralized or decentralized impact (Löchl, 2006). Such studies have shown less importance in choice theory, but transportation plays a fundamental role in choosing an ideal location in both macro and micro approaches. There is a significant concern about the effects on the retail sector regarding any toll on the city's inner cordon because its shape is an essential part of an economy and a livable city. Another critical factor, maybe even the most crucial, is the way of generating revenue. In other words, factors such as assigning and collecting costs from users are among the most critical ones (Evans et al., 2003). Since congestion pricing policy changes the generalized cost in order to define accessibility in terms of network (Guida & Caglioni, 2020).Thus, it is reasonable to examine the effect of pricing on housing and business as a long-term issue shaping urban form.

2. Literature review

In some countries, policies of preventing unnecessary travel to the traffic-congested areas are carried out; however, the traffic flow changes caused by these policies affect the behavior of drivers and other users of the route (or zone) and have significant effects on the spatial dispersion of economic activities (Vandyck & Rutherford, 2018). The backbone of congestion pricing is to change the User Equilibrium (UE) traffic assignment to System Optimum (SO) (Mirzahossein & Zargari, 2018). The literature of this idea and the idea of downtown congestion pricing (DCP) made its first appearance in the minds of British and American academics in the 1950s and has spread to five cities since then: Singapore, London, Stockholm, Milan, and Gothenburg—with most activity occurring since 1997. Today, serious plans are afoot to adopt DCP in a handful of additional cities worldwide (Lehe, 2019).

De Vos' investigation of the effects of congestion pricing shows that road pricing in a multicenter urban area dramatically reduces the distance traveled by car in urban areas, but the use of motorways or highways marginally declines to a limited extent (De Vos, 2016). Additionally, road pricing has a significant impact on the income of people whose revenues depend on their daily travels (Abulibdeh et al., 2018). Road pricing can have a considerable effect on many levels of the hierarchy of behavior: Both short and long-term tactics, such as route choice, travel time, vehicle choice, destination choice, frequency of travel, and travel chains, as well as long-term strategic decisions, such as location choice, vehicle ownership, change in the share of public transport, choosing residence and employment locations, as well as commercial and residential construction (Deakin et al., 1996).

Eliasson and Mattsson vaguely describe the effects of congestion pricing. According to them, the effects also depend on how many complex interactions between different applications and what factors should neutralize the effects of road pricing. Additionally, they believe it is unclear to what extent the impact of reducing traffic density caused by road pricing is likely to be disrupted by the scattered residential location patterns (Eliasson & Mattsson, 2001).

Anas and Xu concluded that a general equilibrium model for calculating the overall result would be that road pricing impacts residential density and employment. However, they admit that their model does not consider cumulative economies that may focus on employment in separate centers (Anas & Xu, 1999). Tilema et al. found out that people generally prefer to pay higher housing costs and take longer travel times to avoid more travel costs (Tillema et al., 2005). Tilma et al. showed the cost of travel (such as toll and fuel) as an essential factor by using multinomial logit (MNL) models and mixed logit (ML). It also showed that the respondents (drivers in their study) are more sensitive to travel costs than higher rent prices. Moreover, travel time plays a smaller role in these decisions (Tillema et al., 2010). Whitehead has shown that the effects of road pricing on business depend on different causal chains used in other cities, depending on city scales and regional competition (Whitehead, 2002).

Zhong and Bushell showed that the impact of road pricing on the Potential of Job Accessibility (PJA) is precisely related to the zone's construction environment. They conclude that a higher number of jobs, better public transport conditions, and better street design with more intersections caused the region is affected by the adverse effects of the toll roads, and vice versa (Zhong et al., 2015).

Using the nested logit model, Eliasson and Mattsson showed that location allocations depend heavily on where the cordon of toll roads lie. However, they concluded that the overall effects of the location are small compared to travel patterns since people try to reduce the cost of pricing by changing their travel time, mode, and cost of travel (Eliasson & Mattsson, 2001).

In another study, Spiekermann et al. concluded that shipping costs had essential effects on travel behavior but had a marginal impact on land use. The reason is that there is considerable potential for the reorganization of housing and workplaces in existing buildings (Spiekermann et al., 2005). Zhong et al. state that higher population density and higher employment, together with better public transport conditions, would negatively impact road pricing in the region, and vice versa (Zhong & Bushell, 2017). While Quddus et al. 2007, who examined several retail stores in London, concluded that no effect on total congestion was achieved; however, there may still be a redistribution of sales from specific regions to other stores in central London (Quddus et al., 2007).

In a study in Trondheim, Tretvik found that 10% of clients changed their buying behavior by changing their purchase to or after the introduction of the cordon pricing (Tretvik, 2003), while the Trondheim Chamber of Commerce the predetermined result has concluded that pricing limits do not have any effect on business.

Daunfeldt et al. show that pricing in Stockholm (still) does not affect the retail revenue for shopping centers or stores in the area. Although, in general, long-term measuring effects (locations) in a cohesive way seem to

be generally complex. For example, economic cycles' domination affects economic and commercial activities (Daunfeldt et al., 2009).

Boussauw, Alert, and Whitlux also argue that pricing in the city's central area will increase urban densities and suburban growth and increase travel distances, thereby increasing the cost of suburban municipalities (Boussauw et al., 2013).

It is not simple to recognize how much experiences and conclusions from one city can be transmitted and generalized to other, as these effects to a large extent depend on the specific characteristics of each city, such as its space composition, the shape and capacity of the network, and the quality of the public transportation. Nevertheless, it is essential to know that in most studies carried out on transport and land use, more attention has been paid to the effect of land use on transportation, and less has been discussed about the effect of transportation on land use (Tillema et al., 2011), especially the behavioral process in these choice phenomena. In particular, when road pricing is coupled with the addition of new road and public transport capacity (Gupta et al., 2006; Löchl, 2006), the impacts of land use from road pricing depend heavily on its schemes, such as pricing schemes (the scope, and range of pricing).

