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Effectiveness of Flexible Working Hours on Traffic Index, a Case Study for Tehran

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ABSTRACT

Nowadays, traffic congestion is a major problem in metropolises that affect daily life. The imbalance between supply and demand causes congestion. Demand management is used to balance demand and supply since has more reasonable costs and fewer restrictions in comparison with increasing transportation supply. One policy in order to manage the demand and reduce Tehran traffic congestion is to implement flexible working hours since October 2022. In this study, the effect of flexible working hours on traffic congestion has been investigated by using the length of Tehran's congested roads. The linear regression has been modeled based on the length of traffic congestion of the second week of October 2019 before the Covid-19 epidemic in comparison with the second week of October 2022. By flexible working hours, the graphs of the average hourly queue length have become smoother. In 2022 this chart has two prominent peaks as morning peak and evening peak. In 2022, the height of these two peaks has decreased and the trips have been more evenly distributed over time. In 2022, the height of these two peaks has decreased and the trips have been more evenly distributed over time. It was expected to face more road congestion due to the traditional education after the virtual education during the Covid-19 epidemic, user behavior changes, and an increase in the usage of private cars. Nevertheless, by implementing flexible working hours, Tehran's traffic congestion has been far more suitable except for the Limited traffic zone than the urban management's prediction.

Keywords:

Demand management, Flexible working hours, Linear regression, Traffic index.

1. Introduction

Nowadays, traffic congestion in big cities is one of the most important problems that affects daily life. The imbalance between transport supply and demand causes of traffic congestion [1]. one way to met the balance is adding more transportation supplies through solutions such as the road and intersection construction that are not at the same level as the widening of roads. The cost of implementing such projects is staggering, and on the other hand, in some cases, it is practically impossible due to the lack of sufficient privacy around the roads. Another solution in order to keep a balance between supply and demand is demand management, which involves far fewer costs and restrictions. This management can be done to reduce demand by implementing plans such as traffic plan [2]. instance, Ghodsi et al.[3] found that online shopping is one of the effective ways to reduce urban traffic. In transportation studies, traffic volume forecasts are made with the aim of balancing supply and demand [4]. Mode choice and time of travel are decisions that are effective in urban travel demand [5]. Another approach in demand management is to distribute the travel time properly so that the excess travel demand of citizens during peak traffic hours can be reduced and these trips can be postponed to non-peak hours, or the length of the peak traffic interval can be extended and the intensity of traffic congestion can be reduced. Since significant part of trips during peak traffic hours are business trips, coherent policies regarding these types of trips can be effective in reducing traffic congestion [6]. One of these policies is implementing flexible working hours. According to this policy, the employees of government offices and part of the private sector employees will be able to choose the start time of their work activity within the predetermined allowed period and the end time of the work activity will be changed accordingly [7]. Therefore, for two reasons, these people are expected to choose the time of their business trip in a way that helps to manage travel demand. In the first case, person chooses a time for his business trip when the traffic density is less. In the second case, the person chooses a time for his business trip when he can use a shared vehicle with other family members [8]. Teleworking and flexible working hours have been growing steadily in recent years [9].

According to the mentioned merits of the implementation of flexible working hours, this plan was implemented in the city of Tehran in the second half of year 1401. The starting time was set between 7 and 9 in the morning. The end time of the work has also been floated in proportion to the duration of the activity. This study aims to measure the effect of the implementation of this plan on traffic conditions. For this purpose, the traffic index of the average queue length of the transportation network of Tehran, for one week of the implementation of the flexible working hours in October 2022 and a similar week in October 2019 when such a plan was not implemented, was calculated and compared. Since , special corona conditions prevailed in the country between 2020 and 2021, these two years were not considered in this study. To make this comparison more accurate, simple regression has been modeled. Depending on the value and sign of the estimated coefficient, it is possible to check the decrease or increase of that traffic index due to the implementation of flexible working hours with statistical interpretations. Also, the analyzes have been carried out according to the scope of the traffic zone, low emission zone, and the whole city at daily and hourly intervals.

The review of previous studies shows that flexible working hours has also been implemented in other countries of the world. Yildirimoglu et al. [10] propose an optimal flexible scheduling problem to minimize the travel time of the entire network and avoid delays during morning peak hours. The goal is to optimize the start times of individual companies with minimal deviations from their original schedules while considering that travelers choose their travel times selfishly to minimize their travel costs. The numerical results show that the implementation of the proposed

policy for selecting the starting time of the passengers' journey can significantly reduce the traffic density in the urban transportation network. In one of Van der Loop et al.'s studies [11], study aims to identify the level of working hours and also the effects of the selected level on traffic indicators in one of the cities in the Netherlands. The purpose of the study is focused on indentifying level of working hours and also effects of the selected level on traffic indicators in one of the cities of the Netherlands. The study indicates that flexible working hours have played an important role in reducing the growth of car use and traffic congestion, especially during peak hours. Similar results are presented for public transport. In another study by van der Loup et al. [12], the research shows that in the Netherlands, working from home and adjusting work hours to avoid peak traffic times are the most significant forms of flexible work. By working from home for one day or adjusting work hours from peak to off-peak, delay on national roads has been reduced by approximately 0.1 hours during the morning peak and 0.2 hours during the afternoon peak.

