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Research Paper

Influence of Social Indices on Demand and Supply Policies in Petrol Stations with Congested Queue

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Abstract

The growth and development of urbanization and irregular migration have caused many problems in cities. These issues arose as a result of an imbalanced demand and supply in traffic facilities, resulting in congestion and fuel waste. This problem has explicitly emerged in Iran and is more explicit in Tehran, as its developing capital. One of the main traffic facilities that shows the demand and supply functions is the petrol station. This unbalance is more visible, particularly in Tehran's north, due to high residential density and high land prices. It means it is not possible or cost-effective to construct new stations. Thus, most of the time, long petrol queues waste energy and negatively affect the people in the line. Increasing prices is one of the proper solutions for managing demand to solve this problem, which has been suggested by traffic engineers in recent years. The current study collects data from users of petrol stations in the north of Tehran randomly via questionnaires using the stated preference method to show the sensitivity of price for them. This data is analyzed using SPSS, and the influence of gender, age, residence, education, occupation, car's value, users' threshold of tolerance, and time is investigated. Results show that in all these indices, time has great importance and it makes exceptions. When time is important to the user, he or she is willing to pay more. This is true regardless of the user's wealth, education, job, or place of residence.

Keywords: Stated Preference, Increasing Price, Petrol Station, Tehran

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1. Introduction

Migration to cities, the growth of cities quickly, and urbanization all lead to more traffic and a higher demand for traffic facilities. However, due to the high cost of constructing new facilities, these facilities' development speed is lower than the demand increase. As a result, they cannot accept a large number of demands. Because of this, demand is higher than supply, and many service providers who work in these facilities are having trouble.

On the other hand, people prefer to use personal vehicles due to convenience, traveling time, access, privacy, and not having to face people. This has increased these problems. Congestion, air pollution, sound pollution, an increase in travel time, and many other problems are the undesired results of this choice. One of the service providers in the large group of traffic facilities is the petrol stations.

When traffic increases, the need for refueling and using petrol stations also increases. As the demand for petrol grows, more petrol stations must be built. Even though these stations can be built quickly to meet demand, adding more is neither cost-effective nor possible. In addition to the economic problems, it might result in environmental problems also. Therefore, the current supply level cannot respond to the new demand, resulting in congestion and long queues in gas stations, especially on holidays and weekends. Maybe the term "queue" is strange for some small or even big cities. But this is a big problem in big cities like Tehran, especially in the north, where building new stations makes no sense because land is so expensive and there are so many people living there.

One of the best methods to reduce queues in many human and economic phenomena and even technical problems is to use demand and supply control policies. These policies, which are usually tied to price, are the most straightforward and lowest-cost methods for controlling such problems. Usually, a simple increase in price can reduce demand. Indeed, this problem does not seem so simple at first sight, and all variables and the influential factors should be studied and simulated. The results should be used to make a good choice and put the policies of interest into place.

The stated preference method is being used in this study to look at some of the social factors that affect how people react to rising fuel prices.

2. Literature Review

As mentioned, one of the best methods to reduce queues in many human and economic phenomena and even technical problems is to use demand and supply control policies. Therefore, in section 2.1, a review of supply and demand sources and section 2.2, a review of queue length, are mentioned.

2.1. Supply and Demand

The classic view (competitive) is an economic market for a specific product, including two interacting groups: producer and consumer. The behavior of producers is a function of supply, and consumers' behavior is demanded. The supply function represents the number of products stated by the providers as a function of the product's price. By increasing the price, more profit is generated, and the demand increases. The demand function describes the consumer's general behavior via the relationship between the product and its price. As price increases, consumption decreases [Sheffi, Yosef, 1985].

Shafee et al. [Shafee, Khairul, et al., 2004] have studied the PETRONAS petrol station fuel consumption forecast system by computerizing them. The need for the forecast at each PETRONAS station was necessary because the manager had to report the new fuel delivery orders at least one week earlier. They used the unique paper forms method. This project was accomplished using the exploratory development cycle, and it has begun with analysis, design, development, testing, and final evaluation of the system.

Aburto and Weber [Aburto, Luis , Weber, Richard, 2007] in 2007, presented an intelligent hybrid system with autoregressive integrated moving average and neural networks for demand forecasting. They improved the forecasting accuracy of a Chilean market's replenishment system, leading to fewer sales failure and lower inventory levels than the previous solutions.

Khoo et.al. [Khoo, Hooi Ling, et al., 2012] in 2012 studied the short term impact of fuel price policy change on travel demand in Klang valley region of Malaysia. They studied the impact of this policy on private transportation using spectral analysis for estimating road traffic measurement and travel demand elasticity concerning fuel price. They also estimated the demand for cross-elasticity values of rail transit and buses. The results showed that traffic flow is decreased as fuel price increases, and there is a potential mode shift from private vehicles to rail-transit as fuel price increases. Besides, reducing fuel price subsidy might be a practical approach in managing travel demand for reducing congestion.

Dutsenwai et al. [Dutsenwai, Hauwa Saleh, et al., 2015] in 2015, studied the factors influencing customer loyalty in Malaysian petrol stations through non-probabilistic random sampling. Data collected from 223 customers of petrol stations through self-administered questionnaires and analyzed using SPSS. The results showed a significant correlation between marketing strategies, customer loyalty, and customer satisfaction mediating the relationship among variables. On the other hand, the location of petrol stations reduces the relationship between satisfaction and loyalty.

Mwenda and Oloko [Mwenda, Samuel , Oloko, Dr. Margaret, 2016] in 2016 studied the determination of motorists' choices of a petrol station in Thika Sub-county of Kenya through random sampling via 260 questionnaires and regression analysis. The findings showed that service quality, accessibility, brand preference, and promotion affects the choiaffectby motorists, whchoice ile the price has no. At the same time, on choosing a petrol station by motorists.

