Journal of Civil Engineering and Materials Application
Journal home page: http://jcema.com

Received: 26 March 2018 • Accepted: 27 June 2018

Research

doi: 10.22034/JCEMA.2018.91991

Evaluation and Feasibility of Establishing Public Transport Lines in Qazvin

Amirmasoud Hakimian[1*], Ruth Madigan[2]

[1] Department of Civil Engineering, Islamic Azad University, South Tehran Branch, Tehran, Iran

[2] DLR German Aerospace, 38108 Braunschweig, Germany

*Correspondence should be addressed to Amirmasoud Hakimian, Department of Civil Engineering, Islamic Azad University, South Tehran Branch, Tehran, Iran; Tel: +989121381748; Fax: +98345568954; Email: amhcivil@yahoo.com.

ABSTRACT

Launching a public transit route will be effective in generating employment and returning capital, while satisfying citizens. This requires the definition of appropriate lines in terms of type and number of vehicles, origin and destination, line path as well as their scheduling. Hence, the proper knowledge of the origin and purpose of the passengers by passengers and the estimation of their travel attraction will be of particular importance. This is due to the fact that in many cases there is no comprehensive database of trips available to the designer. In such a situation, it is important to adopt a scientific method that can provide the required data with minimal time and cost. Different methods can be developed depending on the conditions of the desired range. In this study, a method is presented to examine the possibility of establishing public transportation lines in the Minoodar town neighborhood located in the 3th district of Qazvin. In this regard, along with adopting a scientific method for identifying the patterns of travel and the amount of public transport demand in this area, lines designed to meet the travel demand of the study area and economically feasible.

Key words: Bus Line Feasibility, Van and Taxi System, Qazvin Bus System.

Journal of Civil Engineering and Materials Application is published by *Raika Pajuhesh Pars*; Journal p-ISSN xxxx-xxxx; Journal e-ISSN 2588-2880.

1. INTRODUCTION

Although the necessity and benefits of creating public transport lines are quite clear, the decline in the use of personal vehicles and consequently the reduction of traffic congestion, air pollution and fuel consumption from the first improvements to the public transport situation, especially in medium and low income areas are the priorities of urban management in the country (1-3). Therefore, by conducting appropriate studies, it is necessary to carry out the measurement of public transportation lines. The efficiency of a transportation line and its success in attracting passengers depends on how it is designed and implemented. Recognizing the correct travel patterns and the amount of demand and providing a plan in harmony with the terms of the study range will reduce the cost and travel time and create desirability for travelers. Accordingly, it is necessary to conduct studies in this regard before any action is taken to establish or develop public transport lines. The methods adopted for achieving the desired parameters are different in various cases and depend on the conditions prevailing on the problem. In the present paper, the methodology proposed for feasibility studies for establishing public transportation lines in the Minoodar neighborhood located in the 3th district of Qazvin is presented. In this study, along with identifying travel patterns within the scope of the study, executive suggestions for creating new public transport lines are presented. As the literature assesses, the public transit planning process is usually divided in a sequence of five steps: (1) the design of routes, (2) the setting of frequencies, (3) the timetabling, (4) the vehicle scheduling and (5) the crew scheduling and rostering. This review addresses the three first and thus fundamental elements of the public transit planning process, also called strategic (step 1) and tactical (steps 2 and 3) planning, respectively (4). All the information needed by the passengers, namely the transit routes network, the frequencies and departure times, is determined during these phases. In the domain of transit planning, several interesting reviews are available. Desaulniers and Barnhart (2006) focus mainly on mathematical methods for each individual steps of the planning process (5). Fan and Machemehl (2004) and Zhao