Mutlu et al. [13] have proposed a mathematical model to reduce traffic congestion following flexible working hours policy. The purpose of this model is to find working hours of each destination node by considering the travel demand between the origin-destination nodes, routes, and road capacities. Finally, by using the proposed program, the traffic density during peak hours has been significantly reduced. Zong et al.'s [14] study evaluates the policy of working hour flexibility in the city of Beijing (China). Evaluations show that this plan has been able to reduce the volume of traffic by 15.24% and the average travel time by 21.73%. Huang and Li's study [15] also investigated the effect of flexible working hours in Guangzhou, China, and the results show that in the short term, flexible working hours had a positive effect on the performance conditions of public transportation, but there was no significant improvement in the performance conditions of personal transportation. In a study, it has been shown that by changing the working hours to earlier in the morning, the morning traffic and the daily load of drivers are reduced [16]. Also, in another study, conducted by the London Metropolitan Transportation Authority, the results showed that changing people's working hours can significantly improve urban traffic and public transportation [17]. Rahman, M. et al. [18] found that the implementation of flexible working hours or flextime policies in Texas reduces congestion by reducing travel demand from peak hours and shifting it to off-peak hours. Sung-Jin et al. [19] evaluated the flexible work policy with an active-based model and found that this policy reduces traffic congestion during peak hours, but its impact on different demographic groups can vary depending on household/individual characteristics. be different. The results of Ying Yang et al.'s study [20] showed that there is a correlation between flexible working time and non-peak hours travel and also showed that different travelers have different reactions to flexible time. Another paper suggests a collaborative method to improve network efficiency by modifying departure times within a specific time period. This method involves redistributing demand and managing travel demand. The study shows that even small changes in schedules can significantly enhance network performance [21]. Also Kunsch et al.[22], Mun & Yonekawa [23], He [24], Fabienne Wöhner [25] and, Ecke et al.[26], in their research examined flexible working hours. In the current study, the effect of flexible working hours on traffic congestion has been investigated by using the length of Tehran's congested roads. The linear regression has been modeled based on the length of traffic congestion of the second week of October 2019 before the Covid-19 epidemic in comparison with the second week of October 2022. In the second section of this article, used data and methodology will be reviewed. The results and related interpretations are presented in the third section. Finally, in the fourth section, summary and conclusion have been discussed.

2. Materials and methods

The flexible working hours plan was implemented in October 2022 in order to reduce the traffic density of Tehran's street. In this study, the effect of the implementation of this plan on the traffic condition on Tehran's roads has been investigated by using the length of the queues on Tehran's roads and public transportation data. To calculate the length of the traffic queue, the main roads of Tehran are divided into parts. Traffic experts recognize the parts in which the queue is formed and the total length of such parts is known as the length of the queue on the streets of Tehran. This data was collected by the Tehran Traffic Control Company. In order to evaluate the effectiveness of the flexible working hours plan, the second week of October 2019 before the COVID-19 pandemic and the second week of October 2022 have been selected. Due to the existence of an official holiday in the first week of October this year in Iran, the second week of this month was the criterion for action. Also, the length of the queue at the crossings has been investigated between 6:00 am and 10:00 pm. Table 1 shows the characteristics of these two time periods.

Table 1. Specifications of the before and after periods.

period	characteristics
previous period	A week is considered from October 5, 2019 on Saturday to October 11, 2019 on Friday. The beginning and end of the working hours of Tehran city offices during the period was from 8:00 a.m. to 4:45 p.m. The beginning and ending of the traffic and ELZ plan was from Saturday to Wednesday from 6:30 a.m. to 7:00 p.m. On Thursdays, only the air pollution plan was implemented from 6:30 a.m. to 1:00 p.m. Cars with Tehran license plates also have a traffic quota of 20 days per season within the scope of low emission zone. Also, the allowed daily traffic of vehicles with city license plates in the low emission zone is 15 days in each season. Schools start at 8 a.m.
Study period	A week is considered from October 8, 2022 on Saturday to October 14, 2022 on Friday. The beginning of the working hour of Tehran's offices is flexible from 7:00 a.m. to 9:00 a.m. and the end of the working hour is flexible from 03:45 p.m. to 05:45 p.m. The start and end time of the traffic and Low emission zone are implemented from Saturday to Wednesday from 6:30 a.m. to 6:00 p.m. On Thursday, only the low emission zone will be implemented from 6:30 a.m. to 1:00 p.m. Maximum daily cost of entering traffic zone is 98850 Tomans in Tehran. Vehicle registration plate of Tehran can enter the low emission zone freely for 20 days during each season. While vehicle registration plate of other cities can enter the LEZ freely for 15 days. The activity time of the morning shift of tehrans's secondary schools were 7:30 a.m. and Tehran's elementary schools were considered from 8:30 a.m. to 12:30 p.m.A typical day of Tehran's elementary schools started at 7:30 a.m. and ended at 12:30 p.m.

According to the characteristics of the dependent variable (average length of the traffic queue) and also need of obtain estimating coefficients and discovering dependency between the variables, in this study, multiple regression model have used for modeling**.** In multiple linear regression, the variables' coefficients were estimated by using an objective function and the values of the same variables. In this model, the relationship between the dependent variable and the independent variables is assumed to be linear in the parameter, on the other hand, by using exponential functions, the non-linear relationships between variables can be seen. For n observations, p independent variable x and dependent variable y, we will have [27]:

$$y_i = \beta_1 + \sum_{j=1}^{p} \beta_j * x_j + \varepsilon_i \qquad i = 1, \dots, n \tag{1}$$

In this regard, β is the coefficient of the independent variables that must be estimated and ε_i is the error part or unsystematic part of the regression, which is assumed to follow the normal distribution [3]. In multiple regression, if two independent variables are in a linear relationship with a dependent variable, its shape becomes a plane. If more than two independent variables are used in the linear regression model, the model takes the form of a super-plane [4]. In order to estimate the coefficients of variables as model parameters, the method of error minimization of squares (OLS) has been used**.** The form of the squared error function S(β) is defined as Eq. 2 [28]:

$$S(\beta) = \sum_{i=1}^{n} \left| y_i - \sum_{j=1}^{p} X_{ij}\beta_j \right|^2 \tag{2}$$

Using derivation and solving matrix equations, coefficients of independent variables are estimated. In each linear regression model, the following four assumptions are considered as underlying assumptions [29].

