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Impact of Fuel Prices on Transport Behavior: A Case Study in Istanbul

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ABSTRACT

Traffic flow is an inescapable problem in almost all large cities around the world. Obviously, some social and economic factors make traffic congestion a serious and hard-solvable problem in reality. A key factor in recent years is a sharp increase in fuel prices in the international markets. However, how this price fluctuation affects traffic flows and transport behavior, mainly in large cities like Istanbul, is an important question to study. This study addresses the effect of fuel price changes on Istanbul's traffic flows. The primary purpose of this study is to understand the relation between fuel price variations and traffic flows in Istanbul, as well as other important factors that contribute to the congestion problem investigation. To do this, traffic data from the most crowded regions of Istanbul was first collected, and first the It was mainly observed that the gasoline prices in Istanbul have a significant impact on the traffic flows, and a unit increase in gasoline price reduces the flow rate between 3000 and 7000 units. In addition to the empirical results, a survey was conducted to identify additional factors that affect traffic flows. The survey aimed to investigate the transport behavior of drivers as fuel prices increase in Istanbul. According to the survey results, drivers tend to prefer using the public transportation network more as the gasoline price increases.

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1. Introduction

The traffic flow problem is universally acknowledged as a burdensome and disagreeable circumstance, posing challenges for both traffic management authorities and drivers in major cities worldwide. For instance, in Istanbul, due to its unique geographical location connecting the European and Asian continents, the traffic flow may excess 110% on the entering sides of both continents, according to data from the Istanbul Metropolitan Municipality (IMM, 2021). Many factors impact the traffic flows in Istanbul, including geographical, economic, and social variables. For example, based on the Turkish Statistical Institute (TUIK, 2021), in August 2021, it was recorded about 4.5 million registered vehicles in Istanbul, which is equal to the total number of registered vehicles in the rest of Turkey- a surprising statistic. Out of all vehicles in Istanbul, around 3.1 million are private vehicles, while 96,000 are minibusses, and 38,000 buses and 138,000 trucks are permitted to enter the Istanbul traffic. The remaining vehicles consist of motorbikes and delivery cars.

While numerous past studies considered only the traffic flows and fuel prices in large cities like Dahl (1979) and Holden (1989), the most recent studies have addressed the effect of new factors on traffic flows, including transit behavior, severe traffic accidents, holidays, tax rate and weather conditions. However, recent studies have placed greater emphasis on the relationship between sudden increases in fuel prices and traffic congestion. For example, a survey paper by Goodwin, Dargay & Hanly (2004) reviewed related studies until 2000. found that a fixed 10% increase in the real price of fuel can result in around 1% decrease in traffic flow within a year and an expected 3% reduction in the long term (5 years or more). Moreover, the paper notes that fuel consumption is expected to fall by around 2.5% within a year and by approximately 6% the long term. By considering the results of the survey, it seems that the reason why fuel consumption falls more than the traffic flow is that price increases trigger a more efficient use of fuel.

Several recent studies discuss how traffic flow responds to changes in fuel prices. For example, Mattson (2012) finds out that the gas price change impacts the urban transit demand in the different sizes of cities in the USA. The study developed a polynomial disturbed lag model on transit system data for large, medium-large, medium-small, and small cities. The results showed that there is a significant increase in demand for public transit in large and medium-large cities as gas prices change. Also, the study found that the response to changes in transit behavior is extremely fast in large and medium-large cities, with a significant increase in the use of public transportation, in medium-small cities, there is also an immediate shift towards using public transportation, but at a relatively small rate. In small cities, however, there was not a significant increase in demand until five months after an increase in gas prices.

Despite that, sometimes the fuel price increase happens because of some economic crisis, for example, Musso, Pixxioni, Tozzi, Godard, Lapeyre & Papandreou (2013) focused on the financial crisis in Greece in 2008, which forced the government to increase the fuel taxes by around 82%. Based on the observations of the study, there exists a broad relationship between the income level and demand for road traffic, which also has an indirect effect (via the VOT - Value of Time) on the road traffic elasticity with respect to price.