and Gan (2003) present reviews of the transit network design problem as an introduction to their applied research (6, 7). Finally, Chua (1984) surveys the approaches limited to network design and frequencies setting used by British operators for urban bus services in the 80s (8). The specification of a set of relevant attributes is complex (9). In addition, it is important to identify their relative importance to users' satisfaction. For instance, research has shown that reliability (being on time) is a decisive factor (10-13). The problem is not so much having to wait, but the uncertainty of when the transport will arrive (12). Likewise attributes like frequency (12) and comfort (14) are also highly valued by consumers, being key elements of consumer satisfaction. Other attributes found as having a major negative impact on consumer satisfaction are travel time and fare level (12). Although those attributes are usually considered very important, others may also have a positive effect on satisfaction and can represent great potential for improvement. For instance, service providers should make available clear and simple information. Likewise, the driver assumes an important role in consumer contact. Aspects related to vehicle conditions (for instance, cleanliness) are also meaningful to users (15). It is important to understand that different user segments evaluate the same service quality area differently and their satisfaction will be influenced by different service attributes (16). Also, the needs, beliefs and expectations of users will vary significantly between different segments of the market (17-19). Usually the market is segmented according to socio demographic variables and transport use (car users and public transport users). However, it seems that few differences exist when only socio-demographic segmentation are taken into consideration (17), or when groups are segmented according to transport use (20). This indicates the need for carefully identifying new segments of users according to the underlying psychological constraints, incorporating perceptions and attitudes. Several studies, using different approaches and techniques have made interesting advances in travel market segmentation. Also, it is known that travel behavior is influenced by the service level of the transport system. However, this dependence is not directly related to the objective service level, but is influenced by psychological factors (21). Psychological factors include perceptions, attitudes and habits (22). So, changing the psychological factors may also change travel mode choice, although the level of service remains the same. A way to enhance that knowledge is through qualitative methods which can provide valuable insights into people's attitudes and perceptions towards transport. For example, Guiver (2007) conducted focus groups to discuss bus and car travel, finding that the respondents used different criteria to evaluate each mode, and viewed them differently depending on whether they were users or non-users. When talking about bus travel, respondents focused on worst-case scenarios; however, these were not used to describe car travel (23). Hagman (2003) studied car users and explored how they perceived the advantages and disadvantages of car use. His research showed that advantages and disadvantages are presented differently. Advantages, such as freedom, flexibility and saving time are always personal and a result of personal experience, as are some of the disadvantages such as costs. However, disadvantages concerning environmental impacts are usually presented with references to public discourse. An important aspect of this research is that although respondents seem to agree that car use in general ought to be reduced due to environmental issues, they do not think of reducing their own car use (24).

2. STUDY'S GOAL

According to the Figure 1, the case in this study is the Minoodar town of Qazvin located at the northwest of the city. The area of this region is over 5,000,000 square meters and has a population of over 200,000 people. It is one of the first towns in Qazvin. Investigations and local requests showed that there was a demand for travel between these two parts of the region, but there was no accurate data on the travel pattern of the inhabitants of the region and the points of origin and destination of these trips. Therefore, the study of the possibility of creating public transport lines required detailed studies. Due to the limitations available, these studies should be carried out in the shortest possible time and with the lowest cost, while at the same time it was necessary to have acceptable scientific studies.

In this study, the following objectives were followed:

- Providing a surveying method based on existing limits for collecting trips and passengers data;
- Identifying the origin and purpose of trips within the scope of the study and estimate the daily traffic demand among them;
- Identifying the routes that are eligible for the public transport line;
- Designing public transport lines on designated routes including determining the route of movement, the type and number of vehicles, the location of the terminals of origin and destination.