In previous studies, the effects of congestion pricing on people's income and retail sales and relocation have been investigated using available data. Also, the effects of change of residence and change of job as well as people's shopping behavior using choice models have been studied. Most studies have focused on the effect of congestion pricing on driver behavior. But none of the studies have examined the effects of congestion toll pricing on commercials and clients by product type.

This paper investigates the effects of the Tehran congestion toll pricing (CTP) on commercial land uses (CLUs). Additionally, we examine the clients' behavior in these business applications concerning the price increase. This research's structure is as follows; the next section describes our methodology's framework, and the following section describes the data and the scope of the case study. In the fifth section, we analyze the models' results and the probability of CLUs' displacement. In the final section, the conclusion is presented by list numbers. A summary of the literature review can be seen in Tab.1.

No.	Author	Subject	Result
1	Deaken et al. 1996	Transportation Pricing Strategies for California: An Assessment of congestion, Emissions, Energy. And Equity Impacts.	Road pricing has short and long-term effects
2	Anas & Xu 1999	Congestion, land use, and job dispersion: a general equilibrium model	Road pricing impacts residential density and employment. However, their model does not consider cumulative economies that may focus on employment in separate centers.
3	Elisson & matsson 2001	Transport and location effects of road pricing: A simulation approach	A small toll circle causes displacement of households, workplaces, shops, and service centers outside the ring.
4	Whitehead 2002	Regional labor markets, commuting, and the economic impact of road pricing	The effects of road pricing on business depend on different causal chains used in other cities, depending on city scales and regional competition.
5	Tretvik 2003	Urban road pricing in Norway: Public acceptability and travel behavior	Clients changed their buying behavior by changing their purchase to or after the introduction of the cordon pricing.
6	Tillema et al. 2005	Road pricing and (re) location decisions households	People generally prefer to pay higher housing costs and take longer travel times to avoid more travel costs
7	Spiekermann et al. 2005	Spatial scenarios for the eastern Ruhr area	shipping costs had essential effects on travel behavior but had a marginal impact on land use.
8	Löchl 2006	Land use effects of road pricing: Aliterature review	Impacts of land use from road pricing depend heavily on its schemes, such as pricing schemes (the scope, and range of pricing).

No.	Author	Subject	Result
9	Quddus et al. 2007	The impact of the congestion charge on retail: the London experience	No effect on total congestion was achieved.
10	Daontfeldt 2009	Congestion charges and retail revenues: Results from the Stockholm road pricing trial	Pricing in Stockholm (still) does not affect the retail revenue for shopping centers or stores in the area.
11	Tillema et al. 2010	The influence of (toll-related) travel costs in residential location decisions of households: A stated choice approach	Rent price is more effective than travel time.
12	Tillema et al. 2011	Evaluating the effects of urban congestion pricing: geographical accessibility versus social surplus	In most studies, less has been discussed about the effect of transportation on land use.
13	Boussauw et al. 2013	Colouring inside what lines? Interference of the urban growth boundary and the political–administrative border of Brussels.	Pricing in the city's central area will increase urban densities and suburban growth and increase travel distances
14	Zhong et al. 2015	Distinguishing the land use effects of road pricing based on the urban form attributes	Impact of road pricing on the Potential of Job Accessibility (PJA) is precisely related to the zone's construction environment.
15	De Vos 2016	Road pricing in a polycentric urban region: Analysing a pilot project in Belgium	Congestion pricing reduces distance traveled in urban area more than highway.
16	Zhong et al. 2017	Built environment and potential job accessibility effects of road pricing: A spatial econometric perspective	Higher population density and higher employment, together with better public transport conditions, would negatively impact road pricing in the region, and vice versa
17	Mirzahossein & Zargari, 2018	A Combined Model of Congestion Toll Pricing Based on System Optimization with Minimum Toll	Backbone of congestion pricing is to change UE to SO.
18	Vandyck & Rutherford, 2018	Regional labor markets, commuting, and the economic impact of road pricing	These policies effect on spatial dispersion of economic activities.
19	Abulibdeh et al. 2018	Empirical analysis of the implementation of cordon pricing: potential impacts on travel behaviour and policy implications.	Road pricing has significant impact on the income of people whose revenues depend on their daily travels.
20	Lehe 2019	Downtown congestion pricing in practice	Reviews history of the DCP.

Tab.1 Summary of literature reviews

3. Methodology

Fig.1 shows a conceptual model for the presented model in this paper. It shows the relationship between congestion toll pricing and the (re)location choice decision.

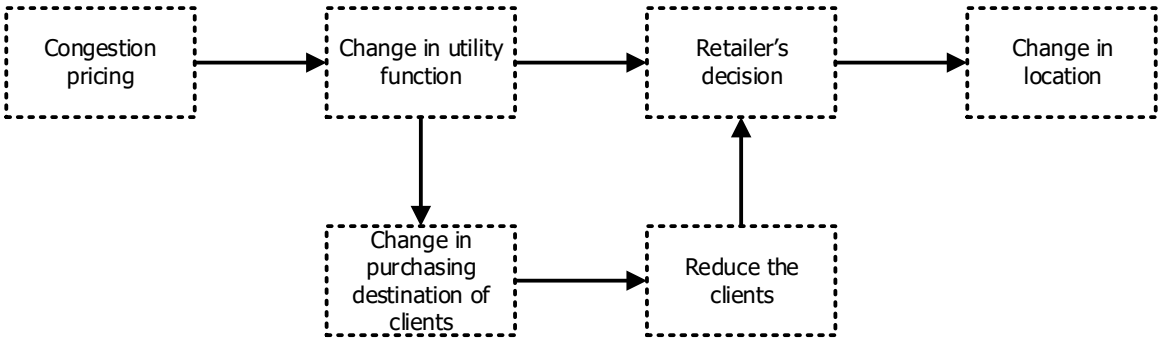

Fig.1 **Congestion toll pricing and commercial (re)location choice process**

The cost of traffic congestion identifies the number of clients attended to these CLUs. Moreover, as shown in Fig.1, to determine the impact of changing the cost of congestion on clients' behavior, this parameter is

considered an active factor in individuals' decisions in their choice process. Some scenarios are simulated by increasing the congestion cost to find the changes in the CLUs within the traffic congestion zone. First, the impact of increased traffic on the changes of the CLUs clients within the traffic congestion range should be measured. A revealed preference (RP) and stated preference (SP) methods are used to do this.