Numerous case studies have been conducted to investigate this topic. For example, evidence from Malaysia represents the significant impact of fuel price factors on the life and driving behavior of people in Malaysia. According to Rohani & Pahazri (2018), there is a significant change in the usage pattern of private vehicles after an increase in fuel prices, based on data from five large cities in Malaysia. After this change, the drivers have started to prefer alternative transport methods such as public transport, cycling, and carpooling.

In addition to case studies and empirical analyses, some studies focus only on theoretical analysis. For example, Chi, Porter, Cosby & Levinson (2013) introduced a theoretical methodology to analyze the effect of time-varying fluctuations in flue prices on traffic safety in the USA. The study found that as the flue prices increase, the rate of severe crashes decreases. Similar to the previous study, a recent empirical study conducted on the data obtained from New South Wales, Australia, discusses traffic flow response to fuel price changes (Zhang & Burke (2020). In this paper, based on data gathered over 8 years, it was explained that there was, on average, a 0.04 size reduction in traffic flows when the gasoline price increased. The study observed that the result was true during off-peak hours on weekends and weekdays, while fuel price positively affected peak weekend weekend hours. The results indicate that fuel excise can help decrease reliance on roads in general and mitigate the impacts of certain peak-hour traffic congestions.

In addition to the mentioned topics, the impact of fuel price changes on transit behavior has been extensively investigated in the literature. For example, Bento, Hughes & Kaffine (2013) studied the effect of changing fuel prices on carpooling and driver responses in California, USA. Based on their data analysis, they found a clear decrease in traffic flow in response to an increase in fuel prices, and this effect was more pronounced when carpooling was considered as opposed to driving alone. More specifically, the study found an immediate reduction in traffic flow in carpool lanes on highways when fuel prices increased, but the response of carpooling behavior of fuel price changes varied over time.

It is greatly important to consider weather conditions as a significant factor impacting traffic flows as well. For instance, Akin, Sisiopiku & and Skabardonis (2011) examined the correlation between weather conditions and traffic flow volume and speed on highways in Istanbul. According to the data collected by RTMS system, they found the rainy days in Istanbul led to an 8 -12% reduction in vehicle speed and approximately 7-8% decrease in capacity. Recent research by Erdoğan & Kaya (2020) used decision-making techniques, including Interval Type-2 Fuzzy AHP and TOPSIS, to evaluate the use of alternative-fuel buses in public transportation in Istanbul. A separate study by Yaman, Sezer & Sezer (2020) focuses on the problem of traffic congestion in Istanbul. They applied the traffic data published by the Istanbul Metropolitan Municipality at the end of January 2020, which indicated that the traffic density is low with 93% accuracy in all locations between 00:00-07:00 am.

Although various factors influencing traffic flow have been discussed in the literature, this study will only consider two critical factors to understanding traffic flow problems deeply in Istanbul. Turkey's sudden rise in fuel prices and the impact of weather conditions in the city. In fact, there are several reasons why fuel prices in Turkey fluctuate, with the most fundamental being changes in global oil prices. Since gasoline, diesel, and LPG costs are directly linked to international oil prices, any increase or decrease in the latter will have a corresponding effect on the former in Turkey. Aside from global oil prices, other factors include exchange rates and tax rates.

As Turkey imports fuel products from abroad, any increase in the exchange rate leads a sharp rise in the pump prices. Furthermore, the special consumption tax (ÖTV) regulation in December 2022 directly impacts fuel prices in Turkey. As a result of fluctuations in exchange rates and the increase in global oil prices, gasoline prices in Turkey increased 33 times in 2021. While 12 of these hikes were directly reflected in the pump prices, the remaining 21 were imposed as a special consumption tax on the public. In 2022, gasoline prices rose with hikes implemented as of January 1. Moreover, with the invasion of Ukraine by Russia on February 24, 2022, oil prices peaked, and this development was reflected as a hike in fuel prices in Turkey. Because of the continuous increase and hike in gasoline prices, as expected, consumers, namely private vehicle drivers, have reacted to the unwilling change. As discussed in the literature part, it is evident that drivers have changed their behavior and shifted to other options due to the continued increase. These options include a preference for public transportation, adopting hybrid working methods to reduce private car usage, car sharing, and other alternatives. To manage traffic density more efficiently, it is essential to consider all the parameters mentioned earlier and transport behaviors.

