

POLITECNICO DI TORINO

**Master of Science
In civil engineering**

Master of Science Thesis

**Analysis of the bus network of Rasht (Iran) and
description of some proposals due to improve the service**

Analisi della rete degli autobus di linea di Rasht (Iran) e descrizione di alcune proposte
volte a migliorare il servizio



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Abstract

Nowadays, according to growth of cities and increase in private car usage, having an efficient public transport is considerably important. It should be mentioned that just having public transport service would not be sufficient and it needs to be planned precisely, otherwise, it cannot help passengers and causes more traffic in the city as well. The bus network of Rasht (Iran), which has around one million inhabitants, is the case study of this dissertation. The goal of the thesis is to analyse such network and provide some initial proposals that could improve the service performance.

Nowadays engineering software is used for saving time and accurate analysis. Software tool that used in this thesis is QGIS which has satellite maps analysis capability. Initial database of this thesis is taken from “Amayesh Sarzamin” research group, which contains the detailed data of each line including travel time between any two consecutive stops, boarded and alighted passengers at each stop for which also the geographic coordinates are known. These data were collected in 2012. With respect to overcrowding analysis, it is proposed to replan the allocation of the bus fleet to different lines for being more effective and efficient. After investigating given information, adding one new bus line is suggested and details of new line are also provided.

In the first chapter of thesis, general statements, purpose and case study of research are represented. Second chapter consists of studying researches and papers related to thesis topic. In chapter three Introducing basic statistics such as public bus transport of Rasht, details of each stations and analyzing all bus routes are mentioned. Chapter forth devotes to QGIS analysis which determining stations with more passengers. First of all, the stations are represented in a map with dots whose dimension is scaled relative to the number of boarded passengers and got off passengers. Then the important stations are highlighted. At the end 6 areas which had high demand of line changing are identified. In fifth chapter overcrowding analysis was done. The concept of this analysis is checking sufficiency of system relative to the capacity of fleet, in the other word with this analysis is possible to verify sufficiency of fleet for each line. For this purpose, number of passengers getting on and off the bus in all stations were assessed over the peak hour. It is found that some lines have more passengers than their actual capacity, in other words, there are overcrowded ones. On the other hand, some lines have less passengers than the capacity. By all these, it would be possible to reduce fleet size of some less useable lines and add them to the high demanded routes in order to improve the function of public transport system. In sixth chapter, according to given results of forth chapter, a new line for public bus transport system is suggested. The purpose of adding new line is to cover the areas which are defined in chapter four. It is designed in a way that can pass through high demanded points. Then is estimated travel time and

interval of passage for this new line, proportional to other existent lines. Chapter seven devotes to conclusion of analysis. The appendix of the thesis includes all statistics data and information that analyzed and represented in some kind of tables.

Riassunto

Oggi giorno, considerando la crescita delle città e l'incremento dell'uso privato dell'automobile, è molto importante avere un trasporto pubblico efficiente. È da considerare che offrire un servizio di trasporto pubblico di per sé non è sufficiente; esso va infatti progettato con precisione, in modo da evitare che esso sia effettivamente d'aiuto ai passeggeri e anzi sia causa di altro traffico nelle città. La rete di autobus della città di Rasht (Iran), che conta circa un milione di abitanti, è il caso studio di questa dissertazione. Il fine di questa tesi è di analizzare questa rete e avanzare nuove e iniziali proposte per migliorare le prestazioni di tale sistema.

Gli attuali software ingegneristici sono usati per ridurre i tempi di progettazione e fornire accurate analisi. Il software quivi usato è il QGIS, il quale ha la capacità di analizzare le mappe satellitari. Il primo database è derivato dal gruppo di ricerca "Amayesh Sarzamin", che contiene dati dettagliati di ciascuna linea per ogni fermata, corredati dalle coordinate geografiche della stessa, inclusi quelli riguardanti le tempistiche di viaggio fra due punti consecutivi e il numero di passeggeri che scendono o salgono da un determinato bus. Questi dati sono stati raccolti nel 2012. Nel rispetto dell'analisi del sovraffollamento, è proposto di ripianificare il collocamento della flotta di autobus su linee differenti, in modo da renderle più efficienti ed efficaci. Dopo aver vagliato le informazioni date, si avanza la proposta di aggiungere una nuova linea, della quale si illustrano le principali caratteristiche.

Nel primo capitolo della tesi vengono presentati obiettivi, caso di studio e informazioni generali sull'argomento. Il secondo capitolo consiste nell'approfondimento dei documenti di ricerca utilizzati. Nel capitolo tre si introducono le statistiche di base relative al servizio pubblico di trasporto in autobus di Rasht. Si fa menzione, inoltre, dei dettagli delle singole stazioni e delle tratte degli autobus. Il capitolo quattro è relativo all'analisi con l'aiuto di QGIS da cui sono state determinate le stazioni più affollate da passeggeri. Prima di tutto, le stazioni sono state rappresentate in una mappa con punti di cui la dimensione è scalata in relazione al numero di passeggeri saliti e scesi. Di conseguenza, sono state evidenziate le stazioni più importanti. Infine, vengono identificate le sei aree con la più alta domanda di cambio linea. Nel quinto capitolo è stata eseguita l'analisi di sovraffollamento. Tale analisi è utile per una verifica dell'adeguatezza della capacità della flotta per ciascuna linea. A tal fine, è stato valutato il numero di passeggeri (in ogni stazione) all'interno dell'ora di picco. Sulla base di ciò, si è potuto notare come alcune linee abbiano più passeggeri rispetto alla loro reale capacità. Dette linee sono quelle sovraffollate. D'altro canto, alcune linee risultano avere meno passeggeri rispetto alle previsioni. A seguito di tale procedimento, sarà possibile ridurre il numero di mezzi impiegati su alcune delle linee meno utilizzate,

ridistribuendole su altre con alta domanda di trasporto (pubblico). Si sarà ottenuta, così, una migliore efficienza del servizio. Nel sesto capitolo, in accordo con i risultati del capitolo quattro, si suggerisce una nuova linea per il trasporto pubblico su autobus. L'obiettivo di tale proposta è di coprire le aree aggiuntive già definite nel quarto capitolo. La linea è stata progettata affinché passi per i punti in cui la domanda è elevata. In seguito, è stato stimato un tempo di viaggio ed un intervallo tra i passaggi di questa nuova linea, proporzionalmente alle altre linee esistenti. Il capitolo sette affronta le conclusioni derivanti dall'analisi. L'appendice della presente tesi include la totalità dei dati statistici e delle informazioni analizzate, presentati sotto forma di grafici e tabelle.

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Chapter1: Introduction

Bus transportation is one of the most important public transportation systems in the city; it plays a major role in the travels of citizens in all countries every day, including Iran. Considering that other public transportation systems such as subway, tram, urban and lane train are not available in most cities of the country or are not in operation, the bus is currently the only public transportation vehicle that can carry the whole bunch of passengers.

In addition, most users of the urban bus transportation system are low-income groups of people and the people that do not have the ability to own a car and to use other vehicles due to their lack of financial resources. In comparison to other mass transportation systems, launching of bus lines requires less investment and doesn't need an independent path, since it can easily evolve and change. In addition, the bus occupies a much lower urban space than the car, according to the average number of passengers it carries. For example, a car occupies an area of 13 square meters when crossing a street. If the average number of the passengers is two people, the space required for each person will be about 7 square meters, while this figure will be about one square meter for every passenger for a bus. Another advantage of the bus is the possibility of using it in situations that require more passengers and in a way, which is more affordable.

It is also easy to construct and maintain, and it does not cost too much for passengers to use it, so it is suitable for a massive number of transfers in any city. Despite the advantages, the system also has some disadvantages too, which includes having a high delay time for passengers, less carrying capacity than the rail systems, the need for more manpower to handle it and so on. Therefore, in large cities, individually this system will not be responsive; especially as the growth of societies has increased the need for fast, cheap and safe transportation too.

1.1 Studied case city: RASHT

Rasht has a population of 956971 inhabitants and this value increases to 1,200,000 because of existence of the workers, students and others who come and go during the work hours. they use a relatively small amount of bus system. The main purpose of the research is to provide practical solutions for improving the bus system and increasing the supply of services. According to the statistics¹, the rate of public bus transportation in Rasht is less than 5%, which is very small in terms of global numerical indexes. In large cities like Rasht, which face traffic problems, one of the best ways to solve these traffic problems is to improve the public transportation, especially its bus system. One of the main problems of the public transportation system in Rasht is the lack of study and plans for the future. the solutions are considered to solve the problems in the present time, rather than an attempt to provide a plan that can respond to the future demand. With the study of the bus system and the provision of appropriate facilities for buses, especially design of the bus lines, the public can be more eager to use the bus system. Therefore, the main purpose of the present study is to organize the bus system of Rasht. The following objectives for the present study can be briefly defined:

- Tracking and organizing the bus routes
- Checking and organizing the bus stations

There is a shortage of public transportation facilities in Rasht, which has not been studied until now. Considering that the best way of solving the problem of traffic development is public transport, the organization of the bus system of Rasht is mandatory. While the use of public transport is very low, the optimization of it should be considered now.

In the peak hours and days Rasht is experiencing about one million people² because of its tourists. The facilities in the city are not responsive to such a population. Also, car per capita is higher than the other cities, and the volume of private vehicles is more than the city's capacity, and of course the supply is low in demand. Public transportation in Rasht can only be done at or above earth surface.

To improve the bus system, can do these:

- Completing and adding city buses
- Planning regarding regular bus movement around the city

¹ Rasouli R . <https://www.isna.ir/news/94050703585> . Accessed':Jul 29, 2015.

² Institute of AMAYESH SARZAMIN . Second report.Jun 2012.(اتوبوس ویژه مسیرهای سنجی امکان و اتوبوسرانی شبکه ساماندهی مطالعات). p.28

- Providing facilities suitable for various public transportation systems such as air conditioner, television and so on
- Locating appropriate routes for ease of access
- Appropriate locating of the stations according to the other related systems and convenience of the Passengers

1.2 Research goal

So far, a brief introduction of Rasht and its bus system has been presented. To improve the bus system in Rasht, will be analyzed overcrowding of buses or new lines will be added that would increase the travel speed and reduce the wait times. In that case the passengers would like to use the bus service more often.

The QGIS software was used to do this, which will be explained in more detail in the following chapters.

2 Chapter 2: Literature review

In this chapter we review some of the papers which are relevant to our research because they are either using analysis tools like ours, for example GIS, or they are studying public transport system of Rasht.

Public transport system problems could be solved with the help of relevant software and spatial information system methods (Badamchi et al., 2016). The purpose of this article is to examine the GIS solutions to accelerate solving of some of the issues and problems encountered in the system of fast buses in the country. Thus, with the help of GIS, issues such as optimal routing for the construction of new bus routes, optimal location of stations, finding routes with high demand level, designing the needs of the bus system after the traffic limitation plan, designing of access areas for the public transport for each zone, modern design for the bus routes, locating intelligent traffic lights, finding networks requiring replacement of buses or increasing the fleet size, improving the bus system services with the announcement of station names, the provision of maps for the BRT routes and the design of an informative SMS system for informing the arrival time of buses. The results from this article will help us to find out the modern methods provided to encounter the problems in the fast bus system and provide the best solution for them. In this article, it's tried to introduce some functions of GIS that improve the current state of the bus system and highlight the importance of GIS in today's world with the ever-increasing advancement of technology. Some of these functions that have been implemented today in the world are:

- Optimal routing for the construction of new bus routes
- Optimization of stations
- Finding high demand lines

In this research, it's tried to study previously done projects related to the fast bus system and find rapid and accurate solutions with the help of GIS. In most studies in this area, after collecting the required data, a valid database is created and then, according to the determinant parameters of the target, the various information layers are obtained from the database. Eventually, after combining these weighted layers, the optimal route location is selected by the software. After reviewing some of the GIS functions in the field of bus systems, and visiting the traffic control organization of Tehran, they sought to provide suggestions for one of the problems in this organization. one of the problems in this system is in the Tajrish to Rah Ahan terminal. In this terminal there are few buses and the buses are working with delay. This will make the

passengers wait longer at the stations. To solve this problem, it was suggested that the central control system for buses can estimate the number of passengers who want to get out of the buses at the stations after Parkway station ((according to the subscription cards that passengers validate at the station or video controlling system on the images taken from stations). Therefore, this central control system can weigh the parameters by having the parameters like the number of passengers who want to get out of the buses after the Parkway station, the distance from the nearest bus to the station, the distance from each station to Tajrish square, the amount of fuel remaining in each bus and the quantity of passengers on each bus. And in case of need this system order the bus which is on the Rah Ahan – Parkway route to continue its journey to Tajrish. This is a solution to solve one problem of the bus system by using GIS.

In a paper titled Evaluation of Bus Lines in Tehran using spatial information system and data envelopment analysis, (Ghavami et al.,2011) the efficiency of bus lines in Tehran is examined. To evaluate the performance, the number and type of buses in each line were examined. The fuel consumption of each bus, the number of stations, the length of each route, and the location of the trip population were surveyed to assess the population's demand for travel.

The information obtained from the results showed that Tehran's bus transport system currently is functioning 14% below nominal capacities, reflecting the fact that the lines are poorly managed.

In a paper entitled "A New Approach to Urban Buses Routs Design Using GIS (Saberian et al., 2008) a method is made to predict the demand for traffic between urban blocks (zones). First of all, the amount of travel production and travel attraction for each block is predicted." Then, according to the number of trips predicted for each block and the spatial distance between them, the distribution of travel between them is discussed. They use GIS to calculate transit time between different blocks and then use it as input to find the trip distribution matrix. Then they can make a new bus line.