Their reactions to different prices are measured by asking clients about those ranges for different traffic congestion charges. Their decision to buy inside or outside the traffic congestion zone is examined. One of the most prominent advantages of RP is the capacity to show actual circumstances. In contrast, SP's most apparent benefit is the capacity to show individuals' feedback and behavior in a situation that has not yet occurred and simulated for them by the questionnaire. This method is widely used to examine and predict the impact of unfulfilled policies on people's behavior and decisions. Therefore, in this research, using the SP, we set the conditions for price changes as selective options for the respondents to express their decision in choosing these options with the assumption that these conditions are real.

As mentioned, to identify the effects of the traffic congestion zone price on the CLUs, it is necessary first of all to determine the behavior of the clients of these businesses, and then evaluate the results of these CLUs behavior against the changes in the number of clients caused by the traffic congestion charges. Therefore, in this research, two types of questionnaires were needed: one is to show the clients' behavior within the changing traffic congestion zone charges. Another is for vendors' behavior regarding their client's choices. In this study, we use discrete choice models to evaluate clients' behavior and, consequently, sellers' behavior. Discrete choice models describe decision choices among all available options. The underlying assumption of discrete choice models is that when an individual decides, his individual preferences for each option can be expressed in terms of desirability or attractiveness. Therefore, client behavior analysis that chooses between two options for buying inside or outside the traffic congestion zone at different price levels using a binary logit model and analyzing seller behavior in choosing three options; without modification, product change, and shifting beyond the scope of the traffic congestion zone is measured through a logit model. The general form of the logit model is given by equation (1). The probability of choosing the option i (i = 0,1), by the individual n (Pni), assuming the independent and identical Gumbel distribution (IID) for, is the following in the standard logit model.

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_{j=0,1} e^{V_{nj}}} \quad (1)$$

In this structure, any change in the probability of selecting an option or omitting and adding an option has the same effect on the other option. The ratio of the likelihood of choosing each alternative relates to another option independent of different possibilities. Binary logit models are the multinomial logit model that has only two choices.

Considering the second questionnaire (salesperson's behavior questionnaire) is based on the first questionnaire (client behavior questionnaire). Based on the first questionnaire, the CLUs that their clients are sensitive to the traffic congestion zone's price is investigated based on binary logit models. When the price increases, their clients diminish within the traffic congestion zone. The second questionnaire was designed exclusively for this type of CLUs.

4. Location and Data

Tehran is considered a populated metropolis with a long history of traffic congestion charging. Like many other major cities globally, in recent years, problems such as population growth, development of economic and social activities, land-use changes, and urban sprawling have challenged Tehran. The significant issues are the growth and expansion of transportation systems and the accelerated growth of car ownership. Finally, the city's increase in traffic has caused congestion, and reduced travel speed, noise, and air pollution are among other negative consequences.

One of the main strategies to deal with these problems, which has been designed and implemented in different countries for a long time, is creating a traffic congestion zone. According to this plan, entering the city's central areas is exclusive to specific vehicles to prevent congestion. The traffic area of the city of Tehran includes the central part of the city. Besides, major commercial and administrative centers and significant attraction points for daily travel are within the traffic zone marked in red in Fig.2.

At first, we tried to collect actual data about the traffic congestion zone's current condition; however, there was no previous data about Tehran's CLUs. Therefore, we provide the questionnaires to recognize the clients' and vendors' behavior regarding increasing the charges.

Tehran traffic plan is limited from 6:30 am to 7:30 pm. The average cost of entrance tolls for one day during the research is about 12500 Tomans and is constant throughout the day. However, drivers will be fined 20,000 Tomans for each entry and exit if they do not buy a permit to enter the area. No charges are levied on the emergency, military, law enforcement, taxis, and public transport vehicles. The official currency of Iran is rial, but the common unofficial currency in use is toman. For the sake of clarity for questionnaire participants, toman has been used in this article. A dollar is equal to about 4200 tomans at the time this research was conducted in late 2018.