1- The error term of the regression equation has zero mean.
2- The error term of the regression equation has constant variance.
3- The error term of the regression equation is uncorrelated.
4- The error term of the regression equation has a normal distribution.

3. Results and discussion

The items examined in this study are as follows:

1-Analysis and comparison of the average length of traffic queues by hours of the day and night within the scope of the traffic zone, Low emission zone, districts without congestion pricing, and the whole city.

2-Analysis and comparison of the average length of traffic queues by days of the week within the scope of the traffic zone, low emission zone, districts with no congestion pricing, and the whole city.

3-Estimation of linear regression and coefficient of determination[1] according to the graphs provided.

4- Estimation of the variation ratio by comparing before and after of the FWH implementation in different zones, day of the week, and time of the day.

[1] R^2

5- Visualization and comparison of the analysed data.
6- Studying the consequences of implementing FWH.

Based on the average queue length of the traffic zone by day of the week of 2022 and 2019 Fig.1., linear regression is estimated and the average queue length of the second week of October 2022 as the dependent variable and the average queue length of the second week of October of the year 2019 is considered as an independent variable. The width from the origin is assumed zero in the above regression in order to show the net effect of correlation between dependent and independent variables. The coefficient of the independent variable is given in Table 1 and Table 3, which illustrates noticeable changes of the queue length during the period of 2022 compared to the period of 2019 for the area of the traffic zone by days of the week. The table clearly shows that, the determination coefficient of 0.96 is considered significant. Considering that the P-value is less than 0.01, it can be concluded with 99% confidence that the length of the traffic queue in the second week of October 2022 compared to the length of the traffic queue in the second week of October 2019 has changed dramatically.

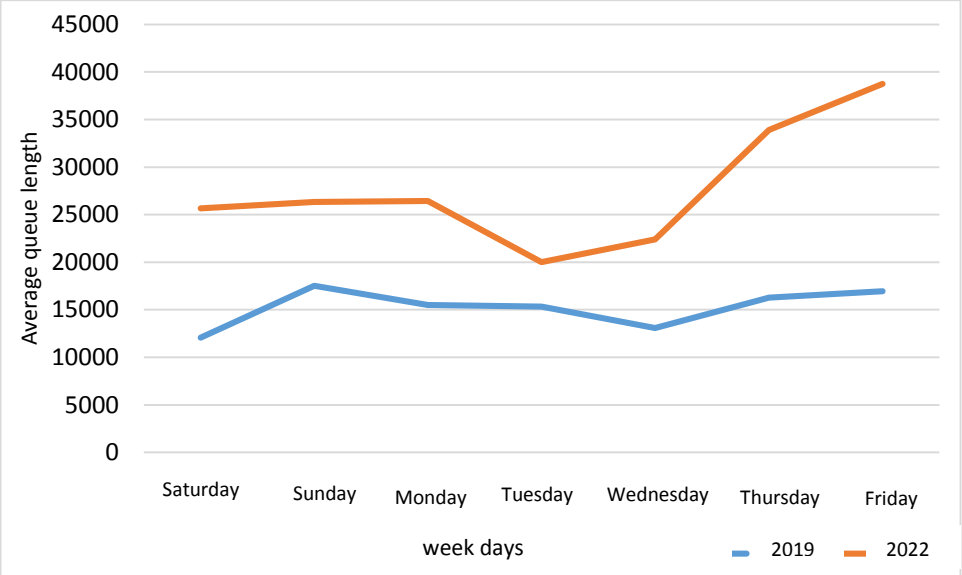

Figure. 1. Comparison of the average queue length of the traffic zone by days of the week.

Table 2. Outputs of the linear regression of the queue length of traffic zone by day of the week.

Indicator	Value
Coefficient of determination	0.96
Adjusted coefficient of determination	0.8
Standard deviation	5657.4
Number of observations	7

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Table 3. The results of ANOVA test and linear regression of queue length of traffic zone by days of the week.

	Degree of freedom	Sum of squares	F statistic	The significance of F
Regression	1	5412382374	169	0.000
Residual	6	192036484		
Total	7	5604418858		

	Coefficient	Standard deviation	t statistic	P-value	Lower limit (95%)	Upper limit (95%)
Constant	0	-	-	-	-	-
Independent Variable	1.811	0.139	13.004	0.000	1.470	2.151

The coefficient of the regression model for the traffic zone by days of the week is 1.81. According to the comparison of the coefficients of the regression model, the biggest changes in the queue length in 2022 compared to 2019 can be seen in the traffic zone by days of the week. As seen from the graphs Fig.2 to 8 show the changes in the average length of the queue by area, hour and daily intervals. Tables 4 and 5 clearly shows the regression models for the mentioned graphs.