In a Chinese article, the concept of APTA³ was introduced as a case for a particular region of Beijing (Yan yan et al., 2016). This article, entitled Study of Chao Yang District, located in Beijing, explores the extent of access to the public transport system of 30 districts (30 districts in the Chao Yang area). Eventually, during this study, with

³ Area Public Transit Accessibility

the help of spatial and non-spatial parameters, then with proper weighting of these parameters in formulas and software, a model of the amount of public transport access available for each region was obtained. According to the calculations and numbers found in the article, they found that: in areas with higher APTA (higher levels of access to the public transport area), the use of public transportation system is high in those areas. So, despite the fact that in a region where even people's living conditions are good, but the possibility of using public transport is also high, people would prefer to use the public transportation system instead of using a personal car if the transportation system is vast. The method used in this paper is based on the need to eliminate redundancies in order to design the bus service area and the road service area because the volume of work is very heavy. So, it used the ARC GIS software. First, in a GIS layer all of the bus and roads in the area were set up. Then, to determine the service area for bus and road routes, 300, and 500 meters radius buffers were used, in which the Dissolve function was used to summarize all the buffers that are overlapping.

In a research (Mohammadi & Booshehri., 2011), the software (EMME3 and Enif) were used to determine the main corridors and main routes for designing long routes in the bus network system of Isfahan. With the use of these maps, and with the consideration of a series of special assumptions for design, as well as the opinions of experts and transport experts of the city three long routes are suggested with the integration of existing routes. The results of the evaluation of these routes show that the improvement in the stopping time at the station, the total time of travel, the speed of the vehicle, the interval and the number of passengers, indicate the effectiveness of designing long route in bus network of Isfahan and improving the performance of this network.

A study on Optimization and Analysis of Public Transportation Fleet using GIS technology (Aami et al., 2008) in Golestan region of Ahwaz has been made with the aim of optimizing bus routes. For routing, factors of road capacity, average speed, land use, pavement status, lane width, road sections, population density zones and length of each edge were determined and recorded in the database. As a result, by creating the layers with the mentioned features and integrating them, areas that were more in need of locating bus stations were identified. After applying the service level algorithm, 3 new stations were defined.

Indicating of Optimal Route for Bus Transport System with GIS (Hajizadeh et al., 2017) In this article is investigated the urban transport situation, especially the interurban system in Ardabil city. In order to reach the goal, at the first stage, the identification of the stations and its bus routes in the city was done and in the next step, each of the criteria influencing the displacement was identified in the city of Ardabil. Then, using the network analysis model, as well as population model, density, family size and vehicle ratio model, the descriptive analysis and analysis of the status of urban routes and urban bus lines in Ardabil have been investigated.

Done analysis are:

- Analyzing of routes locating
- Analyzing of network on the basis of Service Area function related to the bus routes
- Analyzing of bus routes related to population density, family size, vehicle ratio

According to the analysis done by the network analysis model, which is considered by the service area method and the density of the bus, the best place to create bus routes is the streets that travel east-west or north-south of the city. because these streets pass through the city center and the concentration of the population of Ardebil and the commercial areas are located in the city center.

The Existence of a Public Transport Network and Pedestrian Access to This System has been investigated for bus routes in Birjand city (Araghi et al., 2015). For assessing the quality of the public transportation network, several numerical indexes based on GIS tools have been used. One of these indicators is the Public Transportation Coverage Index (PTCI), based on the high service capacity and coverage rate. Also, to check the availability of having the areas for padways around them the ASAI (Average Service Availability Index) are used. By using these indicators, the quality of the public transportation network and its accessibility are studied in the traffic areas and urban planners can use it as a measure to improve or expand the public transportation network and access routes to it.

Determining the coverage of the bus station is an important issue in public transportation planning. The presence or absence of a bus stop near the origin and destination of a route is an important factor for choosing a public transportation system by a person. When the station is not available, other aspects of the public transportation service are not relevant for the journey. The transport service station must be at a reasonable distance from the origin and destination of a route in order to increase the possibility of choosing to use for every passenger in the vicinity of the area. The

coverage level of the bus stations is the area covered by a specific route at the bottom of the station. At TCQSM⁴, this distance is defined around bus stations with a circle with a radius of 400 meters and near the train stations of 800 meters.

the ideal and actual index to access the station and the station coverage index to assess the availability of current bus stations in the study area, only one line that is used the most is selected to calculate the ISAI⁵ and ASAI⁶ and the SCRI⁷ index on the concepts of GIS platform (Osman & Foda, 2010). These indicators can be used to assess the availability of the bus station through the network of pedestrian routes around the station and the proportion of actual accessibility coverage of the station. The idea is to identify all trails around the station at a radius of 400 meters from the station. The end of these roads will create a polygon that is known as the actual coverage surface of the station. The area of this polygon is more significant than the area of a circle of 400 meters radius to measure the access level of a bus station. The ISAI index, as specified in Equation1, is used to assess the access to a station through pedestrian ways around the station. The result of ISAI is the density of the pedestrian network in the range of access around a station in terms of square kilometer. As already mentioned, the ISAI number indicates the level of access to the station through the pedestrian network around the station. The increase in the index indicates the greater density of the pedestrian routes, which means, in other words, a more appropriate connection between the station and the pedestrian network is made. In other words, the larger the ISAI, the more accessible the bus station is.

$$\text{ISAI} = \text{Lp} / \text{Ac} \quad (\text{Equation1})$$

That **Lp** is total length of the ways to access the pedestrian at 400 meters radius around the station and **Ac** is the ideal access area in square kilometer. The true ASAI coefficient is more accurate than the ISAI to measure the level of access of a station to the network of roads around it. This indicator shows the actual density of the pedestrian crossing network around a station

$$\text{ASAI} = \text{Lp} / \text{Ap}$$

Lp is the total length of all pedestrian access roads at a radius of 400 meters and the **Ap** is the polygon area around the station, as shown in Fig. 1.

⁴ Transit Capacity and Quality of Service Manual

⁵ Ideal Stop Accessibility Indices

⁶ Actual Stop Accessibility Indices

⁷ Stop Coverage Ratio Index

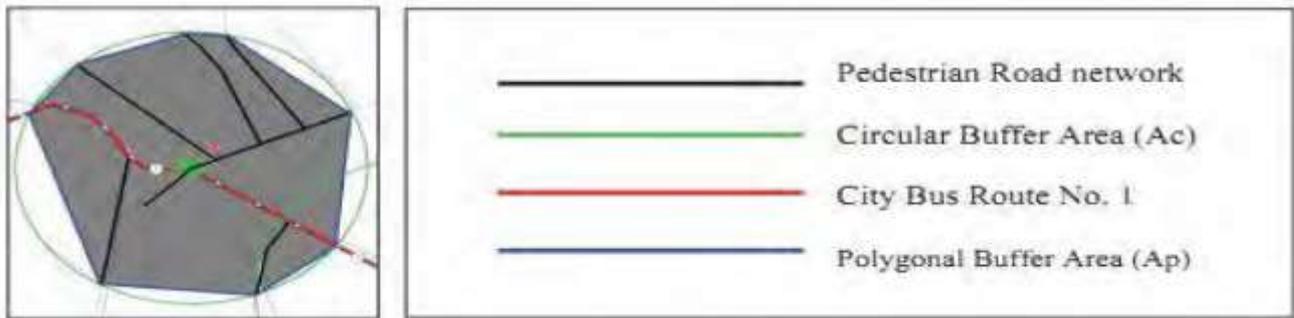


Figure 1 real amount (polygonal area) and ideal amount (circular area) of availability of stations

The SCRI used in Equation 2 is used to assess the actual access to the bus station. In other words, this index represents the actual access coverage to a bus station in its surroundings. The SCRI has no dimension. This index is variable from 0 to 1 for a pedestrian network.

$$\text{SCRI} = \text{Ap} / \text{Ac} \quad (\text{Equation 2})$$

Where **Ap** is the polygon area and **Ac** is the area of the ideal circle around the station.

Paper named “Analysis of the Impact of City (Rasht) Space Organization on Inland Urban Transportation System” (Hosseini et al., 2013) illustrated Vehicle ownership in the current state of Rasht. There is one personal car for every 7.5 people. While the average personal car ownership is one car for every 10 in Iran and 1 car for every 5 in Tehran. This number of cars in Rasht have many reasons such as urban dispersal, long-distance trips, low number of public buses, lack of planning to define new routes, etc. Therefore, analyzing and determining the consequences of excessive use of personal automobiles in the city of Rasht is very important. The purpose of the article was to analyze the relationship between each urban model and its functions with the amount of personal car usage.

The main question in this paper is that there is a meaningful relationship between the distribution of good urban form variables and the way citizens come to access the urban functions.

Therefore, in this research, after identifying the existing and effective components in the spatial organization of the city, it was determined by the studies that citizens of Rasht show different trip-behavior. This means that the form of the city has had a direct impact on the way their urban trips are, so that urban dispersion and expansion have caused most citizens to use personal vehicles to access their daily needs. In addition, because of the overwhelming compression and congestion of applications and activities in the center of the city, travels are shortened, and citizens do their daily activities through walking resulting in a meaningful relationship between the dispersion of the

variables of good urban form (Vitality, accessibility, proportionality, monitoring) and the way citizens commute (above 0/05). As a result, the excessive use of personal cars in Rasht is due to the weakness of the city's spatial organization and its main functions at the local level. In addition, the dispersed city forms, along with weak financial resources and technical facilities, affect the behavior of citizens in a long-term process. It has changed the people's transportation behavior. Also, the findings of this research indicate a significant relationship between the good local organization and the shape of the city and the way citizens commute. This overuse of personal cars, unwittingly, has led to an increase in demand and the amount of travel, and in cases where it has not been accompanied by development control and development policies, it has exacerbated the expansion of the city. In this regard, major neighborhood functions, such as retailing and educational, health, recreation, sports, and essential services are suffering from structural weakness and require re-planning for neighborhood functions in the neighborhood centers. These have led to an increasing demand for citizens to access these services and led to more usage of personal cars. The result of this article confirms the strong relationship between the structure of the city and the functional variables of the neighborhoods meeting the basic needs of the people and urban transportation. Considering the transport situation and the way of urban trips and also according to the results of the research, these suggestions are presented:

- The research indicates that there is insufficiency in commercial, recreational, educational and sporting functions in the urban neighborhoods, and citizens are using a lot of personal vehicles to access these functions. Therefore, in order to address the shortcomings, it is suggested that the spatial organization of the city be redefined, planned and tailored to meet the needs of the citizens, based on the new spatial organization
- The weakness of the public transportation system and the lack of individual lines for public transportation services, especially busy routes, have increased the use of personal cars in Rasht. Therefore, it is recommended to run a comprehensive and modular program to create special and high-speed routes for the buses.
- In developing urban transport strategies in urban strategic plans, especially in the paths leading to the central part of the city the pedestrian and bicycle transportation system should be considered.
- In order to reduce the traffic load in the center of the city, spacial structure of neighborhoods should be re-evaluated, measured, located, prioritized and programmed.
- It is suggested that citizens' access to virtual facilities be promoted in order to reduce the traffic load, especially in the central areas of the city. Real attention is

needed to the pedestrian areas in Rasht. In this regard, the development of the cycling and walking culture should be in the first priority.

With the help of genetic algorithm, the model is designed and optimized to improve the efficiency of the network and reduce the costs imposed on users and service providers to a reasonable degree (Bargegol et al., 2013). In fact, developing such a model is aimed at finding the best urban bus network and finding suitable bus routes and routes that minimize the time of walking, waiting time at the station, travel time, with the least number of routes and buses. In other words, it addresses the needs of users and service providers. In order to run the model faster, the genetic algorithm will be used as an ultra-fast method that will speed up the optimal response. Also, using this method will save time and money. In this paper, the model presented on the network of Rasht city and its results are analyzed and evaluated. Also, the existing network of the city will be compared with the proposed network and its performance improvement will be shown. The statistics of the Bus Station of Rasht show that only 8 percent of the city's population is displaced by public buses, which is very low, and the policies of this network need to be reviewed. In this section, the desirable indicators of the structure of the equipment of the bus system and its comparison with the current status of the bus system of Rasht are discussed. The indexes of the equipment of the bus system are, ratio of active buses to all buses, average service life of buses, ratio between city population and fleet size, average daily passengers carried by each bus, number of passengers and average distance between stations. From Table 1, which shows the comparison between the current bus network of Rasht and the proposed network obtained from the output of the model and implementation of this method in Rasht, it can be concluded that by considering the lines, using the function and the parameters for which it is defined, optimal results can be achieved.

Indicators	Available Bus Network	Suggested Bus Network	Percent change
Fleet sizes	80	79	-0.01%
Number of network lines	21	14	-34%
Km route (round trip)	343500	171100	-50%
Travel time in the network	94258	36390	-61%
Number of direct commuters	37349	29771	-18.6
Total network cost	3148745	1851393	-41%

Table 1 Comparison of available bus network and suggested bus network

Evaluation of Proposed Scenarios for special bus line of Rasht by Hierarchical Analytical Method (Pronello et al., 2013). In this paper, public transportation in general and the bus network (special line) are specifically considered. It has social, economic, and engineering aspects, which has made it a sophisticated system. Considering all aspects of the proposed plan for the proposed special line is the first step in achieving the appropriate solution. This article is a straightforward look at the Rasht bus project. First, proposed corridors of the special bus line of Rasht have been presented. Then, by reviewing the functional indicators, efforts have been made to prioritize the appropriate bus line network through the Hierarchy Process Analytical Process and Expert Choice software (AHP). Then the most efficient corridors are selected.

The proposed public transportation models for the construction of a special line in Rasht are as follows:

Radial paths, diagonal paths, ring paths, radial-ring paths, and special paths.

In the following, identifying the routes that are suitable for the construction of special lines, which is one of the above.

Radial paths:

Rasht has enough potential to construct radial paths. The proposed radial routes for the special line are:

Shahrdari – terminal path (Lahijan path): Shahrdari – Valiasr square path.