Benantar et.al. [Benantar, Abdelaziz, et al., 2016] in 2016 have presented a new formulation for petrol station replenishment. One of the fundamental problems in the petroleum industry is the petrol station replenishment with time windows, which requires determining optimal routes using a fleet of tank trucks to serve a set of petrol stations over a specific planning horizon. They solved this problem by presenting a model.

Khalilikhah et. al. [Khalilikhah, Majid, et al., 2016] in 2016 studied the acceptability of increasing the petrol price as a Travel Demand Managemnet (TDM) pricing policy in Tehran. The goal of Their study was to gauge individual opinions regarding the increasing petrol price policy followed by comparing these options with other TDM pricing policies, including cordon pricing or parking pricing. To this end, they surveyed 266 car commuters in Tehran. Analysis of the collected data showed that increasing the petrol price was the least acceptable policy. To identify the impact of trip-related and socio-economic characteristics of car commuters and their acceptance of increasing the petrol price, an ordered logit model was presented, and the most critical factors affecting commuters were identified. Also, policies that could resualt in better acceptance of increasing petrol price were presented.

2.2. Queue Length

Forming a waiting line is a prevalent scenario that occurs whenever deervice exceeds the current capacity for providing that service. This discrepancy may be temporal, but a queue accumulates during the period. The Formation of a line causes an increase in customers' waiting time, over-utilization of the available servers, and customer satisfaction loss [Onoja, A. A., et al., 2017]. One of the customer satisfaction losses of an organization in today's

competitive organization's success satisfaction is improving service quality. In any service organization, managers are most concerned about how customers are required to wait for receiving their service [Madadi, N., et al., 2013]. Queuing theory is the mathematical study of waiting lines. This theory was presented by Erlang, a Danish mathematician who studied telephone traffic congestion problems in the first decade of the 20th century [Sharma, Ajay Kumar , Sharma, Dr. Girish Kumar, 2013]. Queuing Theory can predict some important parameters like average waiting time and queue length in the petrol station [N.BALAJI, 2017]. The queue analysis is based on building a mathematical model representing the arrival of an item that joins the queue [Sharma, Ajay Kumar , Sharma, Dr. Girish Kumar, 2013].

Odior [Odior, A. O., 2013], in 2013, studied the Queuing Theory in the petrol station of Benin in Edo state of Nigeria. He conducted his study in Benin's 5 petrol stations and obtained the average arrival rate of customers per hour for the five stations. The results show that queues exist in each of the five petrol stations and waiting time in the queue and service time are reduced in five stations as the number of servers increases.

Shojaei et.al. [Shojaie, Amir Abbas, et al., 2012], in 2012, have studied modeling hybrid systems in the non-standard queue and their optimization through simulation in a CNG station. Their goal was to present a mixed model for analyzing the system of non-standard lines considering the scheme's constraints Furthermore, using simulation tools to demonstrate the relatively low efficiency of CNG stations in Iran for providing an optimal combination of servers (fuel nozzle) and efficient schemes for CNG stations were studied.

Moazzam et.al. [Moazzam, A., et al., 2013] in 2013, simulated, modeled, and analyzed the petrol station. They mainly simulated the petrol station's behaviors one of the most important sections of the service industry. Everyone has to deal with every not and then, using Witness 2004 manufacturing edition.

Wei et.al. [Wei, F., et al., 2015] in 2015, proposed an autonomous community architecture and construction technology to solve the city petrol supply management system. In this architecture, each petrol station could share information in real-time. It could also share information with users. Each user could select the adequate petrol station for filling service. Waiting time for the petrol filling service could be decreased.

Ghalankashi et.al [Galankashi, Masoud Rahiminezhad, et al., 2016] in 2016 studied the performance evaluation of a petrol station queuing system through a simulation-based design. Their primary purpose was to design an experimental simulation model to optimize the petrol station queue system and sales rate using Witness 2014 simulation software. Two-level full factorial experiments with center points were done. The model obtained from the experimental design showed that the number of cashiers and inter-arrival time play an essential role in determining the queue length while other factors and their interaction affect the sales rate significantly.

Balaji [N.BALAJI, 2017] in 2017 used MATLAB to simulate queue formation at petrol Bunk stations using multiple servers. The developed model allows the predictions and behavior of different physical and different time occasions through experiments. The simulation gives good results, and different queuing systems used to reduce the wait customers' time of the scribed.

Ghalankashi et.al. [Galankashi, Masoud Rahiminezhad, et al., 2018] in 2018, developed a simulation -Taguchi model to optimize the sales rate of a petrol station. In addition, a regression model to forecast the sales rate. First, Witness 2014 was used to simulate the operating system of the petrol station. The obtained simulation results were then used as the input for the Taguchi method to optimize the

process. Three noise factors like petrol station location, different cashiers, and different dispensers were considered potential factors affecting the response. According to the Taguchi method, the number of pumps and IAT were the most critical factors affecting the sales rate. the purpose of this essay is to the impact of some indices on fuel consumption and the hypothesis considered in this article according to previous studies is that time is vital for users and the person is willing to pay more to save time apart from wealth, education, job, and residence.

3. Methodology

Considering the problem and objectives of this study, different petrol station users' views in the statistical population of interest should be collected about the study problem. In this study, data of interest is collected via a hybrid questionnaire of open and closed questions and scenario making. Figure 1 shows the process of performing the methodology.