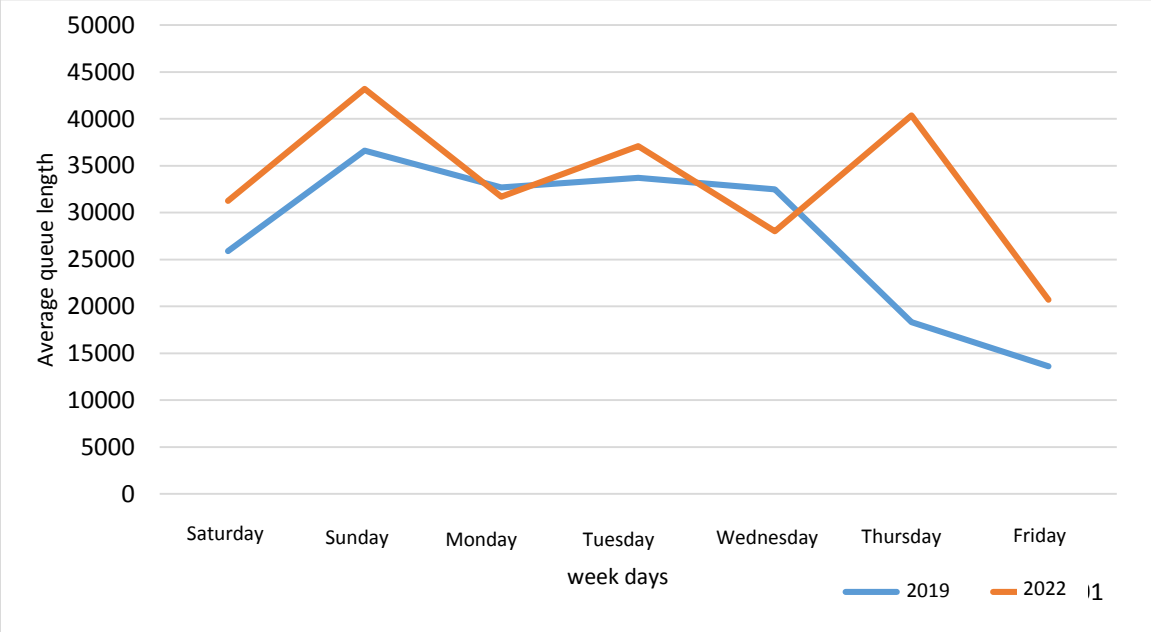

Figure 2. Comparing the average length of traffic queues in the low emission zone by days of week.

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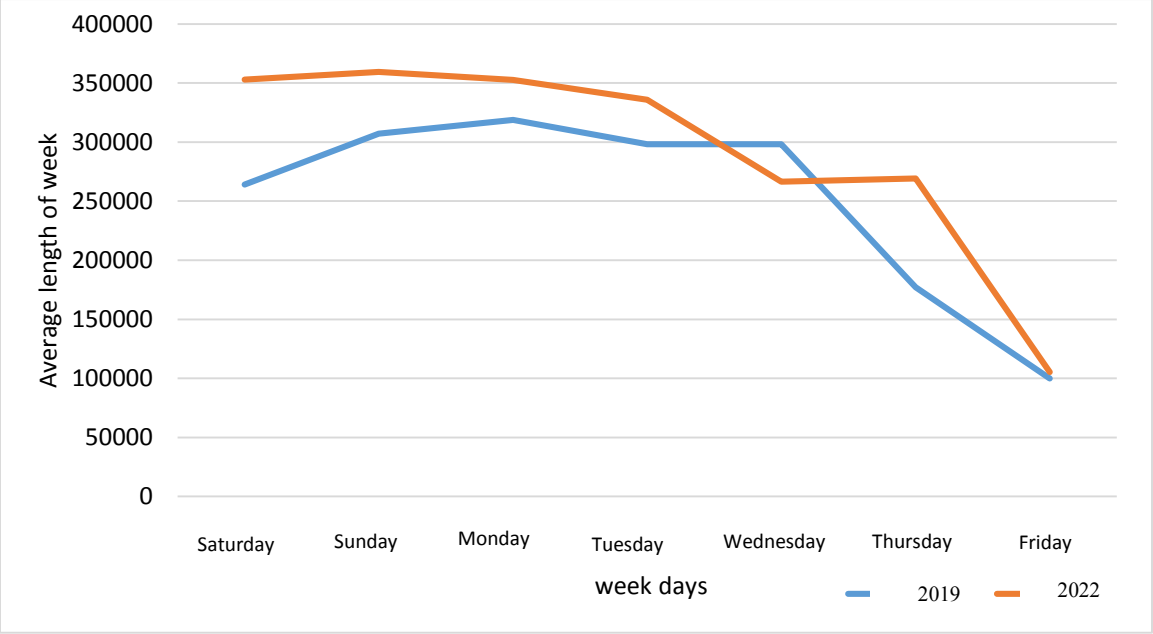

Figure 3. Comparison of the average queue length of districts without congestion pricing by days of week.