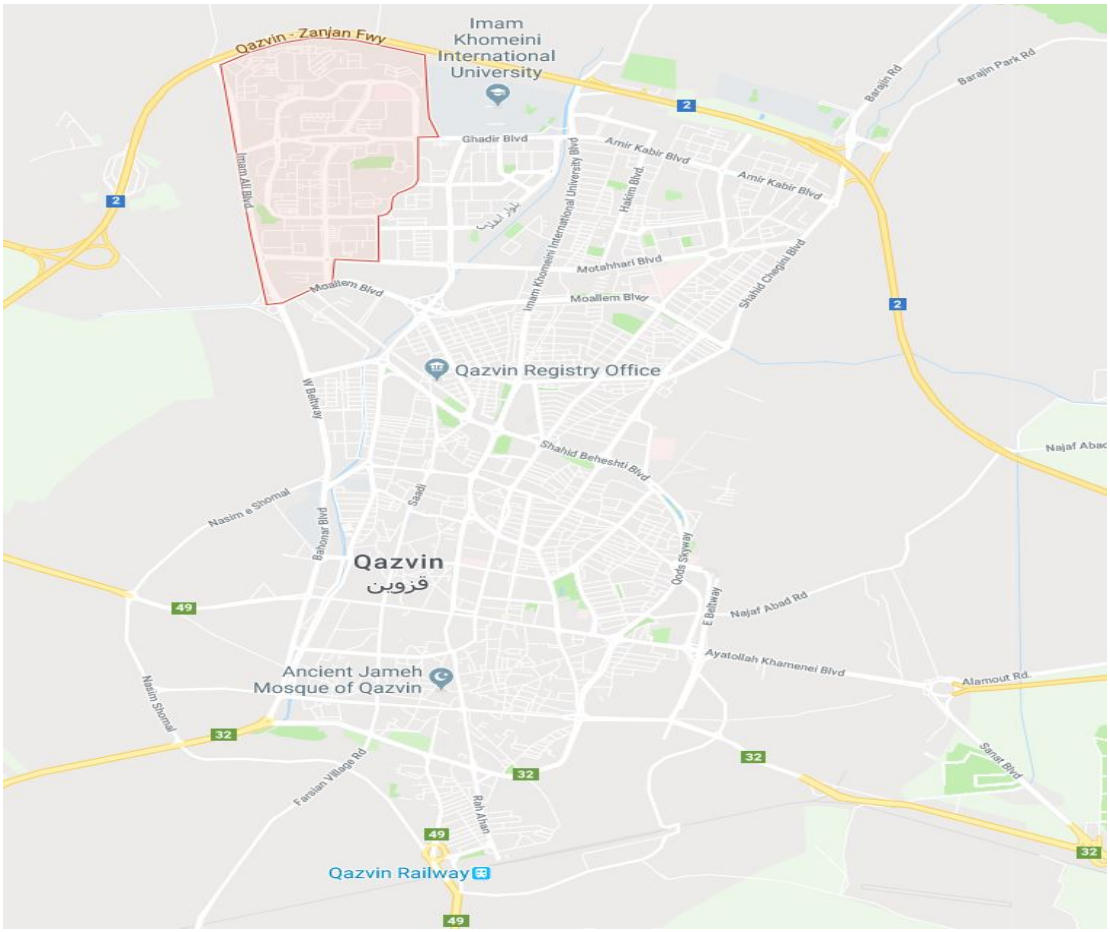

Figure 1. The Case Study Area

3. METHODOLOGY

After a preliminary review of the scope of the study and the estimation of the required information needs, considering the existing limitations, a method has been developed for feasibility of establishing public transport lines within the scope of the study. The steps in this method are shown in Figure 2. The steps are described below.

3.1. Initial Data Gathering

The basic information required for this study includes the conditions of the public transportation systems in the area (terminals and stations, the routes and daily statistics of the passenger), the conditions of use, the points of production and attraction of travel, important intersections and the points of exchange of travel. This information was received from relevant official authorities.

3.2. Surveying

In order to estimate travel demand, an interviewing survey based on a scientific method is used to obtain the result in the shortest possible time. Based on this, a questionnaire designed to be completed by a questionnaire and interview with travelers. The design of the questionnaire has been carried out in such a way that, in its simplicity and speed, the basic information required for the study is provided. The result of analyzing the data of this questionnaire was used to understand the approximate situation of travel demand in the region in terms of number of passengers, origins and destinations, type of vehicle and other necessary parameters. Since the purpose of the survey in this study is to estimate the number of people traveling through the public transport between the two regions in question, the sample population was the number of travelers who travel by using public transportation systems or personal passenger cars. The survey shows that in suburban areas where vehicles are less difficult to drive and park, the utility of a personal vehicle is primarily higher than public transportation, so it is assumed in this study that the passengers of the personal vehicles also use personal transport after creating public transportation lines. Hence, passengers traveling between two points with their vehicle are not included in the sample. Eventually, the study areas included terminals and public transport stations, exchange points and important intersections and public transportation were moving between the Minoodar town and other areas. The survey was conducted on a mid-day work day and covered the entire morning and evening hours. The required number of samples was selected based on scientific methods of the total target population. After the survey, form information was implemented. At this stage, the data is refined and after deletion of irregular data or irrational records, the correct data is used in the analysis phase.