Shahrdari – Bahonar street path: Shahrdari – Taleshan bridge path: Sabze meydan – Azadegan square (figures 2 – 3 – 4).

Diagonal paths:

The city of Rasht has two main North-South and East-West main diagonals. If the sidewalk area of Imam Khomeini street project starts, then the launch of a special line in this path is not possible.

According to this description, the only path is the diagonal line of Rasht which is Valiasr – Shahrdari – Bahonar path, which is in fact a combination of two airport and terminal lines in the present state. This proposed route, which operates in a diagonal network structure, facilitates travel by the public transport lines of the south to the north of Rasht.

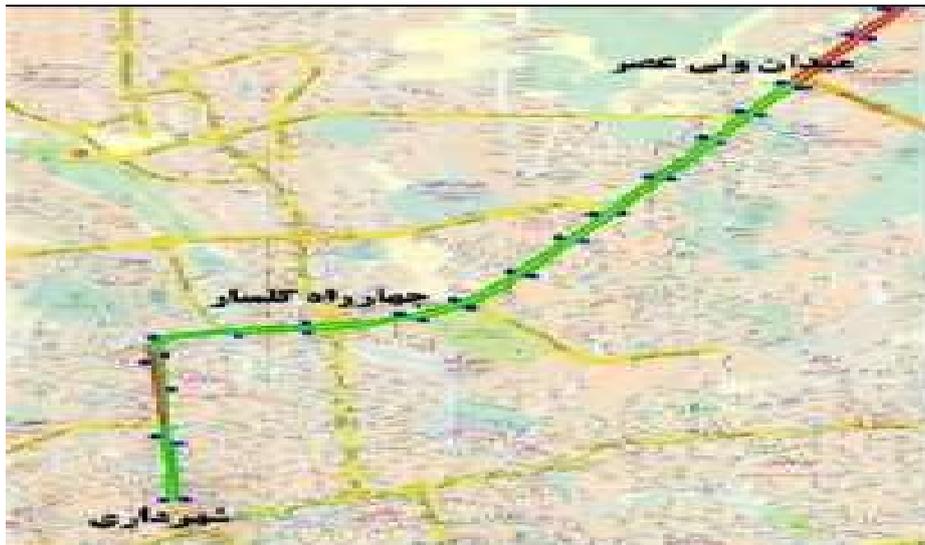


Figure 2 shahrdari - valiasr square path

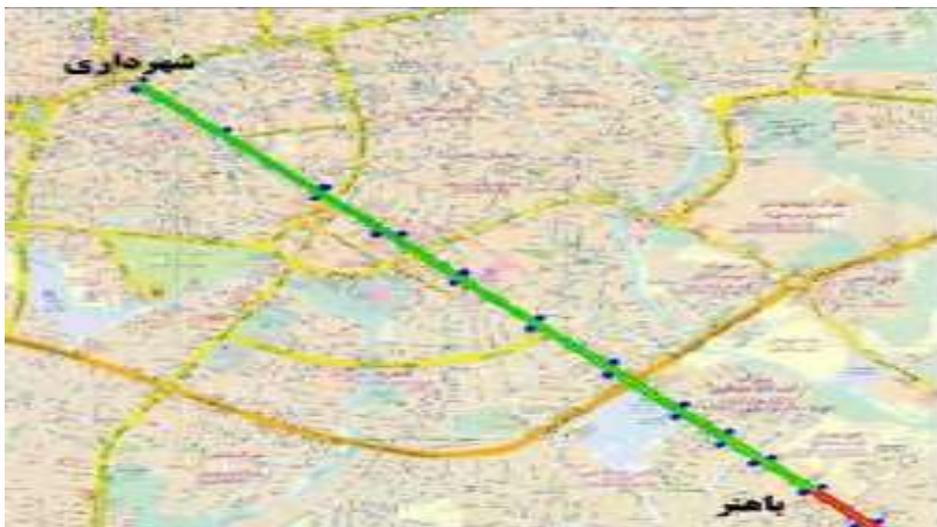


Figure 3 shahrdari - bahonar path



Figure 4 shahrdari - taleshan bridge

ring paths:

Ring paths for the special lines of Rasht are: North-Eastern rings: East-South rings: Ring: Central ring (Figure 5).

Radial Paths – Circular:

Radial paths - Circulars that have been investigated for special lines in Rasht are Taleghan – Shivan Foumani and lakani path (Figure 6).



Figure 5 central ring plan



Figure 6 taleghani - shivan foumani

special paths:

Specific paths are formed from the V-shaped path. The shuttle route is defined from the Shahr-dari to Lankanshahr, and the V-route, is defined from Jafarabad and the airport which can be used as a special path.

Priority	Number of the corridor	Name of the corridor	score
1	12	Central ring	1
2	4	Shahrdari - Bahonar	0.96
3	2	Shahrdari valiasr	0.909
4	10	Taleghani – shivan foumani	0.859
5	5	Shahrdari- taleshan bridge	0.808
6	3	North ring - east	0.606
7	1	Shahrdari – janbazan	0.556
8	6	East ring – south	0.505
9	7	diametric path	0.455
10	9	Sabze meydan - azadegan	0.404
11	10	Highway ring	0.354
12	8	Special path	0.303

Table 2 introduction of top priorities for special path calculated by EXPERT CHOICE application

What was presented in this paper is a proposed method for designing a bus-line network in Rasht. Due to the existence of numerous factors and the use of appropriate tools, this set can be considered as an effective way to carry out similar projects.

Practical Solutions to Operationalize the Line Priorities Project Special Bus for Rasht provided (Pronello et al., 2013).

In this paper, according to a case study carried out in Rasht metropolis, with the help of traffic flow knowledge, the limited use of related software and expert opinions of the consulting group, the proposed solutions for the construction of the special line corridors and the rate of improvement of the functional indicators according to the special bus scenarios has been presented. Considering that due to the width of the urban street, it is not possible to set up a special line that runs continuously and completely separate from the traffic around its route in the entire path. As a result, for each of the selected corridors, it has been tried to consider the technical, economic, and social aspects of the plan. Based on this, three scenarios have been proposed for the corridors of Imam Khomeini, Taleghani, Saadi. The main issue in the operation of executive priorities is the locating of proposed corridors. In this paper, it was tried to first consider the operation of launching the corridors and, in the next step, examine the magnitude of the impact of the scenario. The results obtained from the indicators and the software like SIDRA and AIMSUN and expert opinions of the consulting group, indicate that the main issue in implementing special bus-line projects is the issue of locating of the corridors and its compatibility with the urban transport network in the short and long time. Hence, through the hierarchical analysis method and considering the changes in the performance indicators of the various proposed scenarios, the best and the most effective solution for having a special bus line compatible with the urban transport network can be achieved.

In conclusion after having studied articles and considering the situation of the public transport system of Rasht it can be said that it could be very useful to work on the topic of introducing a new bus line by finding areas which have more passenger attraction and another case which can be studied is the overcrowding problem which will be explained later. These articles are related to our case study, but no one has considered this type of analysis, which is studying public transport system of Rasht with QGIS application and finding areas where there are big number of line changes and designing a new line by considering these areas.

3 Chapter 3: Public transport bus routes in Rasht and related available information

3.1 About city of Rasht

Rasht is the Capital City of Guilan Province, Iran. Rasht is the largest city on Iran's Caspian Sea coast. It is major trade center between Caucasia, Russia and Iran. Using the port of Bandar- e anzali. Rasht is the third most visited tourist city in Iran with the resort of Masouleh in the adjacent mountain and the beaches of Caspian as some of the major attractions.

3.2 Introduction of Rasht bus network

There are currently 77 active buses operating in the city. The lowest and highest speeds are for lines 1 and 18 which are 11 and 20 km / h. The average speeds of all buses on all lines are 14 km / h, which is relatively very low for a public transportation system with a high travel demand. Bus stations on the outward direction are 487 and on the inward direction are 501 which will be explained later in paragraph 3.8 . Also, the total number of passengers displaced by these lines every day is 70211 people.⁸

In order to eliminate this volume of traffic in some specific areas, private vehicles are prohibited, and the only motorized means that can travel there are taxis and buses. In the subsequent picture is shown which part of the city center is limited. The red lines are just for pedestrian and electric vehicle for transport of elderly or disabled persons from one side of pedestrian area to other side. And blue lines are limited lines for bus and taxi.

⁸ Institute of AMAYESH SARZAMIN . Second report .Jun 2012. (مطالعات ساماندهی شبکه اتوبوسرانی و امکان سنجی مسیرهای ویژه اتوبوس) p.41



Figure 7 The view of limited Area of city center

Travel inside this area is only possible on foot or by public transport. Outside the area, there are enough parking spaces available for private vehicles. On some bus lines only one active bus is in service, while the maximum numbers of bus paths are 8 in the city which indicates the low attractiveness of this public transportation system in Rasht.

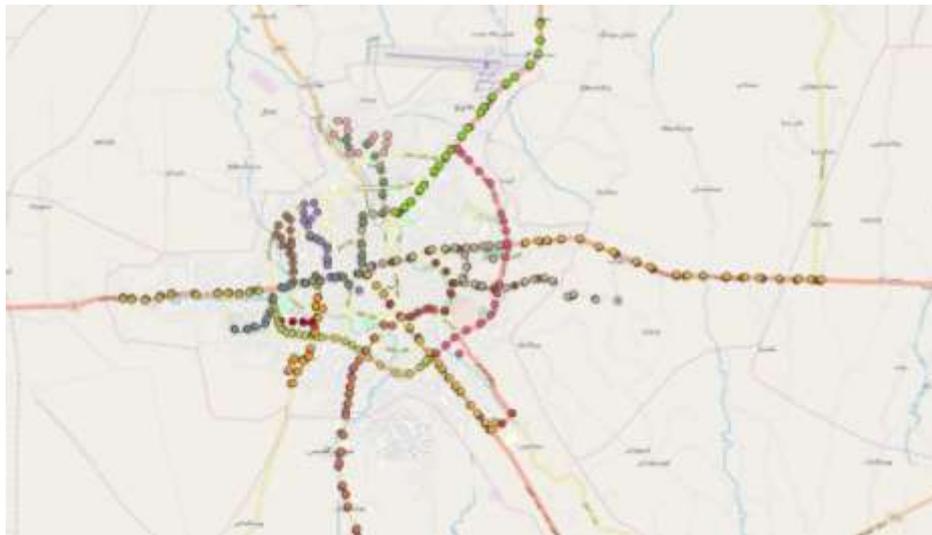


Figure 8 Lines of bus transportation system of Rasht city



Figure 9 the view of city center which the lines overlap

3.3 Bus stations

Bus stations are among the most important components of public transportation systems. These are as on one side provide the safety, convenience and welfare of the users. On the other hand. The bus station is considered as one of the most effective factors on the quality of the public transport system, operational speed, reliability and other performance indicators. According to traffic studies⁹, bus stations are generally divided into two general categories:

- Street stations
- Highway stations

Street stations are called stations that are located proximity to city streets. In designing these stations, it is important to determine their distance from each other, locate them and determine their executive details. On highways and freeways, the location of the stations is on the Entrance and output of the highways. If it is necessary to create a station in the other parts of the highway an additional lane should be considered in to decrease or increase the speed of the bus. It is very important to pay attention to the construction of city bus stations to the required number at certain intervals. Easy access to bus stations, standard station design and the availability of facilities can increase the usage of the bus.

The standard design of bus stations, like other urban furniture, affects the urban landscape.

One of the reasons why people do not use bus stations is that they do not have the proper equipment and standard equipment.

Below is written some necessary equipment that should be considered:

- **Material of the ceiling of the stations**

The ceiling of the most bus stations is plastic, and the plastic ceiling becomes hot in summer.

⁹ Institute of AMAYESH SARZAMIN . First report .Jun 2012. (مطالعات ساماندهی شبکه اتوبوسرانی و امکان سنجی مسیرهای ویژه اتوبوس) p. 13 - 107



Figure 10 Bus station with plastic ceiling

- **Material of the seats**

Also most of the station seats are ferrous, and in the summer those seats are so hot that can barely sit on it.



Figure 11 The station with ferrous metal seats

- **Easy access to the bus stations**

- **Giving information to passengers**

Also giving adequate information to passengers about how the special services of stations work, are effective in providing the necessary facilities.

- **Lack of sufficient number of tickets selling kiosks**

In most cases, there are shortages of ticket sales kiosks in the specific area, and the passengers must walk along the path to get the tickets, or even at some hours, the ticket sales stores may be closed.

- **Lack of garbage cans in most of the stations**

Equipment that should be installed in the stations is garbage cans. There are hundreds of garbage can models but only a few of them have the desired standards.

- **Provision of facilities for passengers**

Provision of facilities such as using happy colors in designing stations for customer satisfaction concept

- **The installation of a map of urban route**
- **The information and time of arrival of the buses**
- **The construction of specific paths for wheelchairs**

These equipments are the observance of the rules and principles of the construction of bus stations and can improve the usage of public transport system.

3.4 About Vehicles of Rasht's Transport System

The total numbers of buses are 130 units in Rasht. A total of 28 bus units are out of service because of battery issues or being corrupted. In other words, about 22% of the vehicles are out of service which is a bit high compared to its conventional number (about 10%)¹⁰. Another factor that is affecting the attractiveness of travel by the bus system is the comfort and welfare of the passengers inside the vehicle. According to the visits and information obtained by Rasht Bus Company, Rasht's bus fleet has almost no such factor, and the corruption of buses in different lines is one of the inhibiting factors in attracting more trips by this system. For example, out of the 20 selected buses to be surveyed¹¹ (The survey that Amayesh Sarzamin Group did it), five buses were corrupted and stopped, which caused passengers to be dissatisfied.