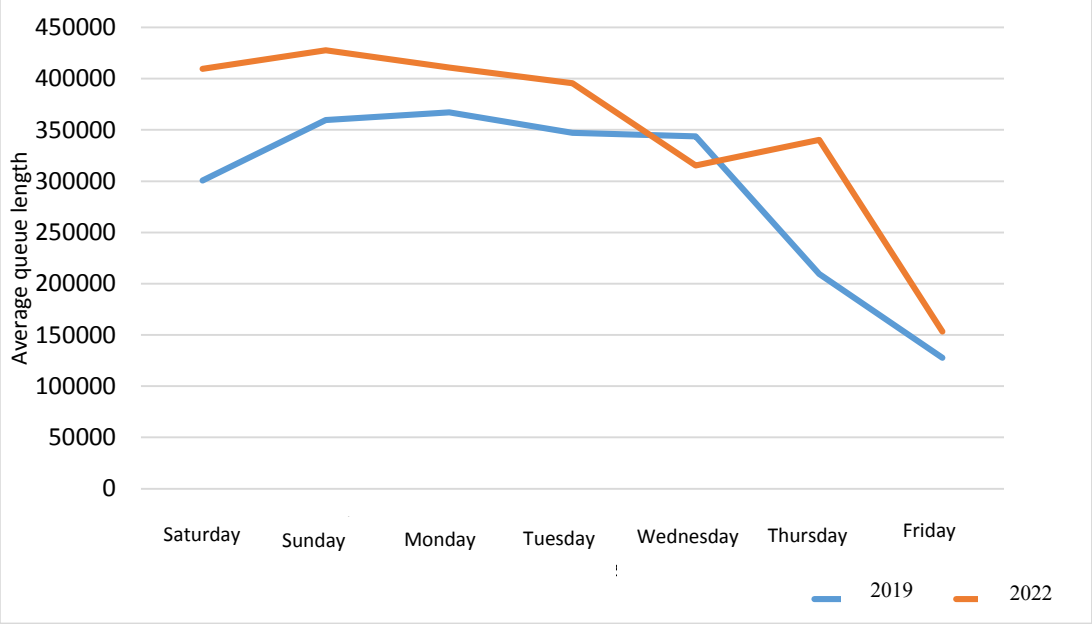

Figure. 3. Comparison of the average queue length of the whole city by days of week.

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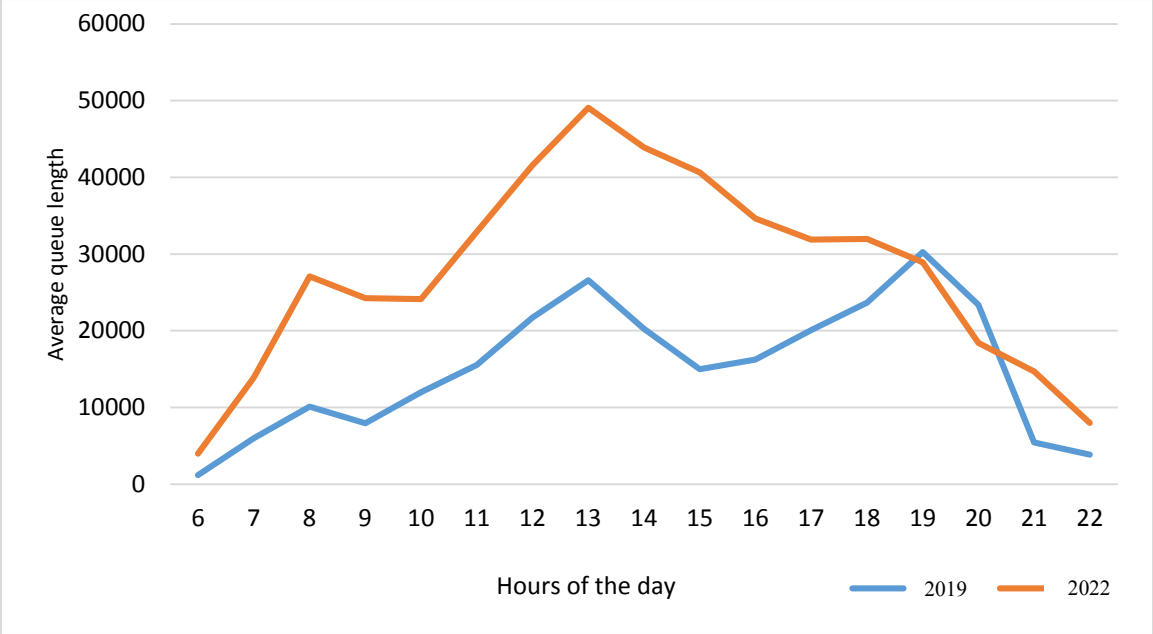

Figure 4. Comparison of the average queue length within the traffic zone by hours of the day.

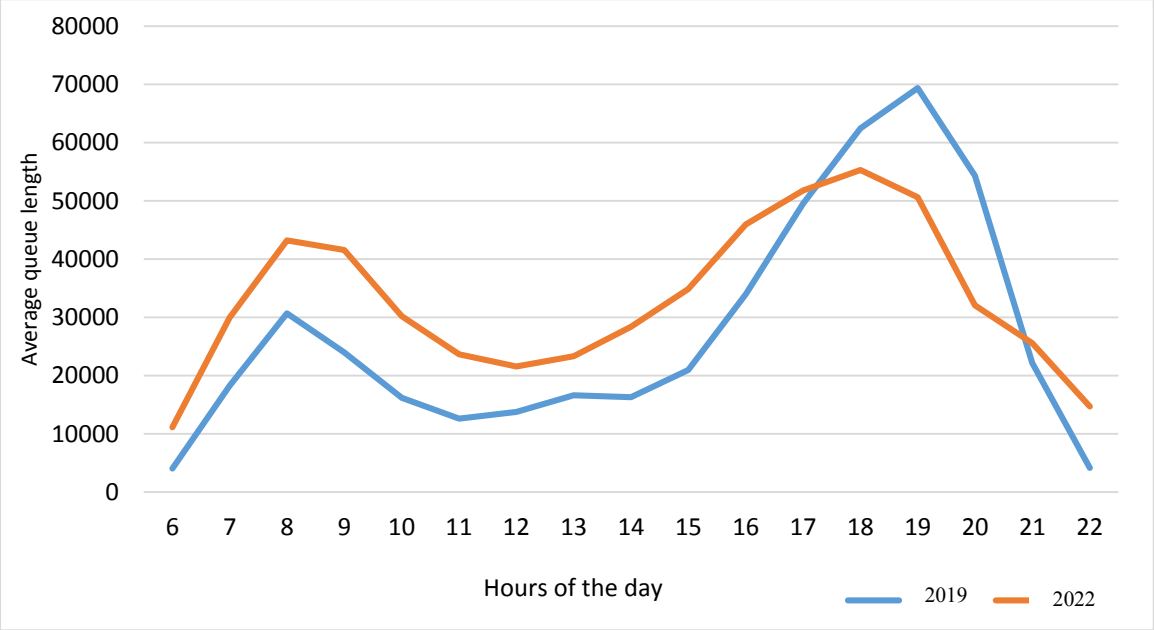

Figure 5. Comparing the average queue length in Low emission zoneby hours of the day.