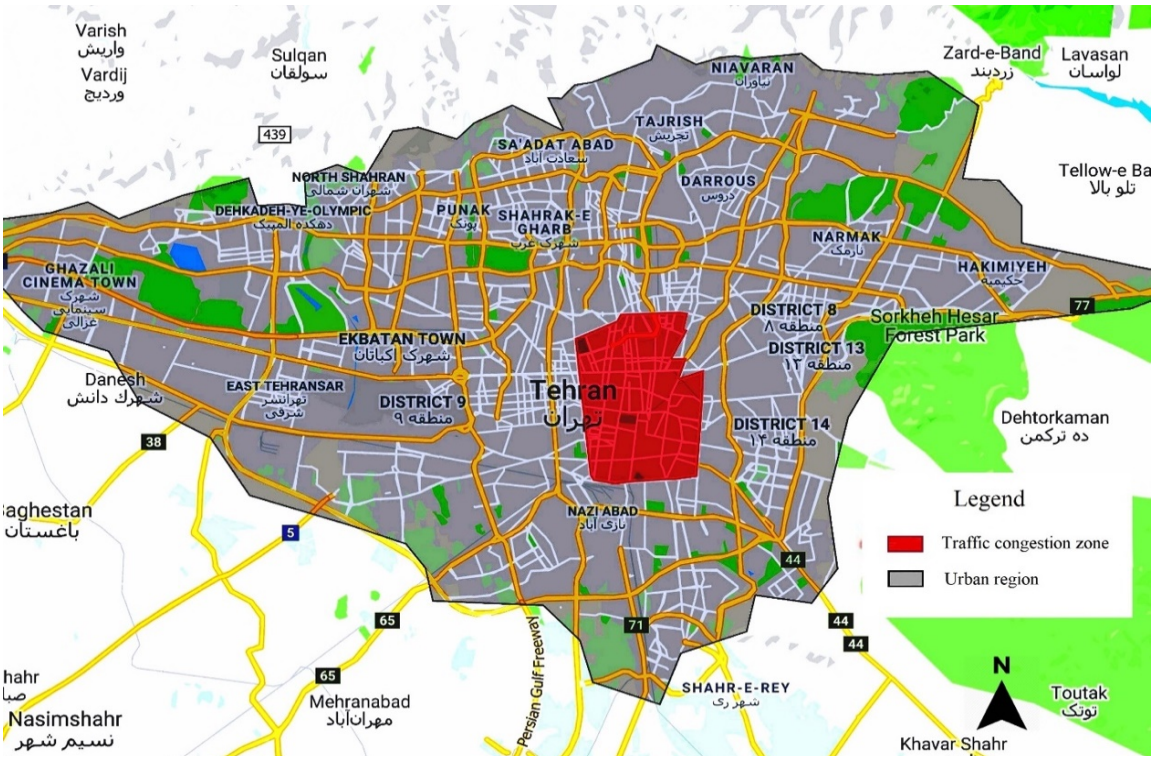

Fig.2. Tehran's map and position of congestion charge range

4.1 Client behavior questionnaire

The design process of this questionnaire lasted from March 21, 2017 to January 17, 2018. This process includes reviewing the characteristics of the area, the type of dominant CLUs, designing a pilot questionnaire, collecting initial information, checking the questionnaire's reliability and validity, and designing the main and final questionnaire. Also, during the process, the received information was evaluated by all relevant organizations and their results were considered in designing the questionnaire. The number of 436 clients' purchasing behavior concerning traffic congestion toll pricing was gathered between 17 January 2018 and 21 March 2018 on workdays, divided into four general sections using both (RP) revealed preferences and (SP) stated preferences. The first section includes the variables, such as the entry of the person by car, the type of entry,

the reason for entry, the frequency and time of entry, as well as purchases in the study period under the actual and prior pricing conditions, which is of the RP type.

The second part is regarding the SP type. It consists of two elements of the travel time perceived by individuals in purchasing in and outside of the zone under non-priced conditions and the choice of purchase for each item under the new pricing scenarios. The third part contains information about the features of and reasons for buying from the traffic congestion zone. Finally, the fourth part includes the individual, economic, and social information of the RP-type individuals. In other words, the toll price variable that is the deciding factor in entering the region, the SP variable, and other variables are used as RP in the logit model. Some RP variables are used as dummy variables and some as continuous and discrete variables in the logit model. In this research, the target community of drivers is those who own a car in their family. Because clients of these CLUs include one of the following:

1 . Those who had entered the area for the purchase of a commodity under former pricing conditions with their vehicle, but under new pricing scenarios decided to; a) do not buy from this area b) change travel mode, or c) continue entering the area with a private car;
2 . Those who did not buy a product from this area, but under new pricing scenarios, may use personal vehicles to enter the area or still do not buy from it;
3 . Those who used other travel modes (excluding private cars) to buy a product from the traffic congestion area and are not sensitive to the charge amount.

This study's remarkable feature is that the use or non-use of a private vehicle to travel to the area to buy a product does not matter and what is significant is to buy a product from the range with any vehicles. When collecting the questionnaire, clients were first asked, "Have they purchased from this area this year?" For trip purposes, they were asked, "What was the main purpose of their travel to this area?" Therefore, this study's target community is anyone who can use a private car to travel to the area to buy a product. The questionnaire has been designed for seven categories of current and best-selling goods in the Tehran traffic area, which are as follows:

1. Clothing, bags, and shoes;
2. Electronic appliances (tablets, mobile phones, laptops);
3. Home appliances (washing machines, meat grinder, TVs, carpets, furniture, chandeliers, and other decorative items);
4. Medicine and medical supplies;
5. Restaurants, fast food, and coffee shops;
6. Books and other cultural, artistic, and academic material;
7. Other goods: Any essential purchased items did not include the six categories above.

Results show that 158 responders from 436 ones entered the congestion zone by private cars. Also, the respondents' replies to the questionnaire under the new pricing scenarios for purchasing any product are 327 clothing stores, 146 electronics, 136 household appliances, 88 medicine, 86 restaurants, 92 books, and 63 other products.

The average age of all people is 36.8 years old. 244 respondents were men with an average age of 38.4 years, while 192 were women with an average age of 34.9 years (44% women and 56% men). Of the 436 participants, 284 were married, and 152 were single (65% married and 35% single).

The average family size was 3.8, while the average number of employed family members was 1.73, with car ownership of 1.247.

4.2 Vendors' questionnaire

As mentioned earlier, to find the relationship between the charging zone and the CLUs, a client questionnaire was first designed. We discovered the sensitivity of the clients of any CLUs to the traffic congestion zone.

Afterward, by modeling the client change, each product category was determined by the charge of the traffic congestion zone. To find the link between client reduction and the CLUs changes, a different questionnaire was needed to discover the relationship between two variables and ultimately to determine the relationship between the charge of the traffic congestion zone and the CLUs' changes. Therefore, another questionnaire was designed to investigate goods sellers' reactions, whose clients are sensitive to the congestion toll and lose their clients. The questionnaire consisted of three main parts.