3.5 Estimation of necessary quantity of the vehicles

By remodeling and recreation of the fleet passengers trust will be earned and this will be huge step for a better system. In a general conclusion, it can be stated that at present, only 25% of the required buses in the city of Rasht are serving daily in this city. Here there are 2 different type of criterion for estimation of necessary number of vehicles for Rasht network system:

¹⁰ Hamsu consulting engineers company, solutions for increasing the efficiency of urban bus system . 2001

¹¹ Institute of AMAYESH SARZAMIN. Second report. Jun 2012. (مطالعات ساماندهی شبکه اتوبوسرانی و امکان سنجی مسیرهای ویژه اتوبوس) p. 43

3.5.1. Population criterion

The first criterion used to determine the number of buses needed in this city is the population criterion. In this criterion, for every 1500 inhabitants living in each city¹², one bus must be active in the public transit system for the movement of the passengers. In other words, the required number of buses is equal to the population divided by 1500 considering that the population of Rasht is estimated at 960 thousand people in 2017. And with the assumption that 10% of the buses are always inactive, the number of buses required for Rasht is 640 (576 active buses).

3.5.2. Trip criterion

In the second criterion, which is being examined, it has been suggested that 45 buses are required for 100,000 trips per day in each city¹³. Since one million journeys per day are carried out in Rasht, it can be concluded that the number of bus required based on this method will be 450 units (405 active units).

3.6 Combined traffic speed of Rasht network system

At the moment, the lack of full fleet use has led passengers to wait longer at the final and middle stations to reach the bus. This is one of the reasons why people are less willing to use the bus. Buses with 40 to 120 seats can travel between 1500 and 2400 passengers per day¹⁴, and the combined traffic speed varies from 12 to 25 kilometers per hour¹⁵. The biggest and most important advantage of the bus versus other public transport vehicles is its complete flexibility.

3.7 Lack of dedicated lanes in Rasht network system

On special lines, buses are separated from other vehicles by moderates or obstacles or by giving priority to the bus at the intersection. But in Rasht Buses use the same route as the other private and public vehicles use which can be a factor in increasing travel time for passengers and reducing the desire to use buses. But it is possible to increase

¹² Jane's urban transport systems 2005-2006, edition by Mary Webb, twenty-fourth edition

¹³ Institute of AMAYESH SARZAMIN. Second report. Jun 2012. (مطالعات ساماندهی شبکه اتوبوسرانی و امکان سنجی مسیرهای ویژه اتوبوس) p. 48

¹⁴ Institute of AMAYESH SARZAMIN. Second report. Jun 2012. (مطالعات ساماندهی شبکه اتوبوسرانی و امکان سنجی مسیرهای ویژه اتوبوس) p. 55

¹⁵ Institute of AMAYESH SARZAMIN. Second report. Jun 2012. (مطالعات ساماندهی شبکه اتوبوسرانی و امکان سنجی مسیرهای ویژه اتوبوس) p. 56

the capacity and number of passengers by creating special lines for the bus in addition to increase the speed of travel and reduce the travel time.

3.8 Lines of bus transportation system of Rasht city

In this section, bus stations of Rasht will be introduced. It should be noted that the following information is taken by the research group *AMAYESH SARZAMIN*¹⁶ Which is responsible for the research on the public transport system of Rasht, with the aim of providing a high-speed bus system called BRT.

¹⁶ Institute of AMAYESH SARZAMIN . First report . Accessed':Jun 2012 . p. 13 - 107

3.8.1. Terminal route



Figure 12 Terminal(outward) route plan



Figure 13 Terminal(inward) route plan

The terminal path is one of the most important paths of the Imam's axis, originated at the beginning of Imam Khomeini's street in the Shahrdari square and its destination is Imam Ali Square. The fleet size of this route, according to the latest inquiry from the Rasht Bus Company, is 5 units, their work hours are usually from 6:30 am to 9:30 pm. The terminal route is due to the passing of Imam Khomeini Street is one of the main routes in the metropolis of Rasht and at the same time is one of the few routes that are almost direct on the whole route. The number of stations in this route is 35 stations, 17 of them are for the outward direction and the rest is for the inward direction. Most of these stations have relatively good facilities, because they are located in urban areas, compared to other stations in Rasht Bus Network.

Fleet size	number of outward stations	number of inward stations
5	17	35

Table 3 Terminal route general information

3.8.2. Lakan shahr route

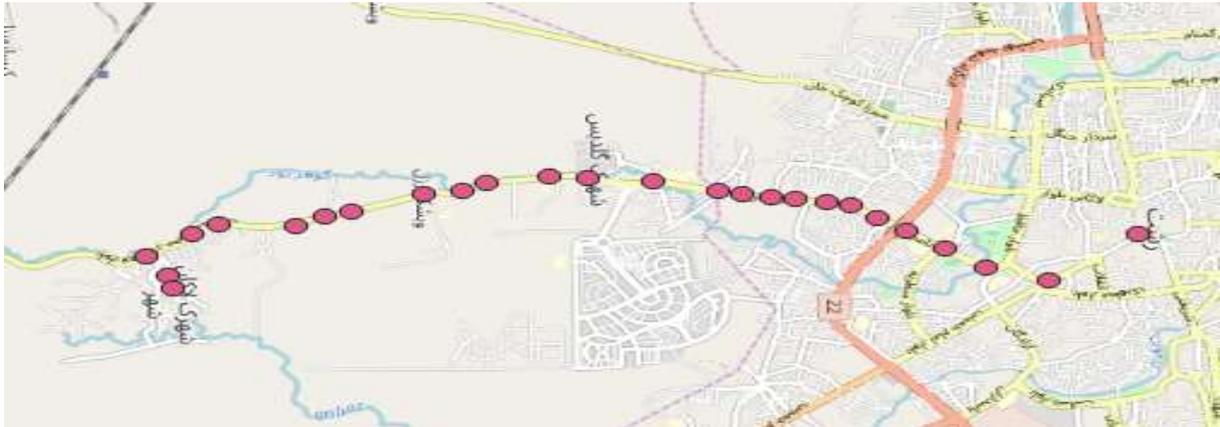


Figure 14 Lakan shahr(outward) route plan

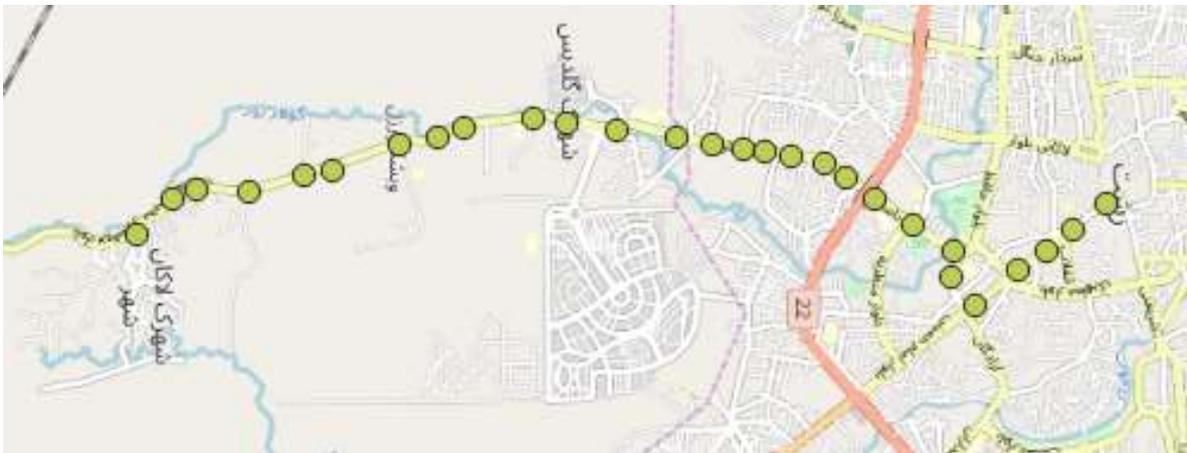


Figure 15 Lakan shahr(inward) route plan

This route is one of the busy bus routes in Rasht and originates at the beginning of Imam Khomeini's street in the Shahr-dari square and its destination is Lakan. The fleet size of this route as the most important route of the bus network of Rasht is 7 units. The number of stations in this route is 54 stations, 26 of them are for the outward direction and 28 of them is for the inward direction. This route, in Lakan Shahr route, the status of the stations are relatively convenient, however this route also serves the countryside, and the stations in the suburbs do not have the facilities and appearance.

Fleet Size	number of outward stations	number of inward stations
7	26	28

Table 4 Lakan shahr route general information

3.8.3. Around city3 route

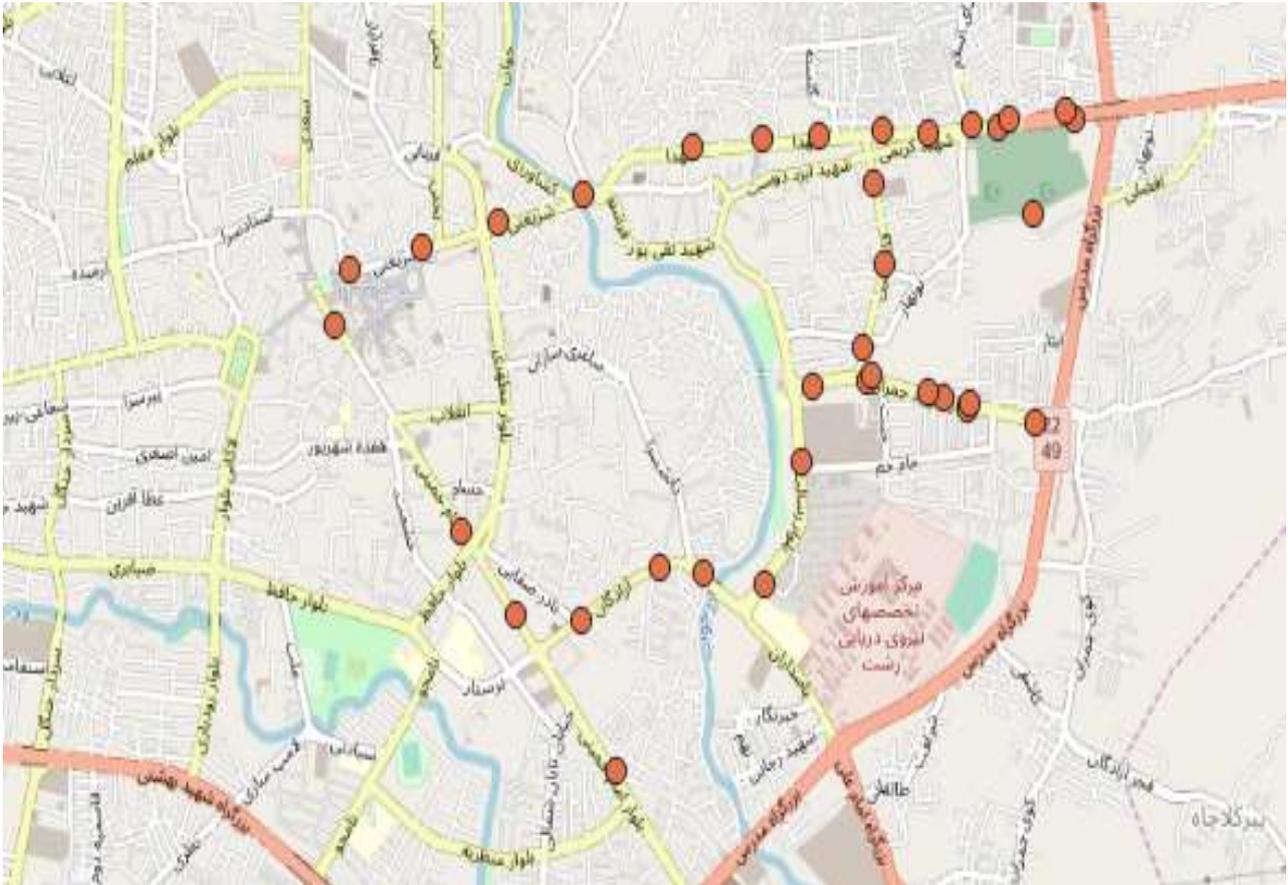


Figure 16 Around city 3 r oute plan

The origin of this path, like the two previous paths, is at the beginning of Imam Khomeini's street in the Shahr-dari square, but its destination is Shariaty Street. This route, which has no roundabout and is called a loop, has 4 bus lines and 35 stations.