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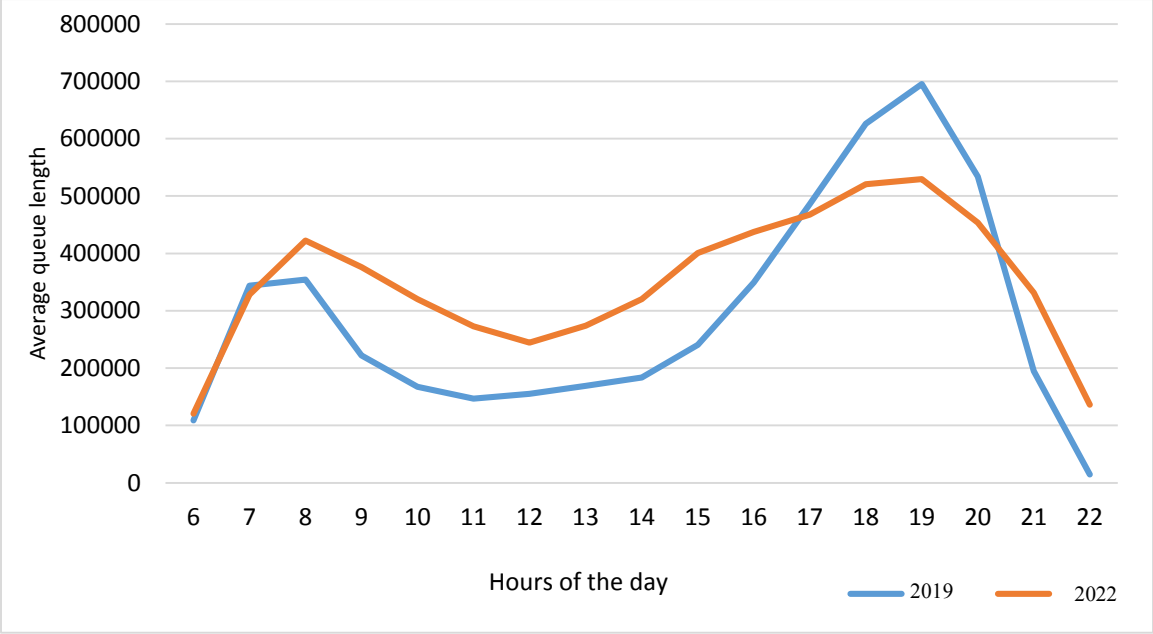

Figure 6. Comparison of the average queue length in districts without congestion pricing by hours of the day.

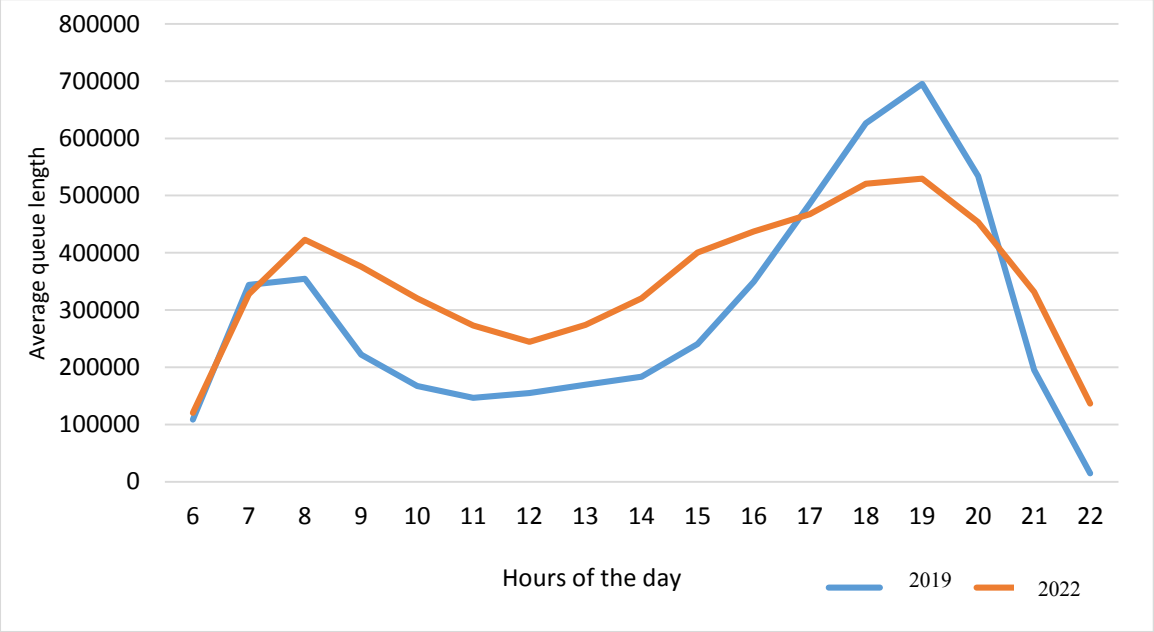

Figure 8. Comparison of the average queue length of the whole city by hours of the day

Table 4. The results of 4 linear regressions of traffic areas by days of the week.

Model	Comparing the average queue length by days of week	Queue length ratio from 2022 to 2019	The coefficient of determination	P-value
1	traffic zone	1.81	0.96	0.000
2	low emission zone	1.14	0.93	0.000
3	districts without congestion pricing	1.14	0.98	0.000
4	The whole city	1.17	0.98	0.000

Table 5. The results of 4 linear regressions of traffic zones by hours of the day.