The rest of the paper is organized as follows: section 2 discusses the survey conducted to investigate the transit behavior of drivers in Istanbul as fuel prices continue to rise, and presents the results and demographics of the study. Finally, section 3 concludes the study.

2. Problem description

Traffic is fundamentally characterized by three main factors, namely flow, density, and speed, in the literature on transportation. Flow (q) is defined as the number of vehicles passing a specific point per unit of time, density (k) refers to the number of vehicles per unit length, and speed (υ) is defined as the distance traveled per unit of time. Therefore, the most basic equation which explains their relations is given by Eq. (1).

$$q = k\upsilon \qquad (1)$$

According to the literature on traffic theory, such as Maerivoet (2005) and Immers (2020), traffic flow can be distinguished as either homogeneous or heterologous. When a traffic flow is in a homogeneous state, there is a strict lane discipline, and the physical dimensions do not change significantly. In contrast, in a heterologous flow state Tiwari 2007, the physical dimensions of the road vary considerably and include all types, such as pedestrians, cars, motorbikes, trucks, buses, etc.

However, the relation between these variables has been discussed extensively in the literature, and some special cases of homogeneous traffic flow can be highlighted. According to 20. one such case is completely free-flowering traffic when vehicles are not obstructed by other vehicles and can travel by their maximum speed u_f. In this case, the flow and density trend to zero. The second one is called saturated traffic. Under this condition, the flow and speed go to zero, and the vehicles are stuck in a traffic jam, resulting in high density.

The focus of this study is on traffic flows rather than densities. Generally, flow refers to the number of people using a transport service in a time window, while traffic density indicates how congested the road is with cars. The density and flow have an opposite relationship, which means that as density increases, the flow on the road goes to close zero. Prior studies also focused on the flow data, as shown by Burke (2013).

By checking the literature, it is mostly observed that as flue prices increase, the density decreases as fewer people tend to drive. This will lead to either a reduction or an increase in flow depending on whether the traffic would otherwise have been congested or hyper-congested. If the road had otherwise been in a congested state, as the density decreased, the flow would have decreased. If the road had otherwise been in a hyper-congested state, a decrease in density should be expected to increase both the average speed and the flow of vehicles.

With respect to weather conditions, adverse weather, such as rain, may significantly reduce visibility or change adhesion properties. Consequently, it can affect drivers' sense of safety, driving comfort, and their reaction to a changing driving environment (i.e., lower speed and increased headways). Individual drivers' changed behavior affects traffic flow characteristics, that is, average speed and headways, and parameters related to highway performance, such as free-flow speed and capacity Essien 2018 and Romanowska 2022.

3. Survey on transport behavior

In this section, we present a survey conducted in Istanbul to study the relationship between fuel prices and transport behavior. The survey aimed to understand better how fuel price changes affect people's traffic and transport preferences and whether higher fuel prices are associated with an increased preference for public transport. A total of 140 participants who were living in Istanbul at the time were surveyed. While the survey focused on analyzing participants' responses to rising fuel prices in Turkey, demographic questions were also included.

The demographic characteristics of the survey participants are as follows: 57.9% were female and 42.1% were male. In terms of age, 42.9% were between 18-30 years old, 20.7% were between 31-40. 13.6% were between 41-50. 8.6% were 50 years and older, and 12.1% were between 20 and 30. Employment status was also asked, with 48.6% reporting being employed, 41.4% being students, and 10% not working.