Fleet Size	number of stations
4	35

Table 5 Around city3 route general information

3.8.4. Lakan route

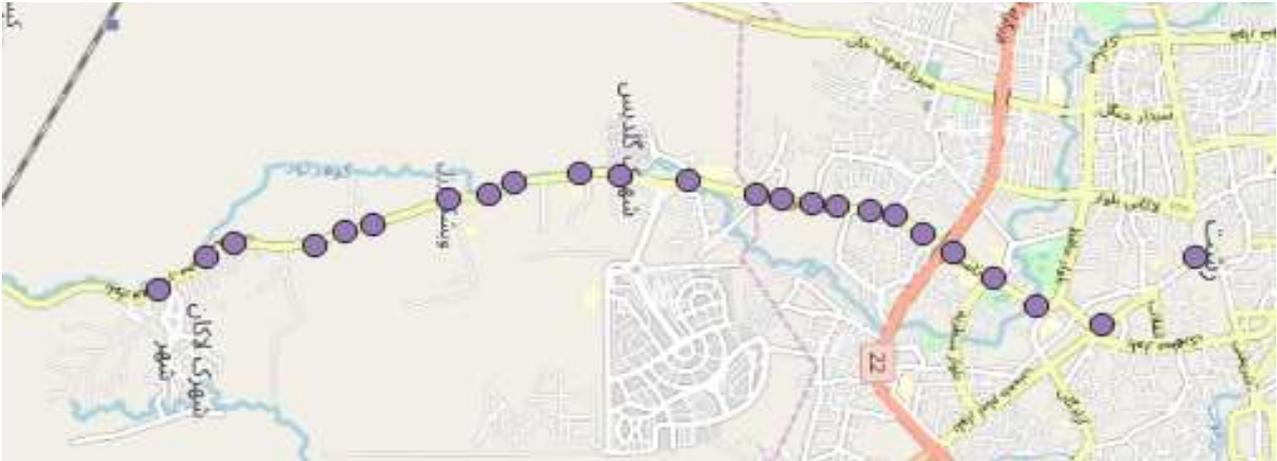


Figure 17 Lakan (outward) route plan

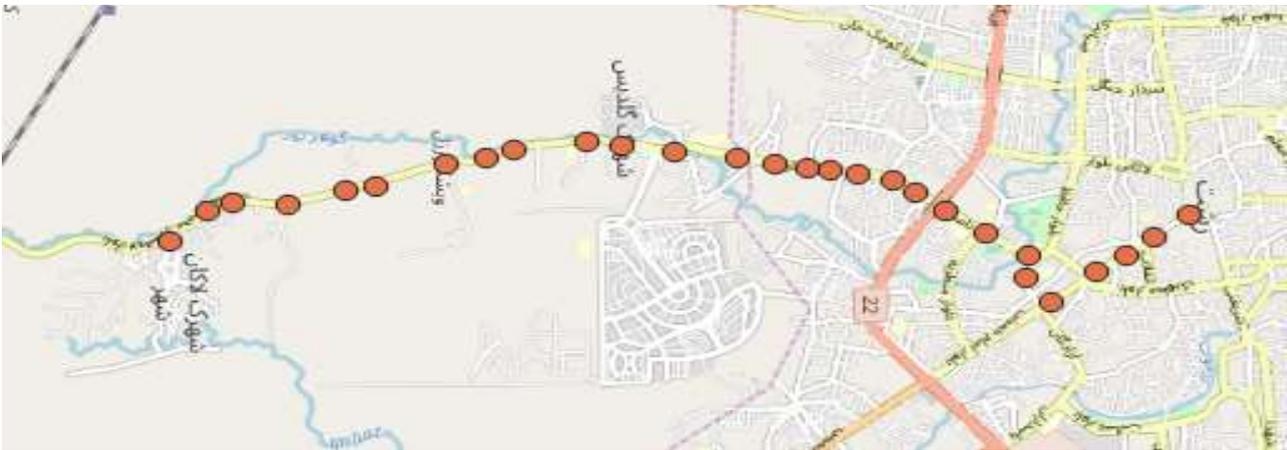


Figure 18 Lakan (inward) route plan

Origin of this path is at the beginning of Imam Khomeini's street located in the Shahr-dari square and its destination is Lakan. The fleet size of this route is 2 bus units and the number of its stations in outward direction are 24, and in the inward direction are 28. The stations on this route and the lakanshahr route are the same. The passengers themselves say where they want to get off the bus or get in. The last station on this route is after Lakan which is located at the gas factory in Rasht. The status of Lakan's stations in the urban area is appropriate and as far as the urban area is concerned, the possibilities and the apparent condition of the stations are reduced.

Fleet size	number of outward stations	number of inward stations
2	24	28

Table 6 Lakan route general information

3.8.5. Imam route

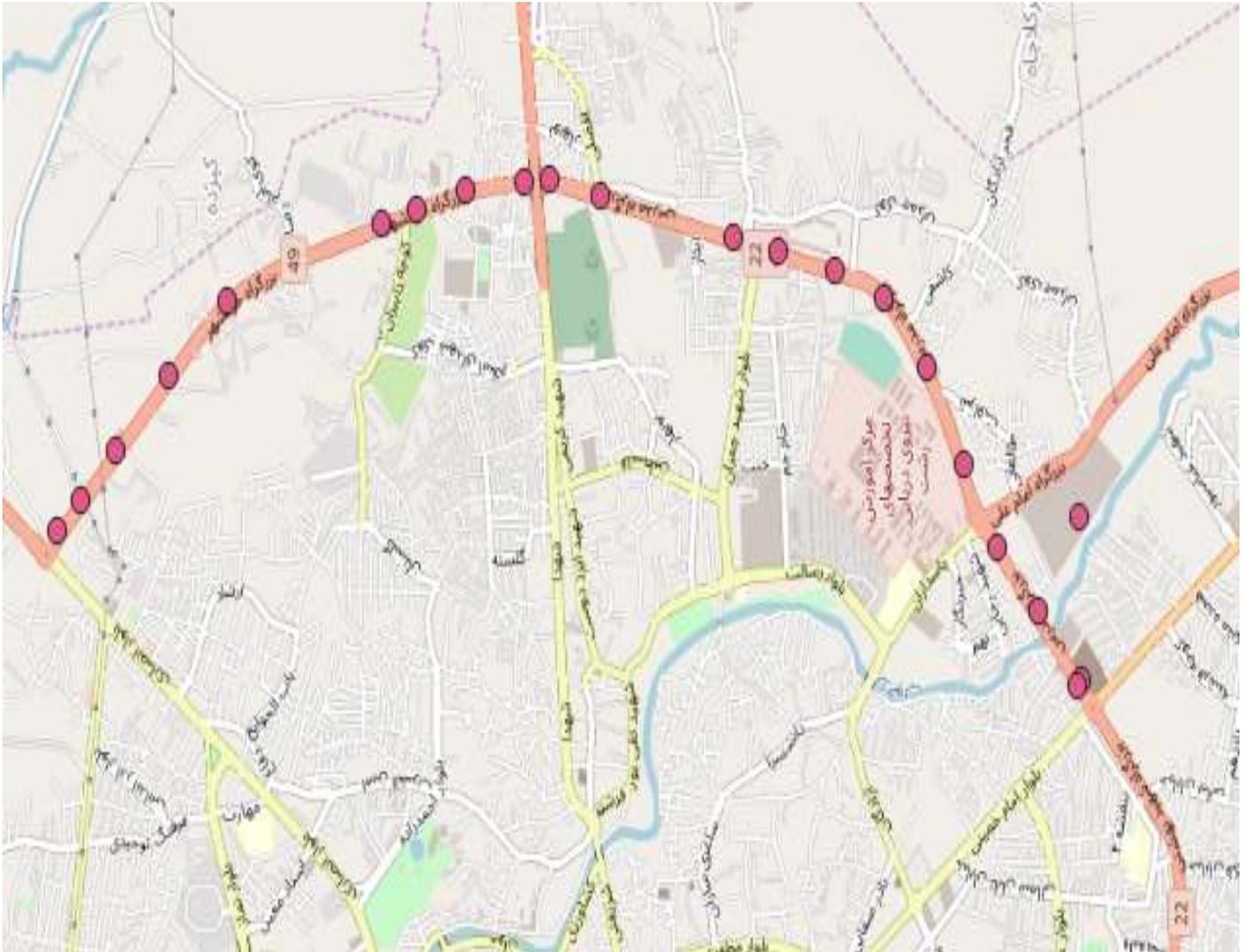


Figure 19 Imam route plan

This route seeks to cover the urban trips of passengers through the highways of Rasht. The size of fleets of this route is 2, which starts from MOSALA square and end in Farzane square. There is no fixed station on this route, he passengers themselves say where they want to get off the bus or get in.

Fleet Size	number of stations
2	-

Table 7 Imam route general information

3.8.6. Around city4 route

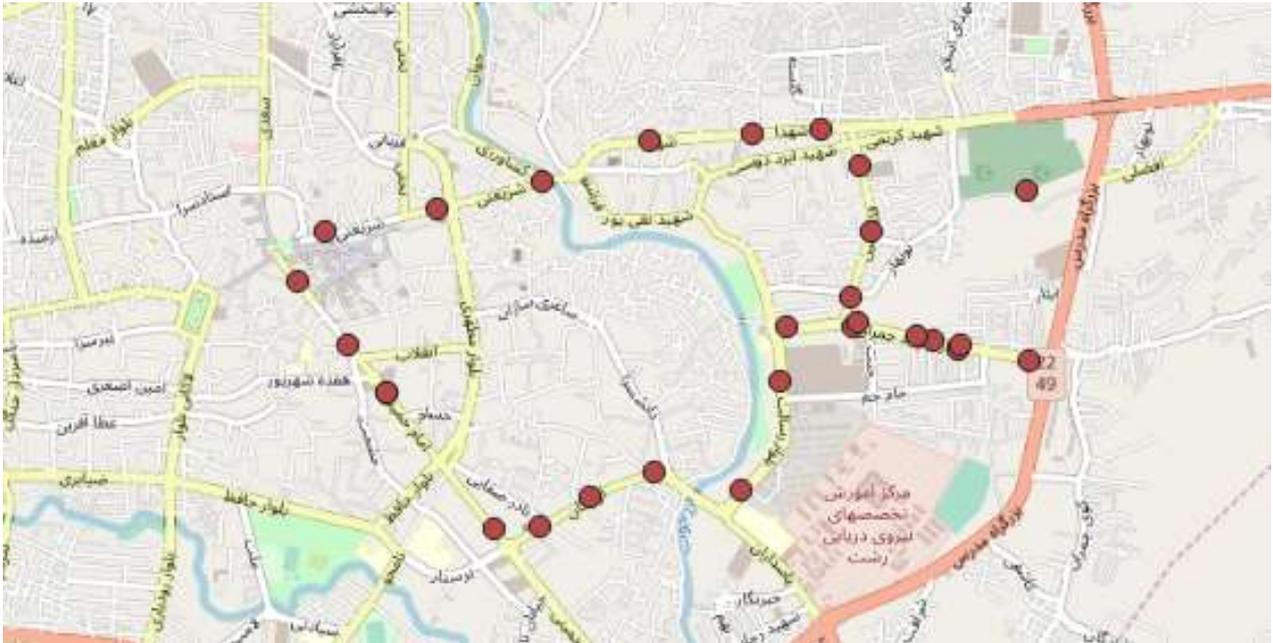


Figure 20 Around city4 route plan

This line is similar to the Around City Route 3 because it fully passes from urban areas, and it has a high passenger travel time and a relatively higher attracting rate of passenger in comparison to other lines. The origin of this route is Shariati Avenue and its destination is on the Imam Street. This route, which has no roundabout and is called a loop have 4 bus units and 28 stations in total. Most of these stations in this pathway have a good status in terms of amenities and physical condition.

Fleet Size	number of stations
4	28

Table 8 Around city4 route general information

3.8.7. Jafarabad route

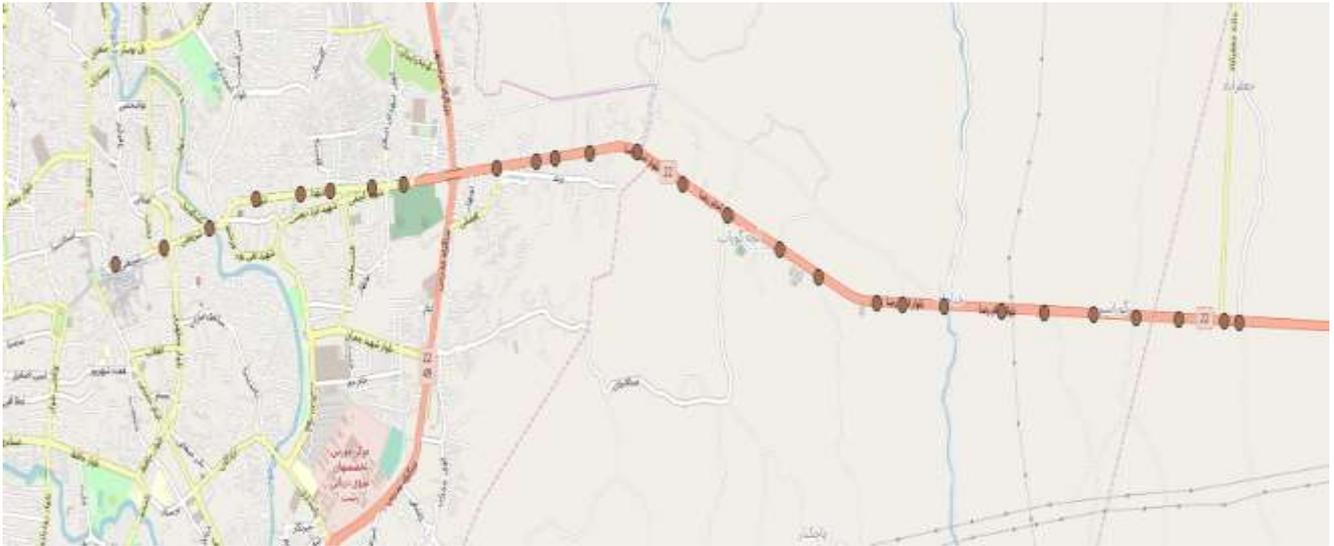


Figure 21 Jafarabad (outward) route plan

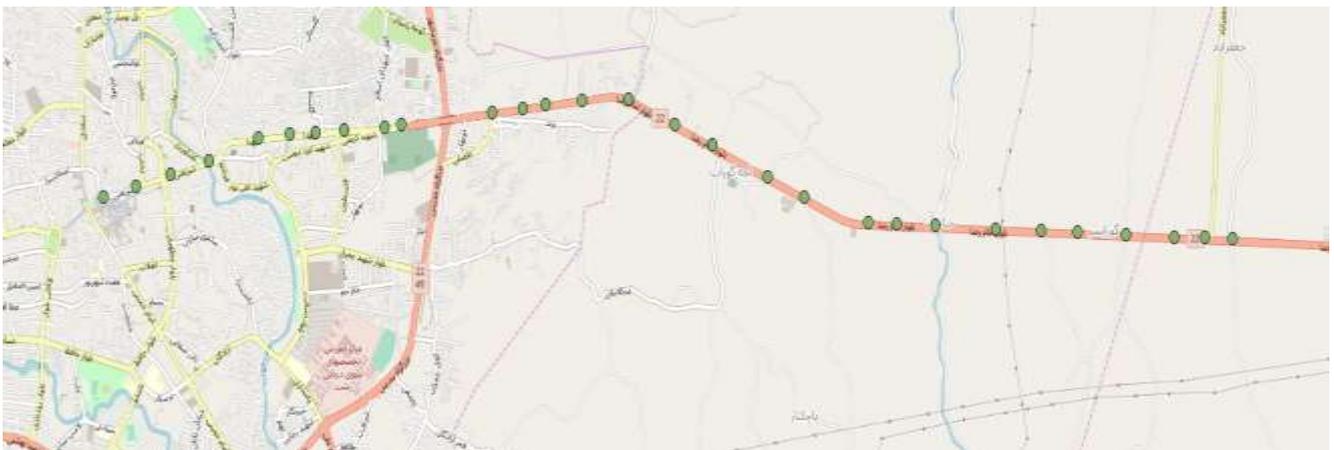


Figure 22 Jafarabad (inward) route plan

The origin of this route is at the beginning of the Shariati Avenue and its destination is Darsazi. The fleet size of this route is 6 units. In the outward direction are 27 stations and 29 stations on the inward direction. This route serves the eastern and suburbs of Rasht. The status of stations in the urban area is appropriate, but by entering the suburbs, the amount of facilities available at the stations is significantly reduced.