Model	Comparison of the average queue length by hours of the day	Queue length ratio from2022 to 2019	The coefficient of determination	P-value
5	traffic zone	1.64	0.89	0.000
6	low emission zone	0.99	0.88	0.000
7	districts without congestion pricing	0.98	0.91	0.000
8	The whole city	0/01	0.91	0.000

In Table 4, model 2, in low emission zone, the queue length in the second week in October 2022 compared to the queue length in the second week in October 2019 has increased by 14%. In model 3, the queue length of 2022 has increased by 14% compared todistricts without congestion pricing, by day of week. In model 4, the total queue length in 2022 compared to 2019 for the whole city by days of the week has increased by 17%. As seen from table 5, in order to study the effectiveness of implementing flexible working hours, queue length has been compared by different hours of day.In this study, the average queue length during the mentioned time in 2019 and 2022 has been used as a basis for comparison. In model 5, in the comparison of the average queue length traffic zone by hours of the day, the queue length in 2022 has increased by 64% compared to 2019 in the same zone by the hours of the day. The queue length in the traffic zone has increased enormously in the morning peak hour and decreased slightly in the evening peak hour.In model 6, in low emission zone, the queue length in 2022 compared to 2019 has decreased by 1% in the low emission zone by hours of day. queue length in low emission zone has rose considerably during the morning peak hours and declined significantly during the evening peak hours. In Model 7, the queue length in 2022 has reduced by 2% compared to 2019 in districts without congestion pricing according to hours of day. In Model 8, in the whole city, the average queue length in 2022 has escalated by 1% compared to 2019 in the whole city by hours of day.

4. Conclusion

The results obtained in this study include the following:

1-after implementing flexible working hour scheme, the graphs of the average hourly queue length fluctuated slighter than before. In 2022 this chart has two prominent peaks a morning peak and an evening peak. Queue length hit two peaks including a morning peak and an evening peak. In 2022, the height of these two peaks has declined and the trips have been more evenly distributed over time.

2- In 2022, the difference between the average hourly queue length in the morning and evening peak hours has fell.

3- The queue length after implementing flexible working hour scheme in 2022 has ascended compared to the corresponding hours in 2019.

4- The queue length after implementing the flexible working hour scheme at the end of work time in 2022 has decreased compared to the corresponding hours in 2019.

5- There is a decrease in the queue length in the evening peak hours in 2022 compared to 2019 which is more noticeable than the queue length increase in the morning peak hour in 2022 compared to 2019.

In addition, in terms of study the consequences of implementing flexible working hour scheme on the queue length within traffic zones, the following can be mentioned:

1- Queue length in thetraffic zone by the days of the week has increased by 80% while by the hours of the day has been associated with a 64% increase in the length of the queue length.

2- The biggest changes of queue length in the second week in October 2022 compared to 2019, can be seen in low emission zone. This issue can indicate the negative impact of other parameters. For example, congestion pricing.

3- Queue length increse by days of the week in low emission zone, districts without congestion pricing and the whole city is less than 17%. After three years, this increase has been less than the prediction of city managers, due to the covid-19 pandemic, user behavior change and the growth of personal transport trips' share.

4- The average queue length has reduced in low emission zone, districts without congestion pricing, and the whole city between 17:00 and 20:00.

5- There is a very slight decrease by 2% in in queue length by the hours of the day in the low emission zone, districts without congestion pricing and the whole city. The approximate stability of the average queue length according to the hours of the days in these areas, according to the prediction of more congestion, illustrates the appropriate distribution of demand in the hours of the days.

6- Considering the non-attendance education of schools and universities in Tehran due to Covid-19 epidemic in 2019 and 2022, as well as notable change in user behavior in Tehran and the increase in the share of using personal transportation compared to 2019, It was expected that with non-virtual schools and universities, we have a considerable congestion on the Tehran's street. By implementing flexible working hour scheme, the queue length, except for the traffic zone, has been far more suitable than the urban management's prediction. In general, this study indicates that implementing flexible working hour scheme as a way of demand management had a good effect on all the whole city of Tehran expect for traffic zone.

Abbreviations (NOMENCLATURE)

β_i (1,2,3 ... k)	Regression coefficients
Eq.	Equation
ε_i	Error part of the regression
Fig.	Figure
n	Sample size
S(β)	Squared error function
x_i	Independent variable
y_i	Dependent variable