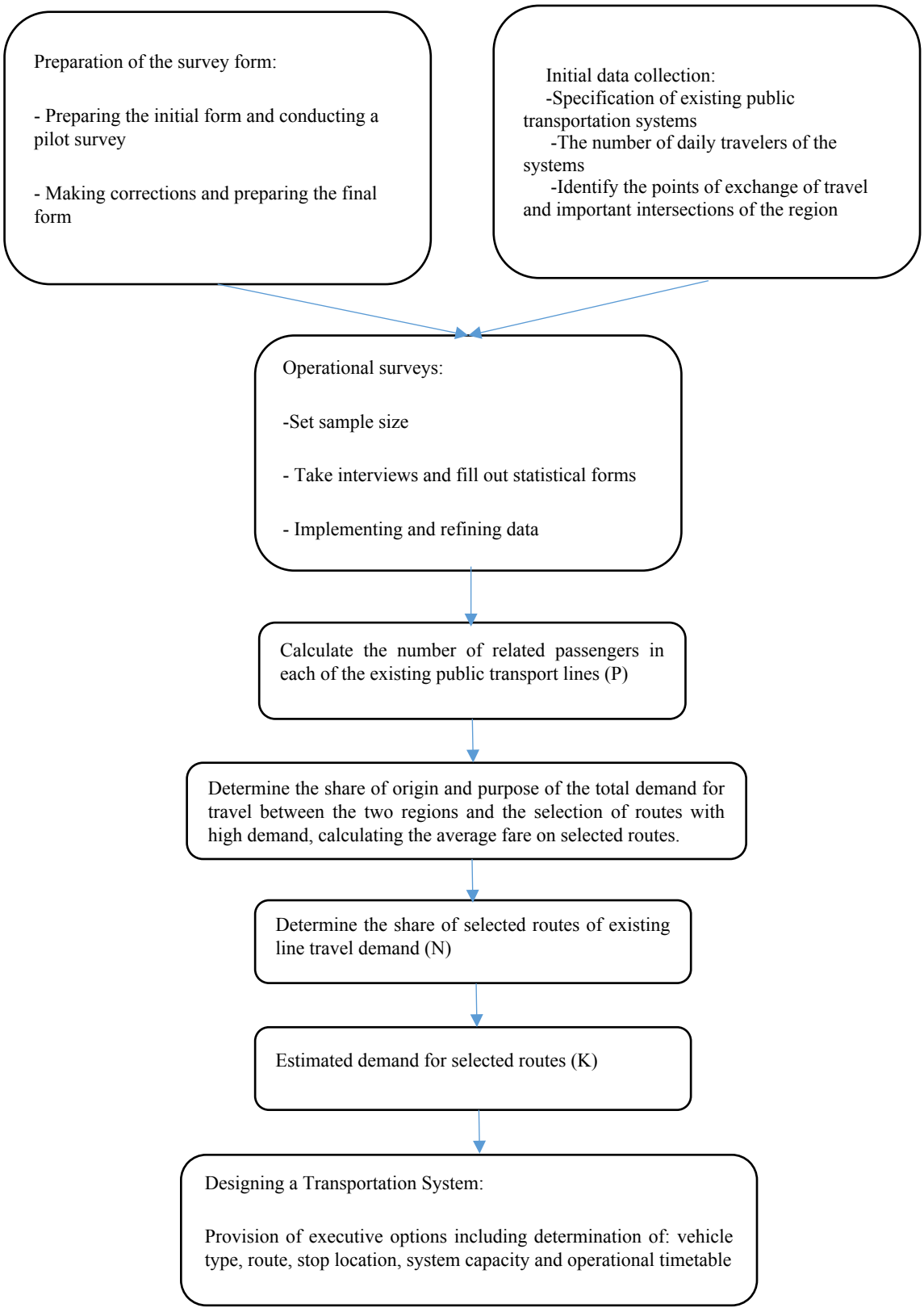

Figure 2. The process of conducting a feasibility study for creating freight lines

3.3. Variable Definition

The methodology of this study is based on the existing statistics on bus and taxi organizations and the results of the survey. A sample of passengers of various types of

public transport has been selected randomly. Naturally, some public transport passengers travel outside the scope of studies or come from areas outside the boundaries that are unrelated to the subject of studies, but travel-related studies, by changing the vehicle at a point of exchange, eventually travel to areas where consider these studies.