Fleet Size	number of outward stations	number of inward stations
6	27	29

Table 9 jafarabad route general information

3.8.8. Kouchesfehan route



Figure 23 Kouchesfehan (outward) route plan

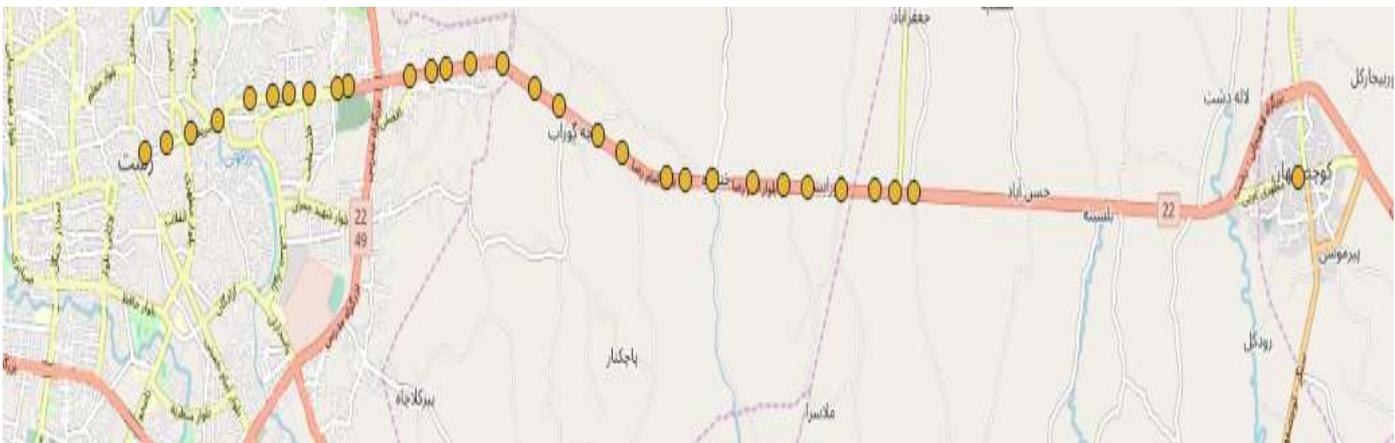


Figure 24 Kouchesfehan (inward) route plan

The origin of this route like Jafarabad Route serves the eastern and suburbs of Rasht are located at the beginning of Shariati Avenue and its destination is Kouchesfehan. The fleet size of this route is 2 buses and the number of its stations is 27 and 29 in the outward direction and inward direction. This Route’s stations and the Jafarabad’s Route are the same and the passenger will get out of the bus or get in it whenever they want. The status of the stations in the urban area is relatively suitable.

Fleet Size	number of outward stations	number of inward stations
6	27	29

Table 10 kouchesfehan route general information

3.8.9. Shahrak saba route



Figure Shahrak saba (outward) route plan

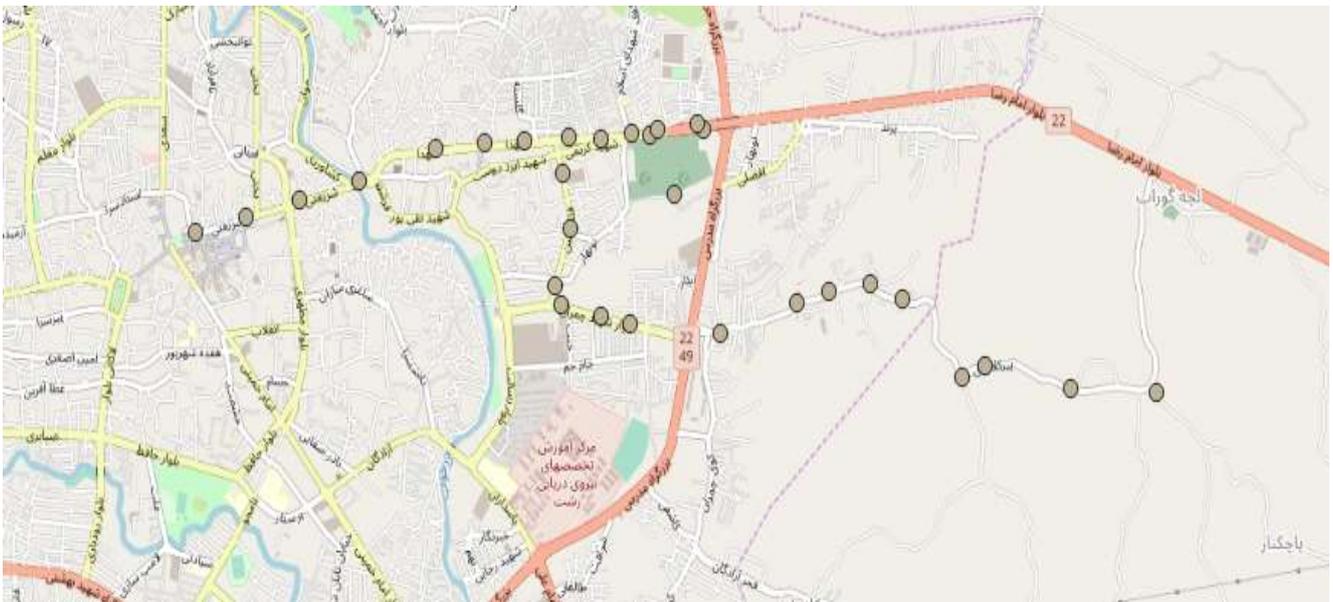


Figure 25 Shahrak saba (inward) route plan

The origin of this route is at the beginning of Shariati Avenue and its destination is inside the Shahrak Saba. The fleet size of this route is 1 and it have 20 stops on the outward direction and 30 stops on the inward direction. The status of the stations of the Shahrak Saba in the urban areas is suitable and the amount of facilities and apparent condition of the stations is reduced when move away from the urban areas.

Fleet Size	number of outward stations	number of inward stations
1	20	30

Table 11 Shahrak saba route general information

3.8.10. Golsar route



Figure 26 Golsar (outward) route plan

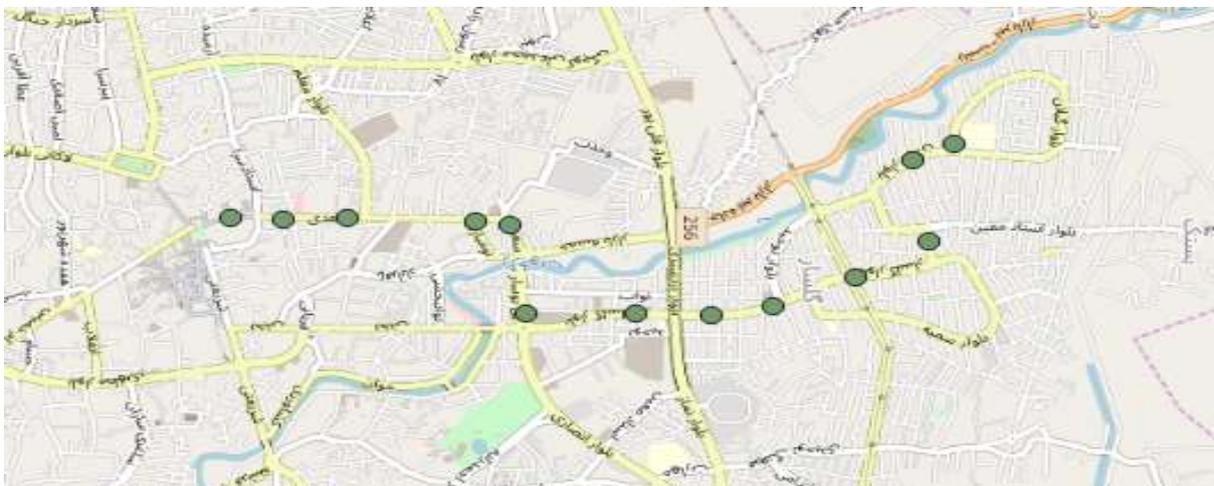


Figure 27 Golsar (inward) route plan

The origin of this Route is at the beginning of Saadi Street and its destination is on Gilan Blvd. The fleet sizes in this route is 5 bus units and the number of stations in the outward direction are 22, and in the inward direction are 14 units. Most of the stations in Golsar are in good condition due to the high level of welfare in this area of the city. in this Route, Private cars park in the Bus stations which will make a difficulty for the buses to stop in irregular areas, and on the other hand this problem will make traffic.

Fleet Size	number of outward stations	number of inward stations
5	22	14

Table 12 Golsar route general information

3.8.11. Airport route



Figure 28 Airport (outward) route plan



Figure 29 Airport (inward) route plan

The origin of this route is at the beginning of the Saadi Street and its destination is Persi Gas located on the outskirts of the city. The fleet sizes in this route is 6 bus units and the number of stations in the outward direction are 30, and in the inward direction are 31 units. This Route has the same path as Golsar Route. it enters the city area by passing Farzane Square. The status of the stations in this urban area is relatively convenient, but most of the stations in the suburbs have no minimum facilities.

Fleet Size	number of outward stations	number of inward stations
6	30	31

Table 13 Airport route general information

3.8.12. Caspian route



Figure 30 Caspian (outward) route plan



Figure 31 Caspian (inward) route plan

The origin of this route is at the beginning of Saadi Street and its destination is Jefrud. The fleet sizes in this route is 2 bus units and the number of stations in the outward direction are 30, and in the inward direction are 31 units. The stations on this route are same as the Persi Gas Station, and thereafter there is no definite station until reaching Jefrud. So, the passengers will get out of the bus and get in it whenever they want. During the oral interview with the travelers during the survey, it became clear that the rate of use of this route will reach maximum in the summer and in the evenings.

Fleet Size	number of outward stations	number of inward stations
2	30	31

Table 14 Caspian route general information

3.8.13. Shahrak imam route



Figure 32 Shahrak imam (outward) route plan



Figure 33 Shahrak imam (inward) route plan

The origin of this path is at the beginning of AlamoHoda and its destination is Shahrak Imam. The main task of this line is to cover the area of Hamidian and its surroundings. The fleet sizes in this route is 6 bus units and the number of stations in the outward direction are 16, and in the inward direction are 15 units.

Fleet Size	number of outward stations	number of inward stations
6	16	15

Table 15 Shahrak imam route general information

3.8.14. MirzaKochik route



Figure 34 MirzaKochik (outward) route plan

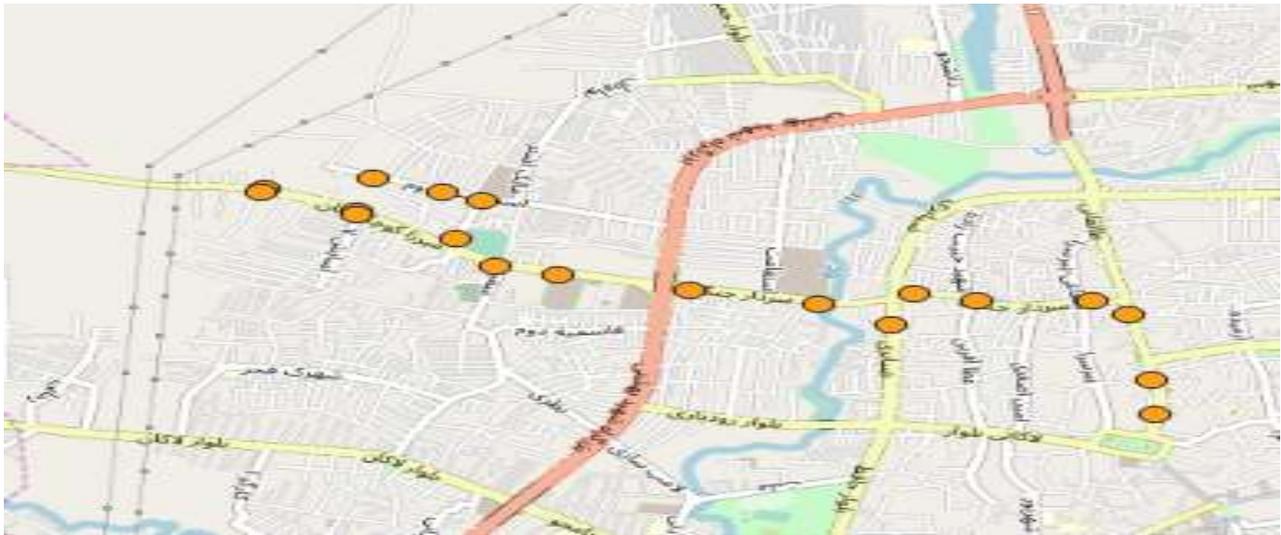


Figure 35 MirzaKochik (inward) route plan

The origin of this Route is at the beginning of the Kelisa and its destination is Asayesh 7 and Maloolin. This Route has the most usage in the whole AlamolHoda Street, and because most people living in this area have low income, the bus service will be a very good option for them. The fleet sizes in this route is 5 bus units and the number of stations in the outward direction are 13, and in the inward direction are 19 units.