- The first part related to the store features and the reason for selling within the traffic congestion zone that included questions such as the duration of the store in the traffic congestion zone, the average number of daily clients, the operation hours of the store, the store size, the store ownership status (rental or private), and the reason for selling the products in the congestion zone;
- The second part of the questionnaire, the SP part, contains three choices in three scenarios, with a different client reduction percentage. In other words, the only variable is based on which vendors plan to reduce their client number due to an increase in the traffic congestion toll. Sellers chose one option for each client rate reduction (a) unchanged, (b) change the sales product, and (c) select shutdown or relocate outside the traffic congestion zone;
- The third part of the questionnaire contains the sellers' individual and financial information, including age, gender, education, home address, and vehicle. The questionnaire was designed for three categories of clothing, electronics, and home appliances that were sensitive to the congestion toll pricing in urban traffic network to analyze the results of client purchasing behavior models.

The summary of the questionnaires for these three categories of goods gathered orally is presented in Tab.2.

Type of statistical society characteristics	Clothing	Electronic appliances	Household appliances
Total number of questionnaires	135	66	36
Average on-site history	5 year	10 year	17 year
Daily client average	66 people	37 people	12 people
Average opening hours of stores	9:30	9:15	9:30
Average closing hours of stores	21:20	20:45	20:30
Market share in option selection for 10% client reduction			
Unchanged	91%	91%	100%
Change the goods	4%	9%	0%
Shut down or change location outside of the range	5%	0%	0%
Market share in option selection for 25% client reduction			
Unchanged	51%	59%	59%
Change the goods	33%	27%	8%
Shut down or change location outside of the range	16%	14%	33%
Market share in option selection for 40% client reduction			
Unchanged	33%	41%	42%
Change the goods	9%	14%	33%
Shut down or change location outside of the range	33%	41%	42%
The reason for selling this type of goods in this zone			
More client	38%	32%	42%
Less rent	11%	14%	17%
To be known	64%	68%	58%
Near the house	20%	36%	8%
The zone is the sales center of this kind of goods	44%	82%	58%
Education			
Under diploma	2%	0%	8%
Diploma	27%	35%	42%
Associate	11%	20%	0%

Type of statistical society characteristics	Clothing	Electronic appliances	Household appliances
Bachelor	53%	45%	42%
Master	7%	0%	8%
Doctoral	0%	0%	0%
Other characteristics of stores			
The average age of vendors	30 year	34 year	41 year
Percentage of male sellers	49%	91%	91%
Married	40%	64%	75%
Head of the family	24%	67%	67%
Ownership of the stores	16%	14%	75%
Average stores area (m²)	29%	21%	32%
The average number of family members	3.94 people	3.74 people	4 people
The average number of family members employed	2.06 people	1.7 people	1.58 people
Has another job	9%	18%	8%
Owns a private car	34%	91%	67%
Average car prices (toman*)	18,000,000	32,000,000	48,000,000

* A dollar is equal to about 4200 tomans in 2018

Tab.2 Summary of vendors' questionnaires

5. Client Choice Models

Discrete binary logit models are used to choose the place of purchase items from inside or outside the congestion area. The results of binary logit models for purchasing goods in the traffic congestion zone are shown in Tab.3. For each variable in the Tab.3, the first row is a variable coefficient and the second row is P-value of the variable.

Variable	Clothing	Electronics Appliances	Home Appliances	Medicine	Restaurant	Books	Other goods
Constant	-0.8493 0.0058	-2.5536 0.0000	-1.9397 0.0000	-3.5512 0.0000	-4.238 0.0000	-5.5099 0.0000	-5.0282 0.0000
Price	-0.0645 0.0000	-0.0467 0.0000	-0.0590 0.0000	-	-	-	-
Peak2	1.1163 0.0000	1.3287 0.0000	-	-	1.0765 0.0001	1.1528 0.0000	0.5348 0.0430
Offpeak	1.5287 0.0000	1.3374 0.0000	-	-	1.6149 0.0000	0.9811 0.0234	-
Enter	-	-	-	-	-	-	1.1787 0.0000
Past	0.4805 0.0036	-	-	-	1.3787 0.0000	1.0337 0.0004	2.9514 0.0000
Lesstime	-	1.1181 0.0000	0.9625 0.0088	0.9690 0.0064	-	-	-
Eqtime	-	1.5045 0.0110	1.2167 0.0089	1.1721 0.0091	-	3.0256 0.0004	-
Prefer	-	1.1860 0.0002	-	-	-	-	-
Brand	0.6761 0.0031	-	-	-	-	-	-
Unique	-	-	1.9787 0.0000	1.8759 0.0000	-	1.2007 0.0000	1.5695 0.0007
Morestore	0.6334 0.0000	1.9882 0.0000	0.2804 0.0000	1.7304 0.0000	-	1.9380 0.0000	-

Variable	Clothing	Electronics Appliances	Home Appliances	Medicine	Restaurant	Books	Other goods
Cheap	0.6252 0.0000	-	-	-	1.4298 0.0002	-	-
Lowtime	-	0.5571 0.0398	-	-	-	-	-
Nearwork	-	-	1.2670 0.0001	1.2373 0.0001	1.4917 0.0000	0.9850 0.0020	-
Med	-	-	-	-	-0.9665 0.0004	-	-
Male	-0.5489 0.0037		-0.9351 0.0093	-0.9086 0.0103	-0.9421 0.0128	-0.9920 0.0047	
Low	-	-0.6584 0.0013	-	-	-	-	-
Teacher	1.1658 0.0075	-	-	-	-	-	-
Freejob	0.4697 0.0142	-	1.1698 0.0007	1.1433 0.0007	1.3032 0.0019	1.3824 0.0081	-
Student	-	-	-	-	-	1.5190 0.0007	-
Employee	-	-	-	-	1.1100 0.0015	1.7100 0.0001	-
pastE	-	0.6878 0.0062	1.2147 0.0002	1.1800 0.0002	-	-	-
$LL(\beta)$	-631.35	-352.02	-263.03	-273.92	-263.24	-225.63	-209.99
$LL(0)$	-906.63	-906.63	-906.63	-906.63	-906.63	-906.63	-906.63
$LL(C)$	-780.03	-509.1	-382.33	-382.33	-348.17	-375.18	-295.55
ρ^2	0.303	0.612	0.71	0.697	0.709	0.759	0.768
ρ_c^2	0.19	0.308	0.312	0.283	0.243	0.398	0.289