Depending on the type of questionnaire and the identification of the origin and purpose of travel, questioners related to the subject, the origin and the destinations that have the greatest demand for travel can also be determined. The number of passengers between each of these origins or destinations to the total number of passengers will determine the share of each of the origins and destinations from the total. Of all the origin and destinations mentioned by travelers, the most frequent cases, as far as significant differences are observed between their frequencies with other less demanding destinations, are identified as selective destinations. In summary, the data needed to estimate the demand for public transportation from the target area to other areas are:

- Total daily passengers of each public transport line in the region, including bus and taxi. (Statistics obtained from relevant organizations);
- The ratio of passengers between the studied area and the destinations related to the total number of passengers in each of the public transport lines (P); (derived from the survey results);
- The share of passengers of the intended destination of the passengers concerned (N);

In addition to the above, the total amount of fares paid by travelers to travel to selected areas is also considered as the basis for the fares to be charged on new probable lines.

3.4. Estimated travel demand for selected areas

With the availability of the indicators presented in the previous section and the available statistics on the performance of active transportation lines within the scope of the study, the travel demand of each of the selected areas is calculated. This demand is equal to the total number of passengers on roundtrip routes to these areas that use different lines. (This does not include personal passenger traffic). To calculate the travel demand for each area, relationships 1 and 2 are used:

$$K_i = P_i * N_i * S_i \quad (1)$$

$$K = \sum_{i=1}^{m} K_i \quad (2)$$

K: Demand for the selected area;

K_i: Demand for travel to the selected area with line I;

P_i: The share of passengers related to the subject in line I;

N_i: Selected area share of travel demand of line I;

S_i: Total Daily Travelers of Line I;

m: Total number of lines available.

3.5. Designing a transportation system

Depending on the amount of travel demand on the selected routes, it is possible to create a transportation line and its specifications. In terms of demand, the proposed system can be a bus, van or taxi. The choice of the type of the device is determined on the basis of economical and desirability of the passengers. The waiting time, fare, station distance to the place of residence and travel time are considered factors affecting the utility of the system for the passenger.

4. RESULT AND DISCUSSION

In the first step, to determine the size of the statistical population, the daily statistics of passengers displaced by taxi and bus systems were obtained from the official authorities. Accordingly, the total number of daily commuters in the Minooder region was estimated to be around 20,000. To determine the size of the sample, the Cochran relationship was used to calculate sample size. This relationship for the 95% confidence factor and the population size (20000) N and the error 0.05, the sample size is 377 and for the error 0.03, the sample size is 1013. Because of the type of questionnaire's questions in such a way that the specimen could not describe all the characteristics of the society, for the greater margin of confidence the error of 0.03 was chosen and in the upper hand the sample size was determined to be 1020 men and women of different ages. In order to prepare a questionnaire in this study, a first questionnaire was prepared first, and a final questionnaire was prepared by performing a pilot study with about 5% of the population of the main sample and eliminating its drawbacks (Figure 3). The survey was conducted on Tuesday, 06/02/2018, at peak hours of the morning, evening, afternoon, the important points of the exchange of travel in this area and in the active public transport vehicles. The method of performing the survey was that interviews with the sample subjects were initiated by first questioning the form based on the intention to travel between the two studies areas, and if the answer was positive, the statistical form was completed. Otherwise, the next sample would be interviewed. A total of 1020 people were questioned. After the implementation of its statistics and refinement, the accuracy of 910 questions was confirmed and 110 forms were completed. The summary of the statistical information obtained is shown in Table 1. This table shows the number of people interviewed, broken down by public transportation lines in the region. The points reported by the relevant passengers, as the origin and destination of the trip, are shown in Figure 3. It is therefore apparent that Elahie, Kabl Alborz and Ghadir are the points that make the largest contribution to the travel of passengers. The share of the three selected regions from the demand for various types of public transport lines is shown in Table 2. (In the future, with the increase in travel demand in the area, it is possible to consider other areas as well).