Fleet Size	number of outward stations	number of inward stations
5	13	19

Table 16 Mirzakochik route general information

3.8.15. Esteghamat route



Figure 36 Esteghamat route plan

The origin of this path is at the beginning of AlamolHoda Street and its destination is Esteghamat. After it completes its turn as a loop it returns to the center of the city again. There are 1 bus and 25 stations in total.

Fleet Size	number of stations
1	25

Table 17 Esteghamat route general information

3.8.16. Aliabad route



Figure 37 Aliabad route plan

The origin of this Route is at the beginning of the AlamolHoda Street and its destination is Aliabad. This Route is a loop like Esteghamat Route and has a total of 3 bus and 27 stations. A remarkable point about Ali Abad's line is that most of the part of this Route goes around the areas with so many occupants, and this is a major problem both in traffic and the lack of available bus stops.

Fleet Size	number of stations
3	27

Table 18 Aliabad route general information

3.8.17. Rajaie route



Figure 38 Rajaie route plan

The origin of this Route is at the beginning of AlamolHoda Street and its destination is Jahad Square. The fleet sizes in this route is 6 bus units and the number of stations in the outward direction are 13, and in the inward direction are 12 units. But due to the non-stopping of the buses of this route at the Jahad Station, this line is practically looped, which means it has a total of 25 stations.

Fleet Size	number of outward stations	number of inward stations
6	13	12

Table 19 Rajaie route general information

3.8.18. Pas vishe route



Figure 39 Pas vishe (outward) route plan



Figure 40 Pas vishe (inward) route plan

The origin of this route, which serves the west and the suburbs of Rasht, is at the beginning of Taleghani Street in the Sabzemeydan and its destination is Pasvishe village. The fleet sizes in this route is 1 bus units and the number of stations in the outward direction are 16, and in the inward direction are 18 units. The station facilities available in this urban area are fairly reasonable and acceptable, but the conditions for the last 3 stations are not suitable for this route.

Fleet Size	number of outward stations	number of inward stations
1	16	18

Table 20 Pas vishe route general information

3.8.19. Molasara route



Figure 41 Molasara (outward) route plan



Figure 42 Molasara (inward) route plan

The origin of this path is at the beginning of Taleghani Street and its destination is Shaft's Road police. The fleet sizes in this route is 5 bus units and the number of stations in the outward direction are 16, and in the inward direction are 18 units. Stations of this Route and Pas vishe are the same. From Taleghani Street to Shaft's Road police, the passengers will get out of the bus and get in it whenever they want.

Fleet Size	number of outward stations	number of inward stations
5	16	18

Table 21 Molasara route general information

3.8.20. Jirdeh route



Figure 43 Jirdeh (outward) route plan



Figure 44 Jirdeh (inward) route plan

According to the Bus Company of Rasht the origin of this route is at the beginning of Taleghani Street and its destination is Jirdeh village. However, after the last visit, it became clear that the last station on this route is located at the gas station of Jirdeh. The fleet sizes in this route is 2 bus units and the number of stations in the outward direction are 13, and in the inward direction are 21 units. Stations in this route, except for the last station in the village of Jirdeh, have proper facilities. There is a population center on the Agha Seyed Sharif's tomb. However, there is no definite station in this place and the passengers will get out of the bus and get in it whenever they want.

Fleet Size	number of outward stations	number of inward stations
2	13	21

Table 22 Jirdeh route general information

3.8.21. kamarbandi route

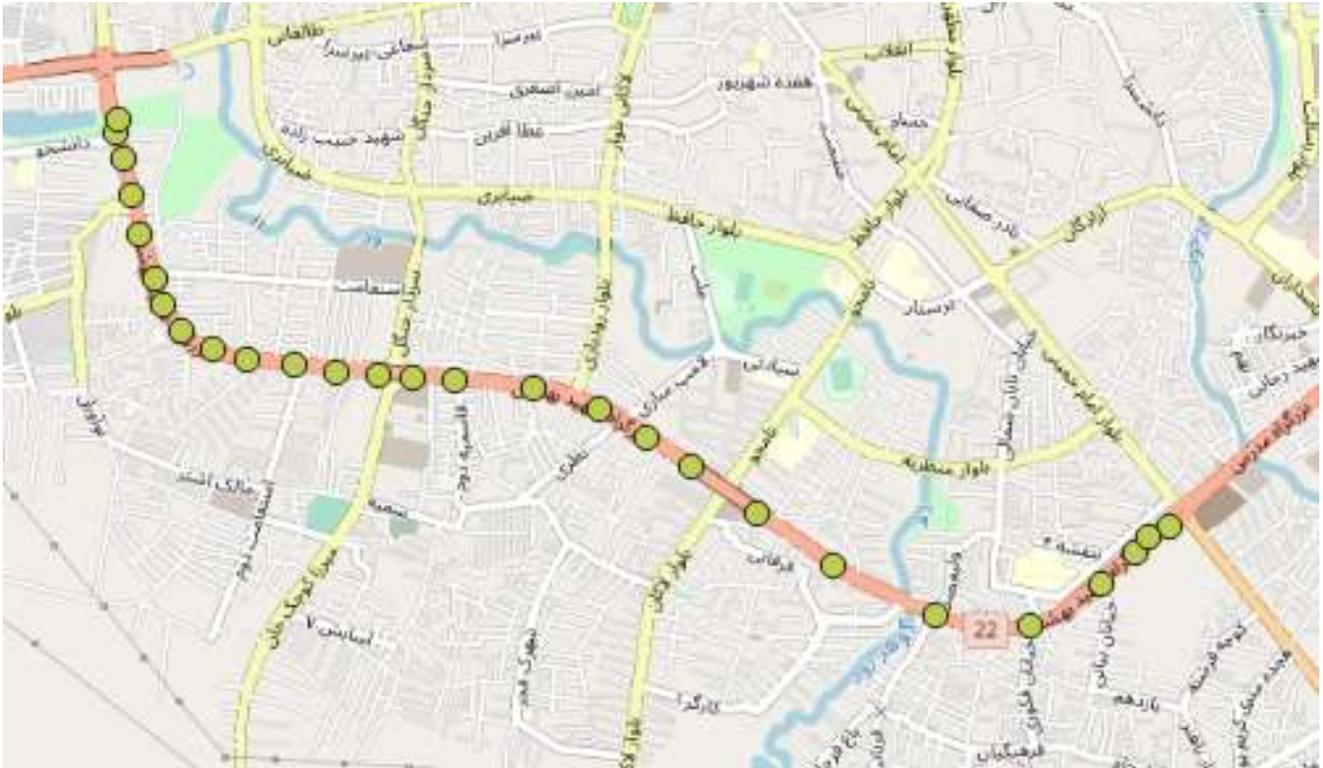


Figure 45 kamarbandi route plan

In this Route, its origin is in the Azadegan Square and its destination is Mosala Square. There is no fixed and stable station in this Route, so the passengers will get out of the bus and get in it whenever they want. The sizes in this route is 2 bus units

Fleet Size	number of stations
2	-

Table 23 Kamarbandi route general information

4 Chapter 4: Analysis of the bus routes

4.1 GIS representation of the number of passengers boarding and alighting at the different stops

QGIS software is used to analyze the data and checking the lines of the bus system in Rasht. To do this, data files are loaded for each line, saved as CSV files into QGIS software and that lines are created on the software. But at first glance, it was very difficult to detect the stations with a lot of passengers from the stations with low passengers. In order to simplify the review of lines, the stations are scaled.

In QGIS software, each station can be displayed with a specific symbol and a specific size. First, two groups of shape files of each line are produced, called shape file boarded, which is related to the shape files of each line whose symbol size is adjusted according to the number of daily boarded passengers. And the other group named shape file go out, which is related to shape file for each line, the size of the symbol of each station in this group are set corresponding to the number of passengers got off the buses.

Now, each group after scaling the stations according to the number of passengers boarded or got off is represented as below.

4.1.1. Terminal route

4.1.1.1. Terminal (outward) route scaled relative to the number of boarded passengers



Figure 46 scaled Terminal (outward) route plan

The line that is shown in figure 40 indicates the most frequented boarded passengers in the city center, which is normal in scaling of lines according to the boarded passenger. This route moves a large number of passengers to the farther of the city center. It is also worth noting that according to the data, this line loses its capacity of boarded passengers after the intersection of Imam Khomeini and Modares Highway

4.1.1.2. Terminal (outward) route scaled relative to the number of got off passengers



Figure 47 scaled Terminal (outward) route plan

Figure 47 illustrates that the most getting out passengers of this line are in the Pamchal station which is near the intersection of Shahid Beheshti Highway and Imam Khomeini Boulevard and with 525 daily got off passengers indicate the importance of this line, also can be noted that there is large number of getting out passengers at Ashouri station because of nearing to residential area and Payam nour station because of nearing to the Payam nour university.

Table of this route is located **Error! Reference source not found.**

4.1.1.3. Terminal(inward) route scaled relative to the number of boarded passengers

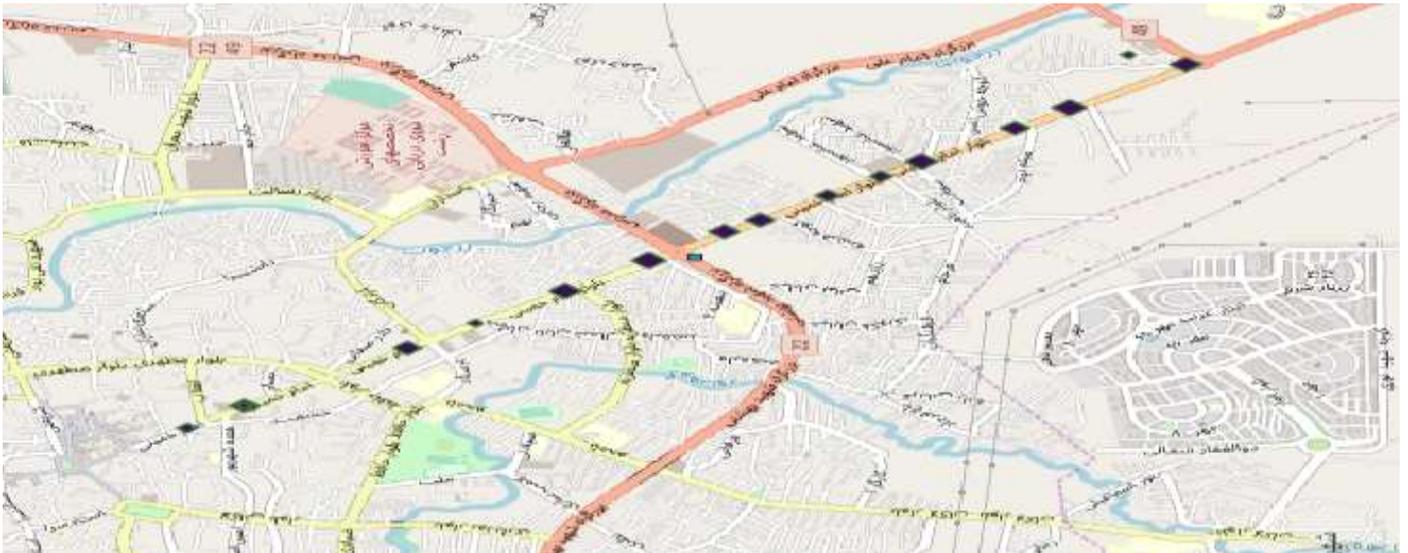


Figure 48 scaled Terminal (inward) route plan

As it is shown, the line beyond Gil Square and the Rasht Urban Bus Terminal has the most numbers boarded passengers. This much of the boarded passengers is continued to the intersection of Modarres Highway and Imam Khomeini Boulevard, after which the boarded passenger number is reduced and then Near Heshmat Square significant amounts of passengers on the way back of this line are indicated.

4.1.1.4. Terminal (inward) route scaled relative to the number of got off passengers



Figure 49 scaled Terminal (inward) route plan

This figure illustrates that the most passengers getting out of the buses are in the center of the city, which can be predicted because it is the last station of this highway, but a remarkable point is the 1,865 passengers departing at this station. But a remarkable point is the 1,865 passengers departing at this station, which is a reason for the significance of this line and the high rate of use of this line. But there are a big number of passengers that get out at Azarnani stations due to the presence of a medical center in this area, and also Michael square, because there are banks and courts in this area.

4.1.2. Lakan shahr route

4.1.2.1. Lakan shahr(outward) route scaled relative to the number of boarded passengers



Figure 50 scaled Lakan shahr (outward) route plan

It is shown that this line has the largest Boarded passenger volume in the city Center and after the passage from the intersection of Namjoo and Shaheed Beheshti highways slowly loses its load. The volume of the daily boarded passengers on the front of the university given the fact that this station is one before the last station of Lakan Shahr's Route and students prefer to take the buses in this station which can be caused by the lack of a suitable airfield bridge near the university

4.1.2.2. Lakan shahr (outward) route scaled relative to the number of got off passengers



Figure 51 scaled Lakan shahr (outward) route plan

As it is illustrated, the most got off passengers of this line are at the Azad university station, which is due to the existence of the university as well as the entrance to the residential town of Mehr. But in general, the total number of passengers on this line can be noted, which is due to the importance of this line for consideration in the next research.