Participants' employment status is an important factor to consider when examining the impact of rising gasoline prices on transport behavior. Regarding monthly salary, only 29.3% earned between 4000-8000 TL, 22.1% earned between 1500-4000 TL, and 21.4% earned above 20.000 TL. Participants were asked whether their workplace provided shuttle services from their home to their workplace. Around 64.6% of the respondents reported that their workplace did not provide such a service, while 35.4% answered affirmatively. This question was added to investigate the relationship between workplace-provided shuttle services and traffic behavior, as it was hypothesized that participants may be more inclined to use workplace shuttles as fuel prices increase. In addition, the survey included a question about the distance between participants' home, workplace, and school, to assess the correlation between high fuel prices and travel distances.

Of the survey participants, 87.9% reported having a valid driver's license, while only 12.1% did not. This question aimed to determine the number of participants who could drive a private vehicle. The next question indicated that approximately 52.9% of participants owned a private vehicle, while 47.1% did not. This question was directly related to the previous question, as the participants who reported having a driver's license and owning a private vehicle could be analyzed together. In the question "Do you use your private vehicle to go to school\work or do you prefer to use public transportation?", surprisingly, around 50.7% of respondents reported that they preferred to use public transport, while only 30.7% preferred their own car and 18.6% preferred shuttle services. In relation to the question, the participants were asked whether they preferred public transportation or their own vehicle for destinations other than work/school. Around 55.7% preferred public transport, while 44.3% preferred their own car.

Question 10 directly inquired about any changes in participants' use of shuttle services for commuting to work over the last five months. From the responses, 40% stated that they continued to use the shuttle service with the same frequency, while 34.5% reported that they continued to use their private vehicle with the same frequency. Interestingly, 23.6% said they had started using their private vehicle more frequently. These answers indicate that the use of shuttle services has increased significantly in Istanbul over the last five months of the survey.

Question 11 aimed to investigate any changes in driving habits among the participants in the last 5 months of the survey. The results showed that only 42.1% continued to use public transportation with the same frequency, while 26.4% stated that they now use their private vehicle more often than before. Moreover, 17.1% reported that they continued to use their private vehicle with the same frequency, and 9.3% said that they now use public transportation more frequently than before. This question specifically targeted participants who own and use private vehicles to analyze their habits in response to increasing gasoline prices.

In the next question, participants were asked about the average number of hours they drive per week. About 80% of the respondents answered that they drive for 0-5 hours, while 14.3% reported driving between 6-10 hours. Related to this question, the next question was asked about the average number of hours participants drive on weekends. Indeed, the purpose was to analyze the hypothesis that an increase in gasoline prices can reduce driving hours on weekdays, which usually involve work shifts or school schedules. Most respondents, 87.1%, reported driving for 0-5 hours on weekends.

The next question asked the average distance between the participants' homes and their school/workplace (in km). Approximately 41.4% reported 0-10 km, 25% reported 10-20 km, and 14.3% reported 20-30 km in Istanbul. As the distance increases, the survey participants may reduce the use of private vehicles due to the rising gasoline prices and instead turn to shuttle services or public transportation. In the question "How do you prefer to travel to places that are short distances (0-3 km) away?", almost 72.9% of the respondents said they prefer to walk, 14.3% prefer public transportation, and 11.4% prefer to use their private car. This question was designed to analyze the behavior of the survey participants for short distances. It aims to investigate whether participants who usually use private vehicles, even for short distances when gasoline prices are reasonable, tend to use public transportation or walk with increasing gasoline prices.

Question 16 asks, "Do you think that the number of public transport services should be increased?" with 57.1% responding in favor of increasing the number of metro services and lines, 34.3% in favor of increasing bus and minibus services, and 8.6% in favor of increasing overall public transport services. This question intends to understand whether the increase in gasoline prices leads to a tendency towards using public transportation or if participants continue to use public and private vehicles at the same rate. Finally, the last question "If the gasoline price exceeds how many TL, do you stop using your vehicle?" with 52.9% responding 30TL, 24.3% responding 50TL, and 20% responding 70TL or higher. The list of the questions is given below in Table 1.