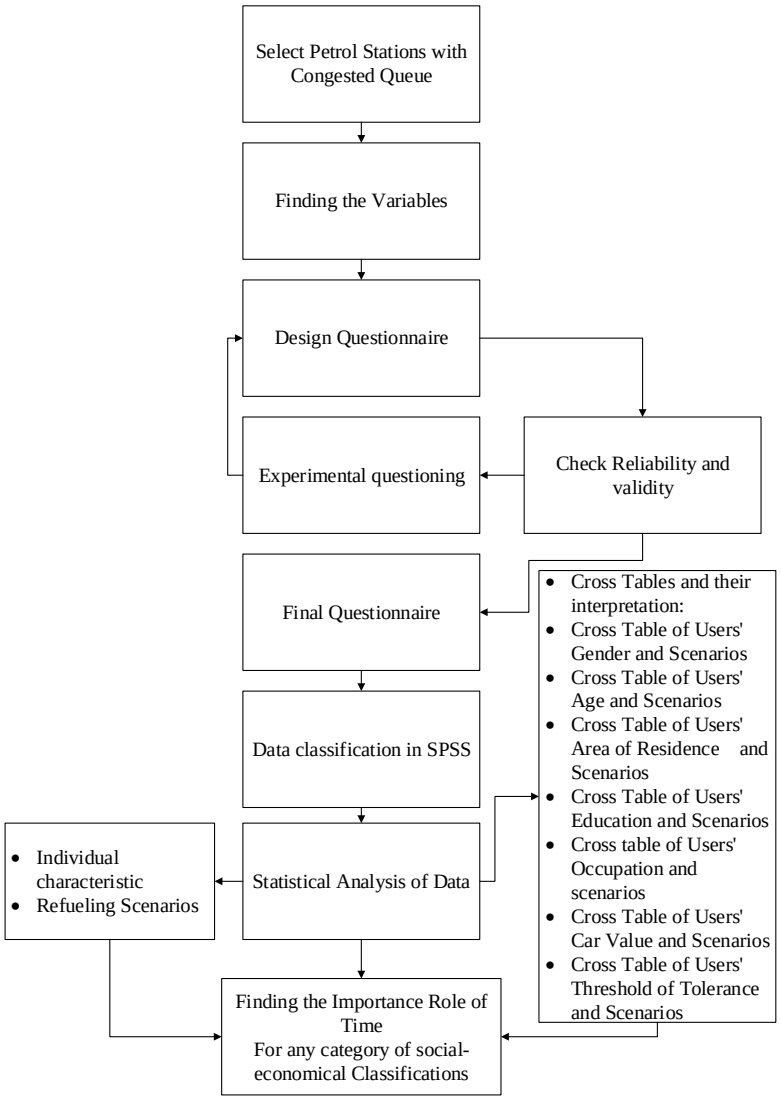

Figure1. The process of methodology

3.1. Revealed and Stated Preference Data

Revealed preference data is associated with the real choices of people in real-world situations. In the revealed preference data, people reveal their tastes or preferences through their choices. Stated preference data is associated with the data collected via experiment or poll, and the

respondents face a hypothetical choice situation. The term "state preference" denotes that the respondents state what would be their choice under such hypothetical conditions [Train, Kenneth, 2002].

Each type of data has its advantages and disadvantages. Revealing people's real choices is the feature of revealed preferences, and it is a significant advantage. However, revealed preference data is limited to the choice situations and attributes of alternatives currently or have existed previously. In some cases, researchers want to know people's decisions in non-real situations; for example, demand for a new product. Revealed preference data is not available for these new situations. Even, in some choice situations, there might be an improper difference in the relevant factors, estimating revealed preference data, impossible [Train, Kenneth, 2002].

Stated preference data complement revealed preference data. A questionnaire is designed in which one or more choices are presented to the respondent. In each situation, multiple options are presented, and the respondent is asked which option he/she would choose in such a situation [Train, Kenneth, 2002]? Limitations of the stated preference data are apparent; what people state they will do is not usually the same as what they do in reality.

3.2. Questionnaire

Reviewing the previous studies and books that have employed the stated preference method and with the help of transportation and statistics experts, designing the stated preference questionnaire was developed. Considering complexities of transportation and facing new variables in each study and its different measurements, questionnaire of a new study cannot be designed based on questionnaires of previous studies and each new study which is conducted using this method requires new questionnaires which have their problems and flaws such as requiring to be checked in terms of reliability and validity. In summary, it can be said that if the questionnaires are designed based on previous studies, they do not need to be checked in terms of reliability and validity, because they have been resolved in the past. But, if like this study, the researcher designed the questionnaire, and it is not based on previous studies, it should be checked in terms of reliability and validity, as mentioned in subsequent sections.

3.3. Designing the Experimental Questionnaire

Hours of the day at which people refuel The initial questionnaire includes three main sections. These three sections and the questions asked in the questionnaire are designed under the supervision of experts of transportation and statistics, which include:

- Individual characteristics: In each questionnaire and most sciences, a part of the questionnaire's questions should identify demographic and individual characteristics. Such questions are as follows:
  - Gender
  - Age
  - Marital status
  - Being head of household
  - Number of family members
  - Number of family members above 15
  - Number of family members below 15
  - Number of working members of the family
  - Approximate location of residence
  - Education
  - Occupation
  - Approximate location of occupation
  - Brand and model of the family's cars
- Information regarding fueling: data regarding fueling and behavior of people in the queue and some data related to petrol station should be collected through the following questions:
  - How much do the people use gas stations (CNG, petrol) throughout a week?
  - Average waiting time of people in the fueling queue
  - Average fueling time

- The threshold of tolerance regarding waiting in the fueling queue
- People's satisfaction of waiting in the queue
- People's use of welfare provided at the stations
- The tendency of people towards increasing the fuel price by the government
- How do people feel about fuel prices after the government has increased them?
- Which days of the week do people refuel
- Hours of the day at which people refuel

- Scenarios: in these scenarios, the price is higher than the authorized price, and people's ideas are studied at different price levels and different levels of queue length. Because it is not possible to change the fuel price and measure the ideas of people of the society (revealed preference). Thus, the questions should be designed and asked regarding hypothetical situations.

In the scenario-making considering the revealed preference of people, usually, one or more attributes like price are varied at different levels, and the people's idea is asked. Usually, in the first and last levels, which are the highest and lowest price levels, it is expected that the people's response is negative. In this study, the first price level is considered the current fuel price, considering people's initial responses.

In these scenarios, it is assumed that there are two waiting lines in the gas station. The first queue is a long queue with a high waiting time and the authorized price of 1000 tomans. The second line is a sparse queue with low waiting time and a higher price than the authorized price. Considering the hypothetical situation, people's idea is asked about different price levels and queue lengths using closed options. They are also asked which line they would join or if they would represent another behavior.