Tab.3 The results of binary logit models for purchasing goods in the traffic range

In Tab.3, the "Enter" dummy variable equals 1 if the person entered the range using the car in the year 2017 at the time of pricing, otherwise, it is marked with 0. The "past" dummy variable demonstrates if the person bought the product in 2017 with 1 and 0. "Lesstime", "Eqtime" and "prefer" are dummy variables showing (with 1 and 0) respectively if the travel time to the range to buy this product is less than or equal to the outside range and if the person prefers to buy from this range. The "Price" variable indicates the entry fee in the range of 1000 Tomans. The "Offpeak" and "Peak2" dummy variables show that time of congestion is for the evening peak. The "Brand" dummy variable means that the product store has a brand reputation. The "Unique" dummy variable shows 1 if the product is found only in this range; otherwise it equals 0. The "Morestore" dummy variable equals 1 if most of the product stores are in this range; otherwise it is marked 0. The "Cheap" dummy variable demonstrates if the product's price in this range is less than outside the range. The "Lowtime" dummy variable means that the purchase time of this product in this range is less than outside it. The "Nearwork" dummy variable means that person's workplace is close to the congestion zone. The "Young"," Med" and "Old" dummy variables respectively show the age ranges of less than 25 years old, between 25 and 56 years old, and over 56 years old with 1 and 0. If the responder is a man, the "Male" dummy variable is 1, or otherwise it is 0. The "Lowedu" dummy variable indicates associate educations and less. If the person has self-employment, "Freejob" dummy variable is equal to 1, and otherwise 0. The "Employee" dummy variable employement status and clerk job. The "PastE" dummy variable shows if a person has entered the range in 2017 using a car and has bought goods, with 1 and 0.

According to the models made to select the purchase destination within and outside the traffic congestion path, as shown in Tab.3, the price variable has been meaningful for the traffic area in three categories:

clothing, bags and shoes, electronics, and household appliances and reflects the sensitivity of the clients of these types of stores to the TCP. Variables such as "peak2", "morestore", "male", and "free job" are specified in most models with the same sign. In most of these types of goods, at peak hours (from 16 to 19 o'clock), there are more product stores within the scope of the traffic congestion charging, and being self-employed has a positive effect on the utility of shopping in the scope, and being male has a negative effect on utility shopping within the scope of the traffic charging zone.

We must see how much clients in these products are changing within the traffic congestion zone's scope at each level of pricing. To determine this, the product purchase probability function is used. In equation (2), P_{in} Shows the probability of purchasing the product by individuals inside the congestion area. In equation (3), Pex indicates the probability that the product will be purchased outside the traffic area.

$$P_{in} = \frac{e^{U_{in}}}{e^{U_{in}} + e^{U_{ex}}} \xrightarrow{U_{ex}=0} P_{in} = \frac{e^{U_{in}}}{e^{U_{in}} + 1} \quad (2)$$

$$P_{ex} = \frac{1}{e^{U_{in}} + 1} = P_{in} - 1 \quad (3)$$

If Ni is the number of clients under the price level *i* that is obtained from equation (4) and M is the number of clients under the previous pricing, then the percentage change in the number of clients P_i will be obtained at the price level *i* of equation (5).

$$N_i = P_{in} \times Observations \quad (4)$$

$$P_i = (\frac{N_i}{M} - 1) \times 100 \quad (5)$$

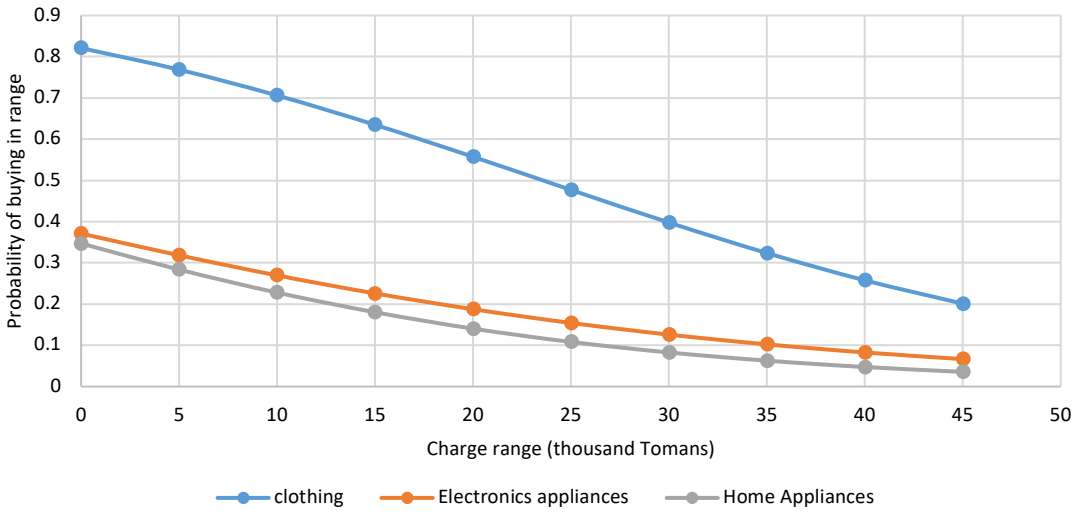

Fig. 3 Change in the client of each product category, based on the average price of the traffic range