Table 1. Summary of statistical information collected

Line Name	*Related People*	*Other People*	*Sum*	*Percentage of related people (P)*
Bus- Bazar	33	263	296	11
Bus-Navab	8	121	129	6
Taxi-Bazar	14	112	126	11
Taxi-Navab	12	147	159	8
Taxi-Minoodar	19	75	94	20
Taxi- Circulating	24	82	106	23
Sum	110	800	910	12

Also, the frequency of paid fares for travel to selected areas of the Minoodar town region is shown in Table 3. Based on the data of Table 1 and Table 2 and statistics received from taxi and bus organizations, the calculation of travel demand was made using relations (1) and (2). The results of the calculations are summarized in Table 4.

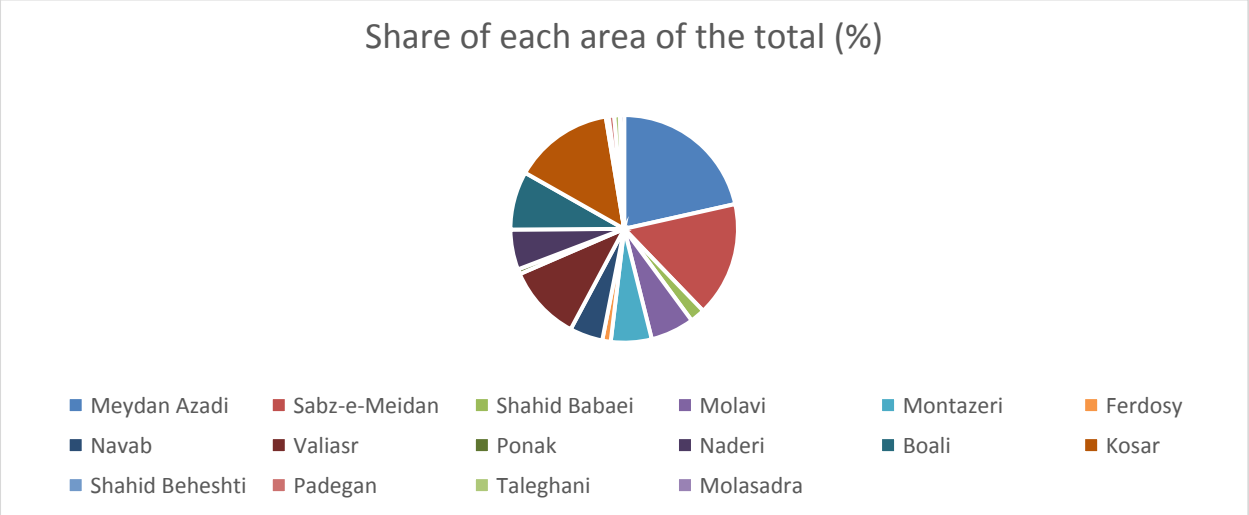

Figure 3. Share of different areas of travel demand

Table 2. Share of area of related persons per line (in percentage) (N)

	Bus- Bazar	*Bus-Navab*	*Taxi-Bazar*	*Taxi-Navab*	*Taxi-Minoodar*	*Taxi-Circulating*
Meydan Azadi	21	44	41	41	26	50
Sabz-e-meydan	79	25	59	59	50	50
Kosar	-	31	-	-	24	-

Table 3. The frequency of paid fares in selected areas

Rout	*Up to 500*	*500-1000*	*1000-1500*	*1500-2000*	*More than 2000*	*The most frequent paid fare*
Meydan Azadi	3	28	5	3	2	500-1000
Sabz-e-meydan	10	8	6	2	9	Up to 500
Kosar	5	9	5	3	-	500-1000

Table 4. Estimated travel demand in selected areas

Region	*Bus Demand*	*Taxi Demand*	*Sum*
Meydan Azadi	911	83	994
Sabz-e-meydan	895	102	997
Kosar	721	38	759