The number of scenarios should be standard. If the number of scenarios is low, the researcher might not obtain the required data. If the number of scenarios is large, then people might get confused and even tired. In this study, 5 scenarios are considered as follows:

1. Fuel price in the second queue is 2000 tomans, and the length of the second queue is 95% shorter than the first queue.
2. Fuel price in the second queue is 1800 tomans, and the length of the second queue is 75% shorter than the first queue.
3. Fuel price in the second queue is 1600 tomans, and the length of the second queue is 50% shorter than the first queue.
4. Fuel price in the second queue is 1400 tomans, and the length of the second queue is 30% shorter than the first queue.
5. Fuel price in the second queue is 1200 tomans, and the length of the second queue is 10% shorter than the first queue.

3.4. Experimental Questioning

As mentioned earlier, since the researcher designs some parts of the questionnaire, it should have experimented, and experimental data should be obtained to resolve the shortcomings and check the questionnaire's reliability and validity. In the experimental questioning, the population questioned should be the same as the population used for the final questioning. On the other hand, the number of people who are questioned lower than the number of people in the final questioning.

In the current study, considering the importance of the problem and role of the questionnaire, 60 experimental questionnaires are filled by the statistical population of interest. 20 questionnaires are used for any of the gas stations in Velenjak, Yadegare Emam and Dadman. 39 questionnaires are filled correctly, and 21 are spoiled. 13 correct questionnaires are obtained from each gas station.

3.5. Reliability and Validity

Reliability of a tool denotes the accuracy and correctness of the data extracted by that tool and data's stability the time. Validity originates from the word "valid" which means "allowed and right" and denotes something is being right. The validity of research indicates if the

measurement tool can measure an attribute of the variable of interest. Validity is important, because insufficient and improper measurement can make a scientific research invalid.

3.6. Reliability and Validity of the Experimental Questionnaire

The data obtained from the experimental questioning and questionnaire is collected, and after discriminating against the correct and spoiled questionnaires, the data is coded in SPSS to be analyzed. The experimental questionnaires have three sections of (a), (b), and (c). Validity of each section is checked independently.

- 6 experts of transportation and statistics verify validity of section (a). On the other hand, this section is designed based on previous valid studies.
- Validity of section (b) is checked through applying Cronbach's alpha test on the experimental data using SPSS. In this study, double-choice questions are checked together, and the results are described as table1. As can be seen, the questions are not highly valid, and they should be eliminated from the questionnaire.

Table 1. Validity of section (b) of the experimental questionnaire

Summary of data processing		
Percent (%)	Number of data(N)	Data
100.00	39	Correct
0.0	0	Rejected
100.00	39	Total
Reliability		
Number of question	Cronbach's alpha	
4	0.356	

- Validity of section (c) is checked through applying Cronbach's alpha test on the experimental data using SPSS. In this study, all 5 questions with 4 choices are checked together and the results are described as table2. As can be seen, the designed scenarios are valid and can be used in the final questionnaire.

Table 2. Validity of section (c) of the experimental questionnaire

Summary of data processing		
Percent (%)	Number of data (N)	Data
100.00	39	Correct
0.0	0	Rejected
100.00	39	Total
Reliability		
Number of question	Cronbach's alpha	
5	0.972	

- Validity of sections (a), (b) and (c) is verified by 6 experts of transportation and statistics. After checking reliability and validity of the experimental questionnaire, many questions are eliminated and modified.

3.7. Statistical Population

The current study's statistical population is simple, including Tehran's gas stations with long and congested waiting lines. A field study concluded that gas stations in the north of Tehran are congested with long waiting lines. In the north of Tehran, the price of land and residential density is high. On the other hand, due to the high land price, investors are not willing to invest in gas stations. Thus, the statistical population changes from Tehran to the north of Tehran.

The simple population has a uniform structure and its people have a common attribute. A uniform and coherent population, simple random sampling (SRS), would be suitable.

3.8. Statistical Sample

By considering the type of the population, 3 gas stations are selected randomly from gas stations of north of Tehran for sampling and collecting data, which are as follows:

- Gas station of Velenjak, located in region 1
- Gas station of Yadegare Emam, located in region 2
- Gas station of Dadman, located in region 2

Each individual usually selects a specific day and hour of the week for refueling. This issue is

not important for some others and they refuel whenever their car runs out of fuel. To preserve randomness of the sampling and to have a correct sample, data should be collected in proper hours and days of the week. For example, if data is collected on Saturdays and Sundays, the people who refuel in the middle of the week or weekends are lost. Thus, it is preferred to sample and collect data on Saturdays, Tuesdays, and Thursdays.

In addition, sampling the population is performed at different hours of the day, including morning, noon and afternoon, as shown in Table 3.

Table 3. Sampling different hours of the day

24:00_1:00	**16:00_17:00**	**8:00_ 9:00**
1:00_2:00	17:00_18:00	9:00_10:00
2:00_3:00	18:00_19:00	10:00_11:00
3:00_4:00	19:00_20:00	11:00_12:00
4:00_5:00	20:00_21:00	12:00_13:00
5:00_6:00	21:00_22:00	13:00 _14:00
6:00_7:00	22:00_23:00	14:00_15:00
7:00_8:00	23:00_24:00	15:00_16:00

When day and hour of sampling are specified, the last problem in this context, would be sampling volume. In the current study, volume of the population is not known. It cannot be said that the users of gas stations in the north of Tehran are only the people who live in the north of Tehran. Passengers and users who refer to these stations from other regions should also be considered; albeit, it is difficult. Therefore, it is preferred to use the Morgan table which is calculated using Cochran's formula with a specific error percentage for different population volumes. The maximum value in Morgan's table for the sampling volume is approximately 384 which does not vary very much in populations with higher volume and it is considered 384 or 385. Therefore, in the current study, the number of people who should be questioned is 387.