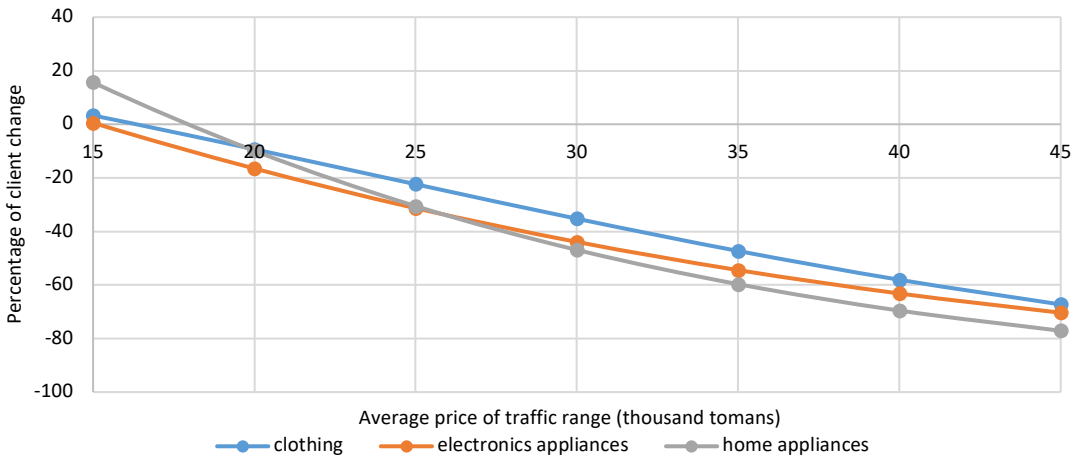

Fig.4 Percentage change in client per category of goods, based on the average price of the traffic congestion

By calculating and charting the price-percentage of the client change, one can see the effect of each level of pricing on the number of clients. The purchase probability chart of the traffic congestion zone for three categories of price-sensitive products is offered in Fig.3. The average toll charge- percentage chart of client change for price-sensitive products is shown in Fig.4.

Based on Fig 3, the probability of purchasing from the traffic congestion scope for each of the three categories of clothing, electronics, and home appliances decreases with the increase in the traffic congestion zone's price. However, this probability varies depending on the type of goods and the number of current clients. As the products of clothing, footwear, and shoes, which currently have more clients than the stores outside of the zone, are more likely to be considered more than the other two categories of household and home appliances. The average toll charge of the traffic congestion for respondents at the time of questioning was about 12,500 tomans. Based on Fig.4, despite the average increase in the traffic congestion zone's price, the number of clients reduced, these fluctuations of client numbers at different price levels are less than 15,000 tomans (+20%) for each kind of good. The household appliances category has the most sensitivity to the price and client changes. The electronic appliances are less sensitive, and the category of clothing, bags, and shoes that have the slightest changes to the traffic congestion zone's price sensitivity. For the traffic congestion zone with more than 15,000 tomans' prices, the level of client changes for each of the three categories is similar. However, these changes are more significant for the appliance category.

6. Vendors Choice Models

The multinomial logit models for examining the relationship between vendors and their clients are as follows. In these models for three categories of prince sensitive commodities, the dependent variable is the vendors' choice: without change, product change, and shutting down or shifting out of the traffic congestion zone. The results are offered in Tab.4. In this table, the first row is a variable coefficient, and the second row is P-value. Also, the symbols ** and *** indicate a significant level of 95% and 99%, respectively.

Based on the results shown in Tab.4 for the utility of changing the type of price-sensitive usage, which is depicted in Fig. 5, sellers can lose their clients significantly. Finally, with Fig.4 and Fig.5, we can map the changes in the CLUs sensitive to a congestion toll charge. As shown in Fig.6, the average price of 15,000 tomans (+20%) does not change any CLUs, even the average cost of 15,000 to 20,000 tomans (+60%) insignificantly affects the number of home appliance stores in the traffic congestion zone. However, with an average price of more than 20,000 tomans, almost these three types of CLUs are slipped and shrunk, while at the average cost of 25,000 tomans (+100%), the effect is very significant.

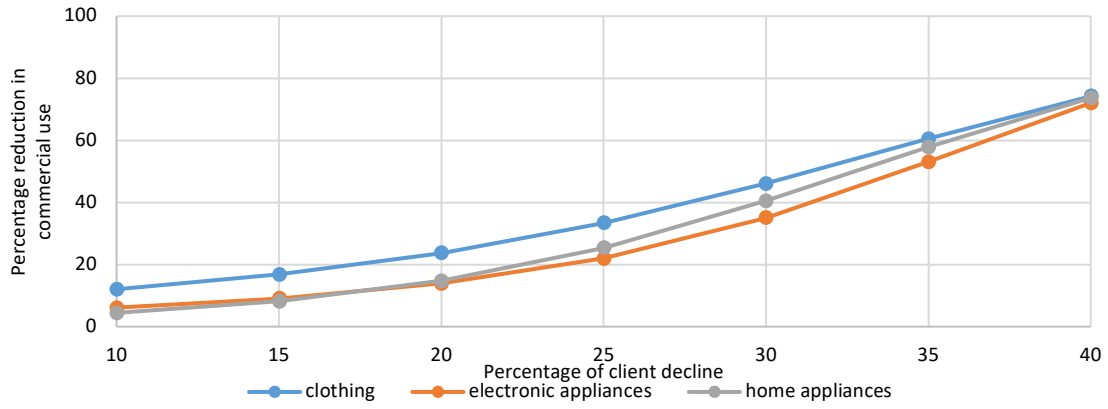

Fig.5 Percentage change in CLUs in terms of changing their clients

It should be noted that this reduction process may only be for these three categories of CLUs, and not all the CLUs, and it may even bring about an increase in other CLUs because of change in the product type, or even create a new opportunity for non-sensitive land-uses within the traffic congestion zone.