Table 1. List of questions.

Q1: What is your gender?
Q2: How old are you?
Q3: What is your employment status?
Q4: What is your monthly Income?
Q5: If you are working, does the place you work provide service to you?
Q6: Do you have a driver's license?
Q7: Do you have a personal vehicle?
Q8: Do you use your private car to go to school/work or do you prefer to use public transport?
Q9: Do you prefer to use public transport or use your private vehicle when going to places other than school/work?
Q10: Has there been a change in your habit of using the shuttle service while going to work in the last 5 months?

Q11: Have your driving habits changed in the last 5 months?
Q12. How many hours do you drive on average per week?
Q13. How many hours do you drive on average on a weekend?
Q14. What is the average distance between your home and school/workplace? (km)
Q15. How do you prefer to travel to short distance (0-3 km) places?
Q16. Do you think that the number of public transport services should be increased?
Q17. If the gasoline price exceeds how many TL, do you stop using your vehicle?

All demographic pie charts are given in Figure 1.

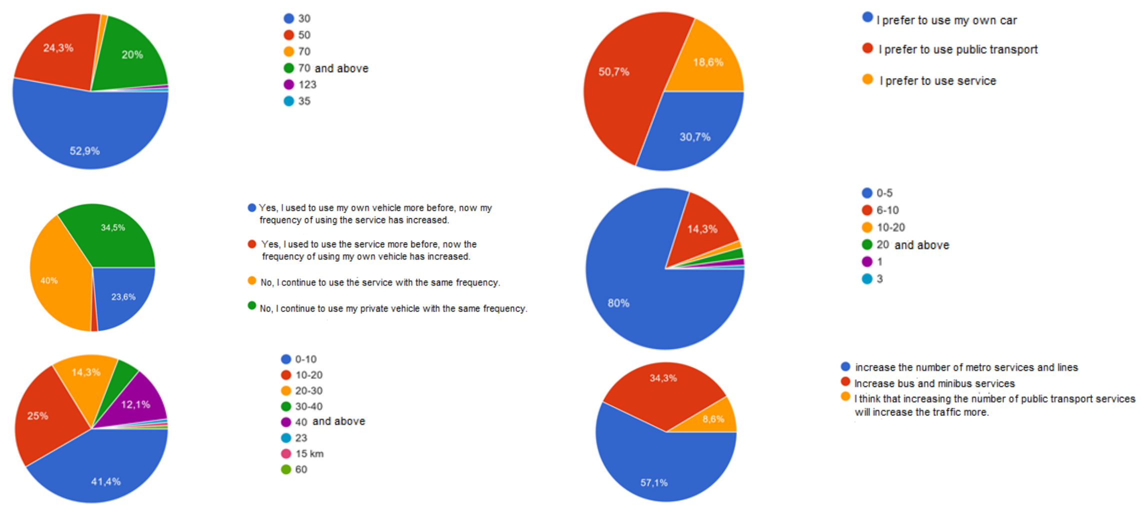

Fig. 1. Demographics Pie Charts.

3.1. Chi-Square analysis results

In this section, the chi-squared analyses were conducted to assess the statistical significance of the observed frequency distribution in relation to the expected distribution, thereby evaluating the presence of any association or deviation between categorical variables. This test yielded a chi-squared statistic of with degrees of freedom and a corresponding p-value. The null hypothesis, positing independence between the variables under study, was rejected or retained based on the predetermined significance level α. The obtained results provide empirical evidence to support or refute the hypothesized relationships within the categorical data, contributing valuable insights to understanding the underlying associations and patterns.

The first analysis is related to two questions: What is the average distance between your home and school/workplace in (km)? And have your driving habits changed in recent months?