3.9. Main Questioning

When location, time, days, and sampling volume are specified, final questioning is performed in gas stations of Velenjak, Yadegare Emam, and Dadman. 129 questionnaires were collected from each station, which makes a total of 387 questionnaires. After collecting the final questionnaires, 360 questionnaires were correct and 27 questionnaires were spoiled. Among these 360 questionnaires, the share of each gas station is 120 questionnaires.

3.10. Reliability and Validity of the Main Questionnaire

After entering the data obtained from the main questionnaires, reliability and validity of the questions are studied as follows:

- Reliability and validity of section (a) of the questionnaire are verified in the previous sections.
- Reliability and validity of section (b) of the questionnaire are verified by eliminating the irrelevant questions and using Cronbach's alpha coefficient.
- The validity of section (c) of the questionnaire is verified in the previous sections. Its reliability is also studied two times as shown in Table 4.

Table 4. Reliability of section (c) of the main questionnaire

Data Processing Summary		
Present (%)	Number of Data (N)	Data
100.00	360	Correct
0.0	0	Rejected
100.00	360	Total
Reliability		
Number of questions	Cronbach's alpha	
5	0.948	

4. Results of Data Analysis and SPSS

This section summarizes the results obtained from SPSS software including descriptive statistics of data and Cross Tables and their interpretation.

Some questions of the questionnaire are

designed as open questions that have numerical values. These values are entered in SPSS as real values and then classified in a new column. Classification provides the possibility to study the data, faster. Classification is performed based on basic statistical concepts. Finally, the variables questioned with open questions are classified and defined with a new column in the software

4.1. Individual Characteristics

In this section, descriptive statistics related to demographic and socio-economic variables are presented in table 5.

Table 5. A summary of descriptive data regarding individual characteristics

Row	variable	Category	category share (percent)	Row	Variable	Category	category share (percent)
1	Gender	Male Female	79.4 20.6	**2**	Age	1 2 3 4 5	34.4 35.8 20.3 7.2 2.2
3	marital status	Single Married	25.3 74.7	**4**	Households	Yes No	63.6 36.4
5	Number of family members	1 person 2 persons 3 persons 4 persons 5 persons 6 persons	1.4 21.7 26.7 41.9 7.5 0.8	**6**	Number of members over 15 years	1 person 2 persons 3 persons 4 persons 5 persons 6 persons	1.7 49.4 21.4 21.4 5.3 0.8
7	Number of members under 15 years	0 person 1 person 2 persons 3 persons	61.7 25.6 12.5 0.3	**8**	Number of family members employed	1 person 2 persons 3 persons 4 persons	56.9 35.3 7.2 0.6
9	Approximate area of residence	North East West South Other	52.5 7.2 24.4 10.3 5.6	**10**	Level of education	PHD MA Expert Associate diploma Under the diploma	7.5 21.7 34.7 5.0 19.4 11.7
11	Job	worker Free Unemployed University student housewife Retired manager Doctor cultural Military Other	9.7 1.9 31.7 1.9 9.7 3.3 6.4 6.7 1.4 6.1 3.9 17.2	**12**	Approximate area of employment	North East West South other	25.3 5.3 13.3 8.9 47.2

Row	variable	Category	category share (percent)	Row	Variable	Category	category share (percent)
13	car type	Inside Outside	74.7 25.3	**14**	Model of car making	1 2 3 4 5	0.3 0.8 7.5 24.2 67.2
15	Approximate value of the car	1 2 3 4 5 6	60.8 11.4 5.3 5.0 2.8 14.7				

According to the table 5, the following results are obtained for the users and the gas station:

1. Most of the users are men.
2. In terms of age, users of age class 2, between 31-42, are more frequent.
3. Number of married users is higher.
4. Number of users who are head of household is higher.
5. Most users live in families with 4 members.
6. In families of most members, there are two members above 15.
7. In families of most members, there is no member under 15. Because most families are formed recently, and they do not have children and in some other families, the couples are old and their children have their own families.
8. In most families of the users, one member is working.
9. Most of the users live in the north of Tehran, which is normal because data is collected in north of Tehran's gas stations.
10. Most of the users are bachelor of science.
11. Most of the users are self-employed.
12. Most of the users work outside their area of residence.
13. Most of the users use cars manufactured in Iran.
14. Most of the cars are manufactured in the fifth interval, between 93-100.
15. Price of the users' car is between 15-115 million tomans.

4.2. Refueling

In this section, descriptive statistics regarding station and refueling are presented in table 6.

Table 6. A summary of descriptive statistics of refueling

ROW	variable	Category	category share (percent)	ROW	variable	Category	category share (percent)
1	Number of users visiting the site per week	1 2 3	94.2 3.9 1.9	**2**	Expected queue from users' point of view	1 2 3 4 5	51.1 46.7 1.9 0.0 0.3
3	Waiting for users to wait in queue	1 2 3 4 5	8.9 39.4 18.9 29.7 3.1	**4**	Satisfaction with queue length	Yes No	81.7 18.3
5	User visits to	Saturday	4.7	**6**	The	8:00-12:00	16.9

the site on	Sunday	3.3	number of	12:00-16:00	1.4
different days	Monday	0.3	users	16:00-20:00	15/3
of the week	Tuesday	4.2	visiting the	20:00-24:00	36
	Wednesday	3.1	site at	24:00-4:00	4.4
	Thursday	15.3	different	4:00-8:00	15
	Friday	12.5	times of the	other	63.6
	Other	80	day		

According to the table 6, the following results are obtained for gas stations and users.

1. Users, usually refer to the station, once a week.
2. From users' point of view, they usually spend 2-14 minutes in the waiting line.
3. Maximum time that the users can tolerate in the waiting line is 10-18 minutes.
4. Most users are satisfied with the time; they currently spend in the waiting line.
5. Weekends are congested in the stations. Most users do not consider a specific day for refueling and refer to the station whenever their car runs out of fuel.
6. Early morning and afternoons are congested hours. Most users do not consider a specific hour for refueling and refer to the station whenever their car runs out of fuel.

4.3. Scenarios

In this section, the users' various preferences regarding higher prices in sparse queue are given, mentioning the share of each choice.