The numbers in Table 4 are the basis for the design of transport lines. In the first step of designation, the selection of the vehicle was done. Here are three types of bus, taxi and van. The choice of bus is a priority because of its many advantages over other vehicles. So, at first, the feasibility of creating bus lines is examined. On the bus lines, two factors, including the number of passengers in order to achieve sufficient economic gain and the passenger waiting time for bus is important. Therefore, in high demand conditions, bus choices will be great for both passengers and bus system. By checking the active lanes of the area and interviewing the bus authorities, the minimum number of passengers required to make a cost-effective economy and create a line was estimated to be 500 per day per bus. Relationship (3) was also used to calculate the mean of the line of the bus line.

$$T = \frac{r.t}{R}$$

(3)

T: Passenger waiting time
r: The number of daily passengers per bus (equal to 500 in this study)
R: Total daily population of line travelers
t: Duration of a bus sweep
Due to the high headway of bus and other reasons that keep the utility of the bus vehicle lower than the taxi, it is assumed that, if the bus line is constructed, most taxi passengers are reluctant to use the bus. As a result, tax passengers are not included in the calculation of daily bus demand. Thus, based on the approximate roundabout time of each path and the numbers in Table 4, the waiting time for travelers is shown in Table 5. This time is, in fact, the average waiting time and increases during the low traffic hours of the day.

Table 5. Estimated passenger waiting time for bus

Region	*Approximate Bus Sweep time (min)*	*Passenger waiting time (min)*
Meydan Azadi	90	22
Sabz-e-meydan	72	20

According to this table, the average waiting time for travelers is more than usual in Qazvin (10-15 minutes) and will not be desirable for travelers. It should be noted that if there is an increase in the number of buses to reduce the headway and waiting time for passengers, drivers' income will be reduced and the line will not be profitable. With the inactivity of the construction of bus lines, the design of taxi or van lines was considered. In this regard, the route of movement and the location of the terminals of the beginning and the end, as well as the number of vehicles needed. The type of vehicle is set in two modes of riding and a combination of riding and van. Rental rates are also lower than the average. In Table 6 and Table 7 the characteristics of the taxi system designed for the selected areas are included. The total amount of fares for bus passengers is taken into account in the selection of the fare for each route, taking into account the greater share of bus passengers.

Table 6. Characteristics of the Meydan Azadi – Minoodar Line

Proposed vehicle type	*Daily Demand Volume*	*Vehicle*	*Sweep time*	*Work hour*	*Capacity*	*Fleet Size*	*Current Bus Fare*	*Proposed Fare*
First Mode: Taxi	890	Taxi	54 min	8	4	16	450	450
Second Mode: Taxi and Van	890	Taxi	54 min	8	4	12	450	450
		Van	54 min	8	10	5	450	400

Table 7. Characteristics of the Sabz-e-Meydan – Minoodar Line

Proposed vehicle type	*Daily Demand Volume*	*Vehicle*	*Sweep time*	*Work hour*	*Capacity*	*Fleet Size*	*Current Bus Fare*	*Proposed Fare*
First Mode: Taxi	880	Taxi	42 min	8	4	14	450	400
Second Mode: Taxi and Van	880	Taxi	42 min	8	4	10	450	400
		Van	42 min	8	10	4	450	300

The location of terminals was determined by local visit and examination of the region's operating conditions. The location of the Minooder terminal was located at the beginning of Minoodar Boulevard and its intersection with Qazvin Imam Khomeini University Street. The Sabz-e-Meydan terminal was designated as the terminal line of the Meydan Azadi-Minoodar and Saadi Street as the Azadi-Minoodar Line Terminal.

5. CONCLUSION

The results of this study can be summarized in the following sections:
1- Provides a scientific method for estimating the approximate transport demand in the study area;
2- Identification of the origin and purpose of travel between the Minoodar town and other parts of the region.
3. Identification of points with high demand for travel to the Minoodar town and vice versa, including the Sabz-e-meydan, Meydan Azadi and Vali Asr neighborhoods;
4. Designing a taxi line with capability of taxi and van for connecting Meydan Azadi to the Minoodar town;
5. Designing a taxi line with capability of taxi and van for connecting Sabz-e-meydan to the Minoodar town.