5. References

1- Koźlak, A., and Wach, D., 2018, **Causes of traffic congestion in urban areas. Case of Poland**, *SHS Web Conf.*, 57, doi: 10.1051/shsconf/20185701019.
2- El-Hansali, Y., Farrag, S., Yasar, A., Malik, H., Shakshuki, E., and Al-Abri, K., 2021 **Assessment of the traffic enforcement strategies impact on emission reduction and air quality**, in Procedia Computer Science, 184, doi: 10.1016/j.procs.2021.03.068.
3- Ghodsi, M., Ardestani, A., Rasaizadi, A., Ghadamgahi, S., and Yang, H., 2021, **How covid-19 pandemic affected urban trips? Structural interpretive model of online shopping and passengers trips during the pandemic**, Sustain., 13, 21, doi: 10.3390/su132111995.
4- Shahdani, F. J., Rasaizadi, A., and Seyedabrishami, S., 2021, **The interaction between activity choice and duration: Application of copula-based and nested-logit models**, Sci. Iran., 28, 4, doi: 10.24200/SCI.2020.56380.4701.
5- Seyedabrishami, S., and Izadi, A. R., 2019, **A Copula-Based Joint Model to Capture the Interaction between Mode and Departure Time Choices in Urban Trips**, in Transportation Research Procedia, 41, doi: 10.1016/j.trpro.2019.09.120.
6-Rasaizadi, A., and Kermanshah, M., 2018, **Mode choice and number of non-work stops during the commute: Application of a copula-based joint model**, Sci. Iran., 25, 3A, doi: 10.24200/sci.2017.4194.
7-Dizaho, E., Salleh, R., and Abdullah, A., 2017, **Achieveing Work Life Balance Through Flexible Work Schedule and Arrangements**.
8- Yu, R., Burke, M., and Raad, N., 2019, **Exploring impact of future flexible working model evolution on urban environment, economy and planning**, J. Urban Manag., 8, 3, doi: 10.1016/j.jum.2019.05.002.
9- Hostettler Macias, L., Ravalet, E., and Rérat, P., 2022, **Potential rebound effects of teleworking on residential and daily mobility**, Geography Compass., doi: 10.1111/gec3.12657.
10- Yildirimoglu, M., Ramezani, M., and Amirgholy, M., 2021, **Staggered work schedules for congestion mitigation: A morning commute problem**, Transp. Res. Part C Emerg. Technol., 132, doi: 10.1016/j.trc.2021.103391.
11- Van der Loop, H., Haaijer, R., and Willigers, J., 2019, **The impact of various forms of flexible working on mobility and congestion estimated empirically**, in Autonomous Vehicles and Future Mobility, doi: 10.1016/B978-0-12-817696-2.00010-X.
12- van der Loop, H., Willigers, J., and Haaijer, R., 2019, **Empirical Estimation of Effects of Flexible Working on Mobility and Congestion in the Netherlands 2000 to 2016**, Transp. Res. Rec., 2673, 6, doi: 10.1177/0361198119845889.
13-Mutlu, O., Durak, Z., and Akyer, H., 2020, **Staggered working hours in order to reduce traffic congestion**, Pamukkale Univ. J. Eng. Sci., 26, 4, doi: 10.5505/pajes.2019.90922.
14- Zong, F., Juan, Z., and Jia, H., 2013, **Examination of staggered shifts impacts on travel behavior: A case study of Beijing, China**, Transport, 28, 2, doi: 10.3846/16484142.2013.803263.
15- Huang, L., and Li, J., 2011, **Applicability of staggered work hours for urban traffic: Case of guangzhou**, doi: 10.1061/41184(419)67.
16- Gatersleben, B., and Uzzell, D., 2007, **Affective appraisals of the daily commute: Comparing perceptions of drivers, cyclists, walkers, and users of public transport**, Environ. Behav., 39, 3, doi: 10.1177/0013916506294032.
17- Metz, D., 2018, **Tackling urban traffic congestion: The experience of London, Stockholm and Singapore**, Case Studies on Transport Policy, 6, 4, doi: 10.1016/j.cstp.2018.06.002.
18- Rahman, M., Gurumurthy, K. M., and Kockelman, K. M., 2022, **Impact of Flextime on**

Departure Time Choice for Home-Based Commuting Trips in Austin, Texas, in Transportation Research Record, 2676, 1, doi: 10.1177/03611981211035757.
19- Cho, S. J., Bellemans, T., C., Joh, H., and Choi, K., 2017, **A Study on the Transport-related Impacts of Flexible Working Policy using Activity-Based Model**, J. Korean Soc. Transp., 35, 6, 2017, doi: 10.7470/jkst.2017.35.6.511.
20- Yang, y., Steiner, R. L., and Srinivasan, S., 2016, **The Impact of Flexible Work Hours on Trip Departure Time Choices in Metropolitan Miami**, doi: 10.1061/9780784479896.199.
21-Kumarage, S., Yildirimoglu, M., Ramezani, M., and Zheng, Z., 2021, **Schedule-constrained demand management in two-region urban networks**, Transp. Sci., 55, 4, doi: 10.1287/trsc.2021.1052.
22- Kunsch, P., Johan, S., and Brans, J. P., 2000, **Traffic crowding in urban areas: Control with urban tolls and flexible working hours**, JORBEL-Belgian J. Oper. Res. Stat. Comput. Sci., 40(1–2), 81–90.
23- Il Mun, S., and Yonekawa, M., 2006, **Flextime, traffic congestion and urban productivity**, J. Transp. Econ. Policy, 40, 3.
24- He, S. Y., 2013, **Does flexitime affect choice of departure time for morning home-based commuting trips? Evidence from two regions in California**, Transp. Policy, 25, doi: 10.1016/j.tranpol.2012.11.003.
25- Wöhner, F., 2022, **Work flexibly, travel less? The impact of telework and flextime on mobility behavior in Switzerland**, J. Transp. Geogr., 102, doi: 10.1016/j.jtrangeo.2022.103390.
26- Ecke, L., Magdolen, M., Chlond, B., and Vortisch, P., 2022, **How the COVID-19 pandemic changes daily commuting routines – Insights from the German Mobility Panel**," Case Stud. Transp. Policy, 10, 4, doi: 10.1016/j.cstp.2022.10.001.
27- James, R., Witten, G., Hastie, D., and Tibshirani, T., 2013, **An Introduction to Statistical Learning - with Applications in R**, Gareth James, Springer,.
28- Moghadami, M., Rasaizadi, A., and Askari, M., 2020, **The effect of coronavirus restrictions on air quality and exiting daily traffic**," Int. J. Hum. Cap. Urban Manag.
29- Williams, M. N., Grajales, C. A. G., and Kurkiewicz, D., 2013, **Assumptions of multiple regression: Correcting two misconceptions**," Pract. Assessment, Res. Eval., 18, 9.