According to the table 7, the following results can be inferred:

1. In each scenario, a significant percentage of users will spend time in congested queues instead of paying more and do not spend less time in sparse queues.
2. In each scenario, a significant percentage of users prefer to pay more and spend less time in the queue. Thus, they join the sparse queue.
3. In each scenario, a small percentage of users pay more and the not tolerate spending the congested queue and change. They probably have an acceptable amount of fuel in their car tanks; otherwise, they cannot give up refueling.

Table 7. A summary of descriptive statistics of scenarios

ROW	Scenario	Selection	Share any selection
1	Scenario 1	Busy queue selection	66.1
		Backyard queue selection	28.9
		Opt out of refueling	5
2	Scenario 2	Busy queue selection	67. 2
		Backyard queue selection	27.8
		Opt out of refueling	5
3	Scenario 3	Busy queue selection	71.7
		Backyard queue selection	22.2
		Opt out of refueling	6.1
4	Scenario 4	Busy queue selection	80.6
		Backyard queue selection	12.8
		Opt out of refueling	6.7
5	Scenario 5	Busy queue selection	82.8
		Backyard queue selection	11.1
		Opt out of refueling	6.1

4.Among the scenarios, scenarios 1 and 2 are more popular to join the sparse queue, although the sparse queue price is higher in these scenarios. This might be because the users feel that if fuel price is 20, 40 or 60% higher, more users join these queues and the

waiting time increases. Therefore, in these scenarios, most of the users prefer the congested queue. However, in the first and second scenarios, since the fuel price is 2 times the authorized price of 1000 toman, fewer users join these queues; thus, their waiting times are much different. Therefore, the sparse queue is more popular in these scenarios.

4.4. Cross Table of Users' Gender and Scenarios

The purpose table 8 is to investigate if there is a difference between the and women's ideas out pricing scenarios? In table 8 represents the response percentage to each option concerning gender.

Table 8. Cross table of users' gender and scenarios

Gender of users		Options	Scenario
Female (percent)	Male (percent)		
17.8	48.3	Option 1	Scenario1
2.2	26.7	Option 2	
0.6	4.4	Option 3	
17.8	49.4	Option 1	Scenario2
2.2	25.6	Option 2	
0.6	4.4	Option 3	
18.3	53.3	Option 1	Scenario3
1.7	20.6	Option 2	
0.6	5.6	Option 3	
18.6	61.9	Option 1	Scenario4
1.1	11.7	Option 2	
0.8	5.8	Option 3	
19.2	63.6	Option 1	Scenario5
0.8	10.3	Option 2	
0.6	5.6	Option 3	

The following conclusions are made according to the table 8:

1. Men join the sparse queue more than women.
2. Men give up refueling more than women.
3. The above conclusions might be due to a lower tolerance of men; they prefer to give up or join the sparse queue and pay more.
4. Another reason is that most men are employed and have less time compared to women. Thus, women show less sensitivity to waiting.

4.5. Cross Table of Users' Age and Scenarios

Purpose of this table is to investigate if there is a relationship between users' age and how they respond to the pricing scenarios? In the following table, response percentage of each age class to each option is presented. According to the table 9, the following conclusions can be made:

1. As age increases, users' preference to pay more is reduced.
2. As age increases, the preference to give up refueling is reduced.
3. The above conclusions might be due to less tolerance of young users compared to the old users that do not tolerate to wait in the lines and prefer to pay more.
4. In addition, the young users who do not pay more, give up refueling; but this is rare among the old users.
5. Another reason might be that young users are full-time employed and they are in a hurry. But old users are either retired or part-time employed.

Table 9. Cross table of users' age and scenarios

Scenarios	Options	Age of users				
		Category1 (percent)	Category2 (percent)	Category3 (percent)	Category4 (percent)	Category5 (percent)
Scenario1	Option1	21.4	22.5	15.0	5.3	1.9
	Option2	10.8	12.2	4.2	1.4	0.3
	Option3	2.2	1.1	1.1	0.6	0.0
Scenario2	Option1	22.5	22.2	15.3	5.3	1.9
	Option2	9.7	12.5	3.9	1.4	0.3
	Option3	2.2	1.1	1.1	0.6	0.0

Scenarios	Options	Age of users				
		Category1 (percent)	**Category2 (percent)**	**Category3 (percent)**	**Category4 (percent)**	Category5 (percent)
Scenario3	Option1	24.2	24.7	15.6	5.3	1.9
	Option2	7.8	9.2	3.6	1.4	0.3
	Option3	2.5	1.9	1.1	0.6	0.0
Scenario4	Option1	27.2	29.4	16.4	5.6	1.9
	Option2	4.4	4.4	2.5	1.1	0.3
	Option3	2.8	1.9	1.4	0.6	0.0
Scenario4	Option1	27.5	30.8	16.9	5.6	1.9
	Option2	4.2	3.1	2.2	1.4	0.3
	Option3	2.8	1.9	1.1	0.3	0.0

4.6. Cross Table of Users' Area of Residence and Scenarios

Purpose of table10 is to investigate if there is a relationship between users' area of residence and how they respond to the pricing scenarios? In the table10, users' response to each option is presented with respect to the area of residence.