Alternative	Variable	Clothing	Electronic appliances	Home appliances
No change	Constant	3.906*** 0.0000	3.74*** 0.0000	13.155*** 0.0000
	Experience of 7 years or more in the range	0.929*** 0.0089	-	-
Change the goods	Constant	0.992 0.1001	1.3926 0.2397	8.208*** 0.0094
	Reduce client (%)	0.0575*** 0.0000	0.0688*** 0.0012	0.0919*** 0.0311
	Close to home	1.551*** 0.0000	-	-
	Store area less than 20 square meters	-	-3.14*** 0.0001	-
	Store area larger than 30 sqmore significanteters	-	2.625*** 0.0005	-
shut down or change place outside the range	Reduce client (%)	0.150*** 0.0000	0.193*** 0.0000	0.204*** 0.0000
	Having another job	- 2.3889*** 0.0008	-	-
	Known store in this range	- 0.7823*** 0.0123	-	-
	There is more client in this range	-1.037*** 0.0008	-2.1845*** 0.0009	-
	This range is the sales center for this product	-	-1.536** 0.0286	-
	Store area less than 20 square meters	-	-0.981*** 0.0015	4.856*** 0.0005
	Store area larger than 30 square meters	-	-	5.661*** 0.0001
	Age under 29 years	-	-2.308*** 0.0003	-
	Have a university degree	-	-	4.015*** 0.0008
Specifications	LL(β)	-289.15	-110.99	-46.45
	LL(c)	-385.96	-179.44	-84.96
	LL(0)	-118.65	-217.52	-444.93
	ρ_c^2	0.25	0.381	0.453
	ρ^2	0.35	0.489	0.6

Tab.4 Results of multinomial logit models for sellers

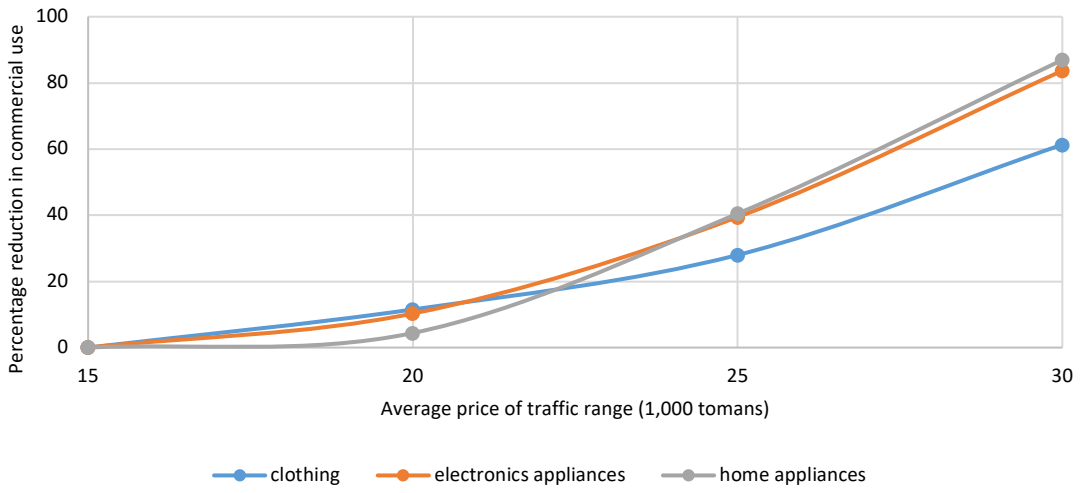

Fig.6 Percentage reduction in commercial land uses into the range under the average price of the traffic range

7. Conclusion

One of the most effective ways to decrease travel demand and its adverse effects on the urban transportation network is congestion toll pricing (CTP). This study investigated the diverse effects of congestion toll pricing policies on commercial land-uses in the Tehran congestion zone. The pricing policy will undoubtedly affect drivers and other users' behavior, including vendors and customers, related to their future choices in the long-term. Therefore, changing road pricing policies has direct and indirect effects. Its direct effects are on users who use personal vehicles, and its indirect effects are usually on activities and land uses, especially the decision to relocate the economic activities. As toll prices rise, clients in the area who use private vehicles will decrease, and this is one of the positive effects of road pricing to control traffic congestion and reduce air pollution. However, with the decline of clients in this area, in the long run, those commercials whose customers have decreased, their income will decrease, so some will have to relocate. The relocation of commercials, which leads to a change in the region's economy, is one of the long-term and adverse effects of road pricing. It means urban policy makers should be aware of this phenomenon and compensate for it by improving the neighborhood infrastructures that increase the public accessibility, leading to higher shares of sustainable mobility like active and public transport. These results are justifiable in the continuation of Masoumi and Moeinaddini researches in regard of socio-economic factors of urban form (Moeinaddini et al., 2012; Masoumi, 2013). Notwithstanding, these changes will not be the same in all vendors. The CLU clients who were sensitive to traffic congestion charges were recognized by designing a client-purchase-behavior questionnaire and were classified by a binary logit model. Another complementary questionnaire based on a multinomial logit model identified the vendors' responses to this customer reduction. The results were as follows:

- Congestion charging has reduced the demand for certain goods (apparel, bag and shoes; electronics; and home appliances) inside the congestion toll pricing zone;
- A 20-percent increase in congestion charges reduced the three retail categories' sales above, demonstrating the price sensitivity range;
- An increase of 60 percent or more will result in a substantial decline in sales (falling in the critical range for commercials);
- When the clients of the three price-sensitive retailers dropped as a result of the congestion price increase, the vendors initially began selling different products in the same price range and, in the long-term, changed their location to the outside of the traffic congestion zone.

Therefore, urban decision-makers should be careful that by implementing the road pricing plan in a metropolitan area, traffic congestion and air pollution are reduced. Still, they may cause changes in the area's economic activities. Decision-makers in Tehran's urban area will use this study's results to find out how much the tolls increase will change the purchasing behavior of the people and consequently change the location of commercials in the region. If they use these results, they will determine which activities and commercial land-use within Tehran's CTP zone will change if tolls increase. Also, the impact of accessibility on clients' choice and its role in reducing the adverse effects of pricing policies could be investigated in future research.

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