FUNDING/SUPPORT

Not mentioned any Funding/Support by authors.

ACKNOWLEDGMENT

Not mentioned any acknowledgment by authors.

AUTHORS CONTRIBUTION

This work was carried out in collaboration among all authors.

CONFLICT OF INTEREST

The author (s) declared no potential conflicts of interests with respect to the authorship and/or publication of this paper.

REFERENCES

1. Manaugh K. Incorporating issues of social justice and equity into transportation planning and policy: McGill University Libraries; 2013.
2. Anderson ML. Subways, strikes, and slowdowns: The impacts of public transit on traffic congestion. American Economic Review. 2014;104(9):2763-96.
3. Abdi A, Bigdeli Rad H, Azimi E, editors. Simulation and analysis of traffic flow for traffic calming. Proceedings of the Institution of Civil Engineers-Municipal Engineer; 2016: Thomas Telford Ltd.
4. Gipps PG. A model for the structure of lane-changing decisions. Transportation Research Part B: Methodological. 1986;20(5):403-14.
5. Barnhart C, Laporte G. Handbooks in operations research and management science: transportation: Elsevier; 2006.
6. Fan W, Machemehl RB. Optimal transit route network design problem with variable transit demand: genetic algorithm approach. Journal of transportation engineering. 2006;132(1):40-51.
7. Zhao F, Gan A. Optimization of transit network to minimize transfers. 2003.
8. Chua TA. The planning of urban bus routes and frequencies: A survey. Transportation. 1984;12(2):147-72.
9. Prioni P, Hensher DA. Measuring service quality in scheduled bus services. Journal of Public transportation. 2000;3(2):4.
10. Bates J, Polak J, Jones P, Cook A. The valuation of reliability for personal travel. Transportation Research Part E: Logistics and Transportation Review. 2001;37(2-3):191-229.
11. Edvardsson B. Causes of customer dissatisfaction-studies of public transport by the critical-incident method. Managing Service Quality: An International Journal. 1998;8(3):189-97.
12. Hensher DA, Stopher P, Bullock P. Service quality—developing a service quality index in the provision of commercial bus contracts. Transportation Research Part A: Policy and Practice. 2003;37(6):499-517.
13. König A, Axhausen KW, editors. The reliability of the transportation system and its influence on the choice behaviour. Swiss transport research conference (strc), monte verità/ascona; 2002.
14. Friman M, Edvardsson B, Gärling T. Frequency of negative critical incidents and satisfaction with public transport services. I. Journal of Retailing and Consumer Services. 2001;8(2):95-104.
15. Swanson J, Ampt L, Jones P. Measuring bus passenger preferences. Traffic Engineering and Control. 1997;38(6):330-6.
16. Wallin Andreassen T. (Dis) satisfaction with public services: the case of public transportation. Journal of Services Marketing. 1995;9(5):30-41.
17. Anable J. 'Complacent car addicts' or 'aspiring environmentalists'? Identifying travel behaviour segments using attitude theory. Transport policy. 2005;12(1):65-78.
18. Jensen M. Passion and heart in transport—a sociological analysis on transport behaviour. Transport Policy. 1999;6(1):19-33.
19. Barabino B, Deiana E, Tilocca P. Measuring service quality in urban bus transport: a modified SERVQUAL approach. International Journal of Quality and Service Sciences. 2012;4(3):238-52.
20. Shiftan Y, Outwater ML, Zhou Y. Transit market research using structural equation modeling and attitudinal market segmentation. Transport Policy. 2008;15(3):186-95.
21. Fujii S, Kitamura R. What does a one-month free bus ticket do to habitual drivers? An experimental analysis of habit and attitude change. Transportation. 2003;30(1):81-95.
22. Ajzen I. The theory of planned behavior. Organizational behavior and human decision processes. 1991;50(2):179-211.
23. Guiver JW. Modal talk: discourse analysis of how people talk about bus and car travel. Transportation Research Part A: Policy and Practice. 2007;41(3):233-48.
24. Hagman O. Mobilizing meanings of mobility: car users' constructions of the goods and bads of car use. Transportation research part D: Transport and environment. 2003;8(1):1-9.