Table 10. Cross table of area of residence of the users and scenarios

Scenarios	Options	Area of residence				
		North (percent)	East (percent)	West (percent)	South (percent)	Other (percent)
Scenario1	Option1	29.7	6.1	18.1	8.6	3.6
	Option2	21.1	1.1	4.4	0.3	1.9
	Option3	1.7	0.0	1.9	1.4	0.0
Scenario2	Option1	3.3	6.4	18.6	8.6	3.3
	Option2	20.6	0.8	3.9	0.3	2.2
	Option3	1.7	0.0	1.9	1.4	0.0
Scenario3	Option1	34.2	6.4	18.9	8.3	3.9
	Option2	15.8	0.8	3.6	0.6	1.4
	Option3	2.5	0.0	1.9	1.4	0.3
Scenario4	Option1	4.6	6.9	19.7	8.3	5.0
	Option2	9.2	0.3	2.5	0.6	0.3
	Option3	2.8	0.0	2.2	1.4	0.3
Scenario5	Option1	42.8	6.7	20.0	8.6	4.7
	Option2	7.2	0.6	2.5	0.3	0.6
	Option3	2.5	0.0	1.9	1.4	0.3

The following conclusions can be made according to the table 10:

1. The users who live in north of Tehran prefer to pay more.
2. The users who live in west of Tehran are more than others.
3. Users who give up refueling mainly live in north and west of Tehran.
4. The above conclusions are because the users who live in north and west of Tehran are wealthier and time is of great importance for them. Thus, they prefer to pay a higher price and spend less time in the waiting lines.
5. Another group of these users who have more time, prefers to choose other times for refueling and giving up.
6. Users of other regions prefer to wait and do not pay a higher price.

4.7. Cross Table of Users' Education and Scenarios

Purpose of table 11 is to investigate if there is a relationship between users' education and how

they respond to the pricing scenarios? The following table represents response percentage of users to each option with respect to education.

The following conclusions are made according to the above table.

1. Users with Ph.D., M.Sc, and B.Sc prefer to pay more, which might be because time is of great importance for them and they prefer to preserve time by paying more. On the other hand, their wealth might be higher due to their education.

2. Among users with other levels of education, some prefer to pay more. It can be concluded that these users have high revenues and time is essential for them; thus, they prefer to pay a higher price.

Table 11. Cross table of users' education and scenarios

Scenarios	Options	User education					
		PHD	MA	Expert	Associate	diploma	Underneath
Scenario1	Option1	3.3	11.1	23.3	3.6	15.3	9.4
	Option2	4.2	9.4	86	1.1	3.6	1.9
	Option3	0.0	1.1	2.8	0.3	0.6	0.3
Scenario2	Option1	3.3	11.4	23.9	36	15.3	9.7
	Option2	4.2	9.2	8.1	1.1	3.6	1.7
	Option3	0.0	1.1	2.8	0.3	0.6	0.3
Scenario3	Option1	3.6	13.3	25.3	3.9	15.8	9.7
	Option2	3.3	6.9	6.4	0.8	3.1	1.7
	Option3	0.6	1.4	3.1	0.3	0.6	0.3
Scenario4	Option1	5.0	16.4	28.3	3.9	16.7	10.3
	Option2	1.9	3.3	3.3	0.8	1.9	1.4
	Option3	0.6	1.9	3.1	0.3	0.8	0.0
Scenario5	Option1	5.6	17.2	28.6	3.9	17.2	10.3
	Option2	1.4	2.8	3.1	1.1	1.4	1.4
	Option3	0.6	1.7	3.1	0.0	0.8	0.0

4.8. Cross table of Users' Occupation and scenarios

Purpose of table 12 is to study if there is a relationship between users' occupation and how they respond to pricing scenarios? In the following tables, response percentage of users to each option is presented with respect to their occupation. These tables are all one table which is separated because it could not be inserted in one page.

Table 12. Cross table of users' occupation and scenarios

Scenarios	Options	Occupation of users					
		Employ	manual worker	Free	Unemployed	University student	Housewife
Scenario	Option1	8.1	1.1	19.7	1.4	5.8	2.8
	Option2	1. 4	0.6	1.6	0.6	3.1	0.6
	Option3	0.3	0.3	1.4	0.0	0.8	0.0
Scenario	Option1	7.8	1.1	20.3	1.4	6.4	2.8
	Option2	1.7	0.6	10.0	0.6	2.5	0.6
	Option3	0.3	0.3	1.4	0.0	0.8	0.0
Scenario	Option1	7.8	1.1	23.1	1.4	6.7	28
	Option2	1.4	0.6	6.8	0.6	2.2	0.6
	Option3	0.6	0.3	1.9	0.0	0.8	0.0

Scenarios	Options	Occupation of users					
		Employ	**manual worker**	**Free**	**Unemployed**	**University student**	Housewife
Scenario	Option1	7.5	1.4	27.5	1.1	7.8	3.1
	Option2	1.7	0.3	2.5	0.8	1.1	0.3
	Option3	0.6	0.3	1.7	0.0	0.8	0.0
Scenario	Option1	8.1	1.7	27.5	1.4	7.5	3.3
	Option2	1.1	0.0	2.5	0.6	1.4	0.0
	Option3	0.6	0.3	1.7	0.0	0.8	0.0

The followings can be concluded from the table 12.

1. A percentage of users are ready to pay more. Time is of great importance for such users. On the other hand, the revenue of these users is higher either because they have two salaries or because their spouse is also working.
2. Self-employed users also prefer to pay more which is because of their high revenue. Indeed, time is of great importance for them.
3. A significant percentage of students also prefer to pay more which is undoubted because they are hasty or because time is crucial for them. Alternatively, these users might be from wealthy families.
4. In the table 13, there are several managers who also pay more. This might be due to their high revenue and time-sensitive occupation.

Table 13. Cross table of users' occupation and scenarios (continued)

Scenarios	Options	Occupation of users					
		Retired	**manager**	**Doctor**	**cultural**	**Military**	Other
Scenarios1	Option1	5.0	2.8	0.6	3.9	3.3	11.7
	Option2	1.1	3.9	0.8	1.9	0.3	4.2
	Option3	0.3	0.0	0.0	0.3	0.3	1.4
Scenarios2	Option1	5.0	2.8	0.6	4.2	3.3	11.7
	Option2	1.1	3.9	0.8	1.7	0.3	4.2
	Option3	0.3	0.0	0.0	0.3	0.3	1.4
Scenarios3	Option1	5.0	3.6	0.3	4.4	3.3	12.2
	Option2	1.1	3.1	1.1	1.4	0.3	3.3
	Option3	0.3	0.0	0.0	0.3	0.3	1.7
Scenarios4	Option1	5.0	3.6	0.3	4.4	3.3	12.2
	Option2	1.1	3.1	1.1	1.4	0.3	3.3
	Option3	0.3	0.0	0.0	0.3	0.3	1.7
Scenarios5	Option1	5.6	5.3	0.8	5.0	3.3	13.3
	Option2	0.8	1.1	0.6	0.8	0.3	1.9
	Option3	0.0	0.3	0.0	0.3	0.3	1.9

4.9. Cross Table of Users' Car Value and Scenarios

Purpose of table 14 is to study if there is a relationship between users' wealth and how they respond to the pricing scenarios? In the following tables, response percentage of users to each option is presented concerning their car value (wealth).