Upon examination of the lower section of the Chi-Square Test Table 3, particular attention is given to the minimum expected count, which registers at 0.37, exceeding the threshold of 20 percent. Simultaneously, scrutiny of the Pearson Chi-Square component reveals a corresponding significance value of 0.002. Considering this finding, it is deduced that the null hypothesis can be rejected, affirming our alternative hypothesis's correctness. Consequently, it can be inferred that a discernible relationship exists between the average distance separating home and school or workplace and the observed shifts in driving habits over recent months.

Table 2. Crosstab 1.

			Have your driving habits changed in recent months?				
			Yes, I used to use my private vehicle more before, now my frequently using public transport has increased	Yes, I used to use public transporter more, now I use my private vehicle more often.	No, I continue to use public transport with the same frequency.	No, I continue to use my private vehicle with the same frequency.	**Total**
What is the average distance between your home and school/ workplace? (Km)	0-10	Count	15	2	25	15	57
		Expected Count	20.0	3.0	24.2	9.8	57.0
	10-20	Count	17	4	9	4	34
		Expected Count	11.9	1.8	14.5	5.8	34.0
	20-30	Count	8	0	8	3	19
		Expected Count	6.7	1.0	8.1	3.3	19.0
	30-40	Count	5	1	1	0	7
		Expected Count	2.5	0.4	3.0	1.2	7.0
	40 and above	Count	2	0	14	1	17
		Expected Count	6.0	0.9	7.2	2.9	17.0
	Total	Count	47	7	57	23	134
		Expected Count	47.0	7.0	57.0	23.0	134.0

Table 3. Chi-Square results of the first hypothesis.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.610a	12	0.002
Likelihood Ratio	32.317	12	0.001
Linear-by-Linear Association	0.39	1	0.532
N of Valid Cases	134		

In Table 2, 10 cells (50.0%) have an expected count of less than 5. The minimum expected count is 0.37.

The relationship between the two questions is studied in the second hypothesis analysis. The first question is related to the monthly Income of the participants and the second question is: Have your driving habits changed in recent months? This relationship investigates how monthly incomes can affect transport behaviors by increasing fuel prices.

Table 4. Case processing summary.

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Monthly Income * Have your driving habits changed in recent months?	134	99.3%	1	0.7%	135	100.0%
Working Status * Have your driving habits changed in recent months?	134	99.3%	1	0.7%	135	100.0%
What is the average distance between your home and school/workplace?(km) * Have your driving habits changed in recent months?	134	99.3%	1	0.7%	135	100.0%

Table 5. Crosstab 2.

			Have your driving habits changed in recent months?				
			Yes, I used to use my private vehicle more before, now my frequently using public transport has increased	Yes, I used to use public transporter more, now I use my private vehicle more often.	No, I continue to use public transport with the same frequency.	No, I continue to use my private vehicle with the same frequency.	**Total**
Monthly Income	0-1500	Count	5	3	19	1	28
		Expected Count	9.8	1.5	11.9	4.8	28.0
	1500-4000	Count	11	1	14	3	29
		Expected Count	10.2	1.5	12.3	5.0	29.0
	4000-8000	Count	14	2	18	7	41
		Expected Count	14.4	2.1	17.4	7.0	41.0
	8000-10000	Count	8	0	3	6	17
		Expected Count	6.0	0.9	7.2	2.9	17.0
	10000-20000	Count	9	1	3	5	18
		Expected Count	6.3	0.9	7.7	3.1	18.0
	20000 and above	Count	0	0	0	1	1
		Expected Count	0.4	0.1	0.4	0.2	1.0
	Total	Count	47	7	57	23	134
		Expected Count	47.0	7.0	57.0	23.0	134.0

Table 6. Chi Square results of the second hypothesis.