Table 14. Cross table of users' car value and scenarios

Scenarios	Options	users' car value					
		Category1 (percent)	**Category2 (percent)**	**Category 3(percent)**	**Categor4 (percent)**	**Category5 (percent)**	Category6 (percent)
Scenario1	Option1	45.8	8.3	2.8	2.5	1.1	5.6

Scenarios	Options	users' car value					
		Category1 (percent)	Category2 (percent)	Category 3(percent)	Categor4 (percent)	Category5 (percent)	Category6 (percent)
	Option2	10.6	2.8	2.5	2.5	1.7	8.9
	Option3	4.4	0.3	0.0	0.0	0.0	0.3
Scenario2	Option1	46.7	8.3	3.1	2.5	1.1	5.6
	Option2	9.7	2.8	2.2	2.5	1.7	8.9
	Option3	4.4	0.3	0.0	0.0	0.0	0.3
Scenario3	Option1	48.1	8.6	3.1	3.1	1.4	7.5
	Option2	8.1	2.5	1.9	1.9	1.4	6.4
	Option3	4.7	0.3	0.3	0.0	0.0	0.8
Scenario4	Option1	51.1	10.0	3.1	3.6	2.2	10.6
	Option2	5.3	0.8	1.7	1.4	0.3	3.3
	Option3	4.4	0.6	0.6	0.0	0.3	0.8
Scenario5	Option1	51.1	10.0	3.6	3.9	2.5	11.7
	Option2	5.6	0.8	1.1	1.1	0.3	2.2
	Option3	4.2	0.6	0.6	0.0	0.0	0.8

The following can be concluded from the table 14.

1. Users' wealth is directly proportional to their preference to pay more.
2. In class 1, a significant percentage of users prefer to pay more. These users might be hasty or wealthy, unlike their car value, oy have time-sensitive occupations.
3. As the price of scenarios decreases, users' preference to pay decreases. This response is not normal and it has been mentioned before, that the users feel that in low price scenarios, the sparse queue's length is as long as the congested queue.

4.10. Cross Table of Users' Threshold of Tolerance and Scenarios

Purpose of the table15 is to study if there is a relationship between users' thresholds of tolerance and how they respond to the pricing scenarios? In the following tables, the users' response percentage to each option is presented with respect to their waiting tolerance.

Table 15. Cross table of users' threshold of tolerance and scenarios

Scenarios	Options	User tolerance threshold				
		Category1 (percent)	Category2 (percent)	Category3 (percent)	Category4 (percent)	Category5 (percent)
Scenarios1	Option 1	5.3	26.9	12.5	18.9	2.5
	Option 2	1.9	11.1	5.6	9.7	0.6
	Option 3	1.7	1.4	0.8	1.1	0.0
Scenarios2	Option 1	5.6	26.9	12.8	19.4	2.5
	Option 2	1.7	11.1	5.3	9.2	0.6
	Option 3	1.7	1.4	0.8	1.1	0.0
Scenarios3	Option 1	5.6	28.3	13.9	21.4	2.5
	Option 2	1.7	9.7	4.2	6.1	0.6
	Option 3	1.7	1.4	0.8	2.2	0.0
Scenarios4	Option 1	6.4	31.7	15.8	23.9	2.8
	Option 2	0.8	6.1	2.2	3.6	0.0

Scenarios	Options	User tolerance threshold				
		Category1 (percent)	**Category2 (percent)**	**Category3 (percent)**	**Category4 (percent)**	Category5 (percent)
	Option 3	1.7	1.7	0.8	2.2	0.3
Scenarios5	Option 1	5.8	32.8	16.4	24.7	3.1
	Option 2	1.4	5.3	1.7	2.8	0.0
	Option 3	1.7	1.4	0.8	2.2	0.0

According to the table 15, the followings can be concluded.

1. Users with high tolerance are less willing to pay more or give up.
2. Middle classes are more willing to pay more, which is not necessarily a linear relationship.

5. Summery and Conclusion

Unbalanced supply and demand in urban and traffic facilities is one of the issues that urban managers must address. One of the main reasons for this problem is the improper and unbalanced development of urbanization and migration. Balanced development of traffic facilities is practically impossible due to its high costs. One of these facilities is a gas station with long waiting lines, resulting in fuel loss and air pollution. Supply and demand management policies have attracted managers' attention due to their low cost; one of these policies is pricing. This paper collects data from users of petrol stations in the north of Tehran randomly via questionnaires using the stated preference method to corroborate the sensitivity of price for them. The reliability and validity of the questionnaires were assessed by using Cronbach's alpha test, which was 0.948. This means the designed scenarios are valid. This data was analyzed using SPSS software. The response percentage to the scenarios shows that some users prefer to pay more. Although many users are not willing to pay more, they will even give up if the waiting line is long. Amidst, users' gender plays an essential role in the responses. Because men are more willing to pay and give up refueling than women, this is less common among older users. The area of residence is directly proportional to the preference to pay more. In areas of residence that are closer to wealthier areas, users prefer to pay more. Education is not necessarily directly proportional to the preference to pay more; this is the same for occupation. Users of expensive cars prefer to pay more; indeed, this is common in cheap cars. Users' waiting tolerance is also directly proportional to their willingness to pay more. In all these indices, time has great importance and it makes exceptions. When time is important to the user, he or she is willing to pay more. This is true regardless of the user's wealth, education, job, or place of residence.

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