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	29,809[a]	15	,013
Likelihood Ratio	30.898	15	,009
Linear-by-Linear Association	0.206	1	0.650
N of Valid Cases	134		

In Table 5, 13 cells (54, 2%), constituting 2% of the total, exhibit an expected count lower than 0.05, with the minimum expected count recorded at 0.05. Upon revisiting the sigma value (Table 6), it is observed to be 0.013, falling below the threshold of 0.5. Consequently, it can be deduced that our hypothesis is substantiated. A noteworthy regression is evident between monthly Income and the observed alterations in driving habits over recent months, signifying a statistically significant association worthy of consideration.

In the last hypothesis analysis, the relationship between two questions is studied. The first question is related to the working status of the participants and the second question is: Have your driving habits changed in recent months? This relationship in fact, investigates how working status can affect transport behaviors by increasing fuel prices.

Table 7. Crosstab.

			Have your driving habits changed in recent months?				
			Yes, I used to use my private vehicle more before, now my frequently using public transport has increased	Yes, I used to use public transporter more, now I use my private vehicle more often.	No, I continue to use public transport with the same frequency.	No, I continue to use my private vehicle with the same frequency.	**Total**
Working Status	I am a student.	Count	15	5	27	6	53
		Expected Count	18.6	2.8	22.5	9.1	53.0
	I am working.	Count	17	2	23	17	68
		Expected Count	11.9	3.6	28.9	11.7	68.0
	I am not working.	Count	6	0	7	0	13
		Expected Count	4.6	0.7	5.5	2.2	13.0
	Total	Count	47	7	57	23	134
		Expected Count	47.0	7.0	57.0	23.0	134.0

Table 8. Chi Square Results of the last hypothesis

	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	12.701[a]	6	0.048
Likelihood Ratio	15.243	6	0.018
Linear-by-Linear Association	0.563	1	0.453
N of Valid Cases	134		

In Table 7, in a total of five cells representing (41.7%), the expected count falls below 5, with the minimum expected count recorded at 0.68. Examination of the significance value in the Pearson Chi-Square analysis (Table 8) yields a result of 0.048. Although this value is near the 5% significance level, its small magnitude permits the inference that a statistically significant relationship exists between working status and the observed changes in driving habits.

The survey was designed to scrutinize the impacts of escalating gasoline prices on Istanbul's traffic density, evaluating both the respondents' reactions and subsequent behavioral changes. The study encompassed an analysis of 140 individuals, involving a comprehensive questionnaire comprising 17 questions. The outcomes of the chi-square analysis conducted revealed several significant findings. Firstly, a discernible correlation was established between the average distance separating home and school or workplace and the observed shifts in driving habits over recent months. Additionally, a statistically significant relationship was identified between monthly Income and alterations in driving habits. Furthermore, a nuanced association between working status and driving habits was observed, albeit with a comparatively modest correlation. These findings contribute valuable insights into the multifaceted dynamics of individual behaviors in response to fluctuations in gasoline prices and their implications for traffic patterns in Istanbul.

4. Conclusion and discussion

Based on our analysis, it has been found that there is a negative correlation between traffic density and gasoline prices. However, increasing gasoline prices alone will not be sufficient to reduce traffic density. Furthermore, rising gasoline prices can be a burden for citizens, especially those with lower incomes, who use both public transportation and private vehicles, both economically and psychologically.

To make transportation easier for people and reduce traffic density in Istanbul, it is crucial to improve public transportation conditions. This will shorten people's time on the road and make their transportation more efficient. Reducing the time spent in traffic is expected to decrease stress levels and traffic accidents. As revealed in our survey, more than half of the respondents would stop using their private cars if gasoline prices exceeded 30 TL. Moreover, there exists a substantial demand for an augmentation of metro services.

Consequently, it is anticipated that the upward trajectory of gasoline prices will instigate a discernible transition toward the utilization of public transportation. Considering these evolving dynamics, it becomes imperative to strategically plan and establish new routes for public transport, aiming to navigate the evolving patterns in traffic proficiently. This proactive approach is essential for ensuring effective traffic management in response to the changing preferences and behaviors induced by the escalating costs of gasoline.

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