4.1.2.3. Lakan shahr (inward) route scaled relative to the number of boarded passengers



Figure 52 scaled Lakan shahr (inward) route plan

In this path, the largest volume of boarded passengers has been seized at the station opposite the university and the station at the intersection of Namjoo and Shaheed Beheshti highways, and the remaining stations have average volume.

4.1.2.4. Lakan shahr (inward) route scaled relative to the number of got off passengers



Figure 53 scaled Lakan shahr (inward) route plan

Figure 53 demonstrates the most got off passengers on this line are located at Shahr-dari station, due to being on the city center and the last station of this line, but the high number of passengers are gotten out of the buses at Gaz square or Electricity company and Farhang stations should be mentioned, which should be investigated in next research.

4.1.3. Around city3 route

4.1.3.1. Around city3 route scaled relative to the number of boarded passengers



Figure 54 scaled Around city3 route plan

This line has the most boarded passengers in the city center. And, a large number of boarded passengers are seen in Michael Square. And, near the blood organization of Rasht. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations.

4.1.3.2. Around City 3 route scaled relative to the number of boarded passengers



Figure 55 scaled Around city3 route plan

The largest number of got off passengers in line is at the Khomeiran Zahedan Station for outward direction, because of its proximity to the Army Residential and for inward direction the most got off passenger are at the Shariati station in the city center. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations. Table of this route is located **Error! Reference source not found.**

4.1.4. Lakan route

4.1.4.1. Lakan (outward) route scaled relative to the number of boarded passengers



Figure 56 scaled Lakan (outward) route plan

This line has largest volume of boarded passengers in the city center and the Michael square has big value of boarded passenger which can be due to the passengers changing their lines. But, as it is shown after the passage of Azad University and residential houses called mehr, there is a significant drop in the daily number of Boarded passengers.

4.1.4.2. Lakan (outward) route scaled relative to the number of got off passengers



Figure 57 scaled Lakan (outward) route plan

Figure 57 indicates that the most got off passengers on this line are at the Lakan shahr station, but in general due to low number of passengers on this line can be considered such as a not important line.

4.1.4.3. Lakan (inward) route scaled relative to the number of boarded passengers



Figure 58 scaled Lakan (inward) route plan

As it is shown this line at the station near Lakan residential complex has the most Boarded passenger, and then at the Imam and Gaz square and the Azad University stations, there is a greater amount of passenger boarded than the other stations.

4.1.4.4. Lakan (inward) route scaled relative to the number of got off passengers

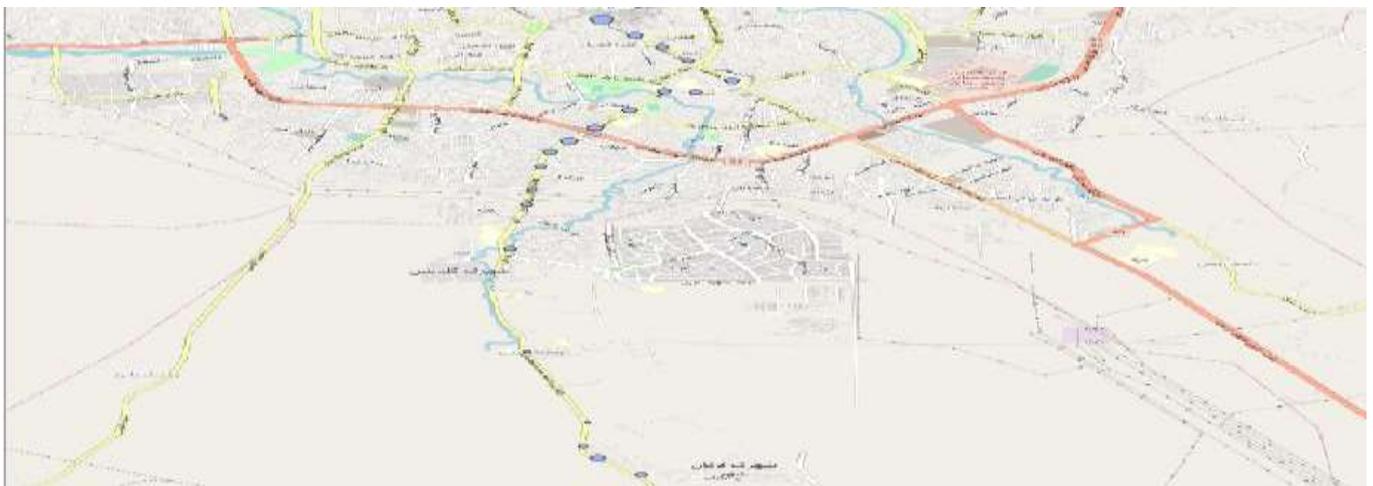


Figure 59 scaled Lakan (inward) route plan

It is illustrated in figure 59 that the most got off passengers on this line are located at Shahr-dari station, but in general due to low number of passengers on this line can be considered such as a not important line.

4.1.5. Imam route

4.1.5.1. Imam route scaled relative to the number of boarded passengers

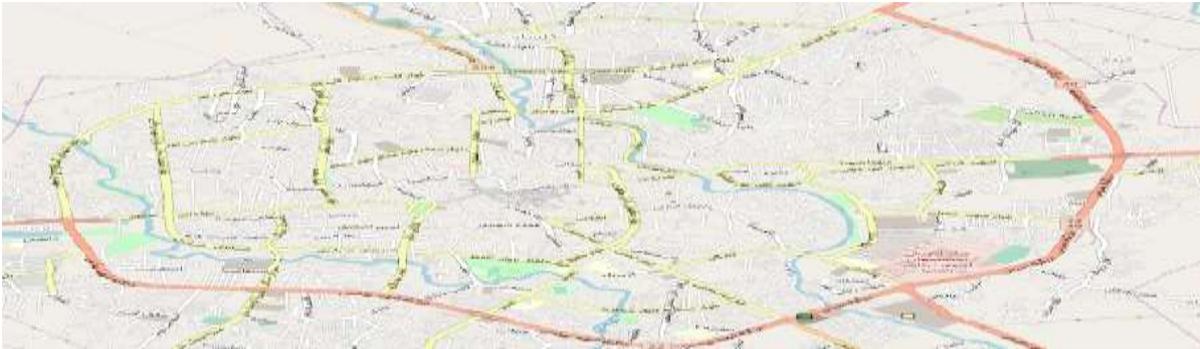


Figure 60 scaled Imam route plan

As it is indicated, with the lack of initial data and the number of boarded passengers for this route, evaluating is not available, but there are significant passenger numbers at the two stations of this line. And mentioned before, getting on board or getting off of this line happens at any points of the entire path due to the absence of a predicted station at any location, and for this purpose, it is not possible to properly assess this line. It should be pointed out that there were a lot of residential complex on this route which can be predicted that there will be lost of passengers. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star icon for the inwards stations.

4.1.5.2. Imam Route scaled relative to the number of got off passengers



Figure 61 scaled Imam route plan

Figure 61 illustrates that with the lack of initial data and the number of boarded passengers for this route, could not properly evaluate this route, but there are significant passengers' number at the two stations of this line. And as mentioned before, getting on board or getting off in this line happens at any points of the entire path due to the absence of a predicted station at any location, and for this purpose, it is not possible to properly assess this line. It should be pointed out that there are a lot of residential complex in this area which can be predicted that there will be lost the information about passengers. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations

4.1.6. Around city4 route

4.1.6.1. Around city4 route scaled relative to the number of boarded passengers



Figure 62 scaled Around city4 route plan

This line in the city center, which is the terminal of this route, has the largest number of daily boarded passengers, also in the stations of Seyghalan, the Palestinian intersection and the station at Chamran intersection with Palestine. There is more passenger's volume than the rest of this line. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations.

4.1.6.2. Around city4 route scaled relative to the number of got off passengers



Figure 63 scaled Around city4 route plan

The largest number of passengers getting out of this line is at Imam Hossein Station in outward direction, due to the intersection of Chamran and Modares Highway, and in the inward direction there is the most got off passengers at Shahr-dari Station in the city center. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations.

4.1.7. Jafarabad route

4.1.7.1. Jafarabad (outward) route scaled relative to the number of boarded passengers



Figure 64 scaled Jafarabad (outward) route plan

In the center of the city, there is the largest number of Boarded passengers, and at the Palestine intersection and Zarjub stations, and more passengers being boarded than the other stations of this line.

4.1.7.2. Jafarabad (outward) route scaled relative to the number of got off passengers

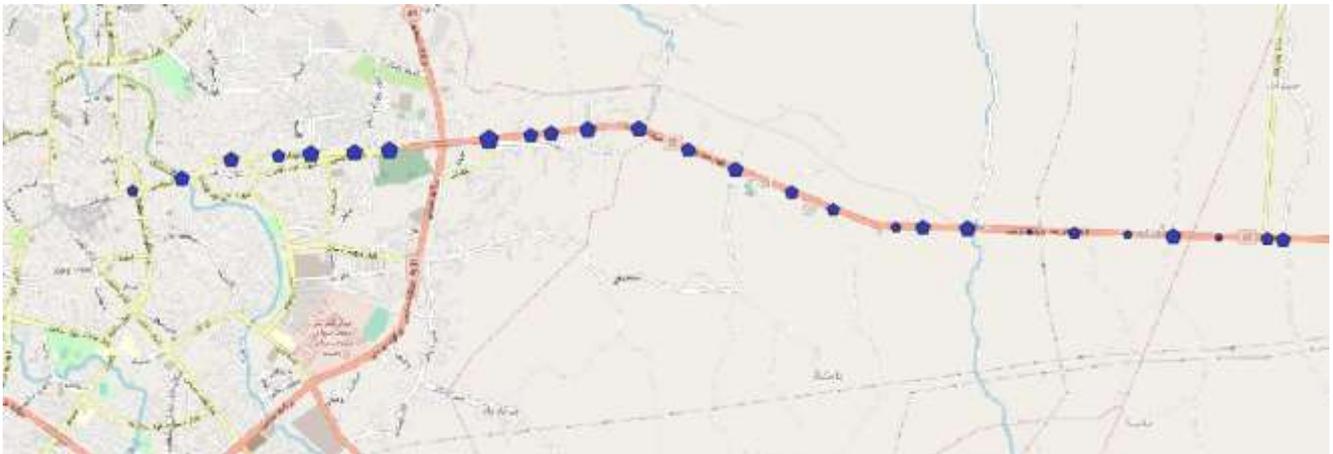


Figure 65 scaled Jafarabad (outward) route plan

The largest number of passengers got off on this line is located at the terminal station near the intersection of Modares highway and Imam Reza Boulevard. In general, this line should be considered as one of the important lines due to the high number of passengers and can be a good subject to research in next examines.

4.1.7.3. Jafarabad (inward) route scaled relative to the number of boarded passengers



Figure 66 scaled Jafarabad (inward) route plan

As it is indicated, the stations of this route have a fixed size.

4.1.7.4. Jafarabad (inward) route scaled relative to the number of got off passengers

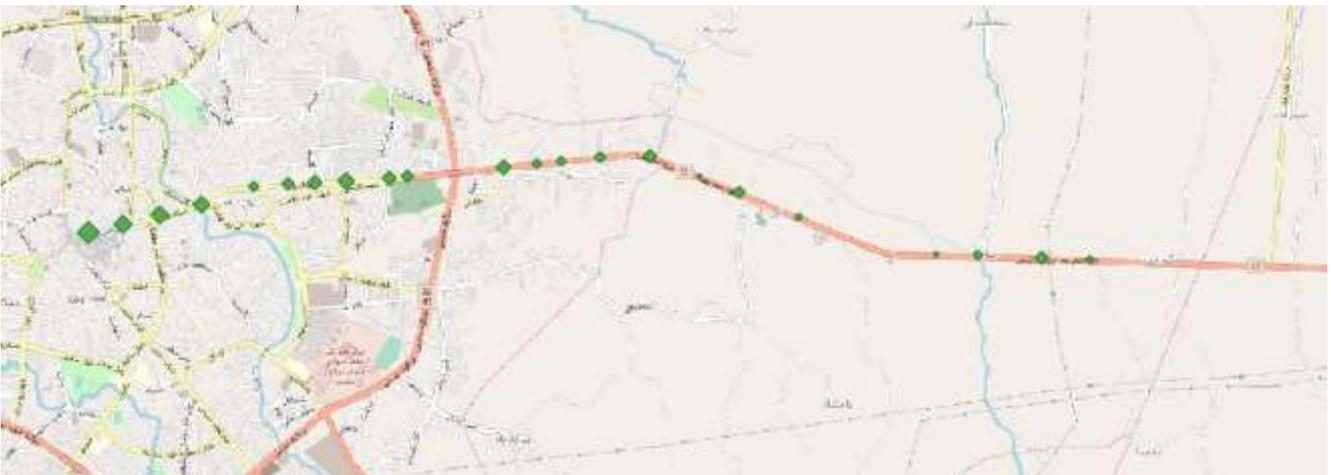


Figure 67 scaled Jafarabad (inward) route plan

The most got off passengers on this line is at Shariati Station. Because it is the last station of the line and is located in the city center. In general, this line should be considered as one of the important lines due to the high number of passengers and can be a good subject to research in next examines.

4.1.8. Kouchesfehan route

4.1.8.1. Kouchesfehan (outward) route scaled relative to the number of boarded passengers



Figure 68 scaled Kouchesfehan (outward) route plan

It is shown that this line has the largest number of passengers in the city center at Shariati station, and the Palestine intersection and Jafarabad stations also have more passengers than the other stations of this line, But for the Jafarabad station, which has a significant passenger volume at the terminal's end station, it can be noted that this station has a higher number of passengers than the other stations, because there are many passengers traveling to the center of Rasht. But due to the lack of a well-equipped airway bridge, the passengers decide to board the station instead of the station opposite the street.

4.1.8.2. Kouchesfehan (outward) route scaled relative to the number of got off passengers

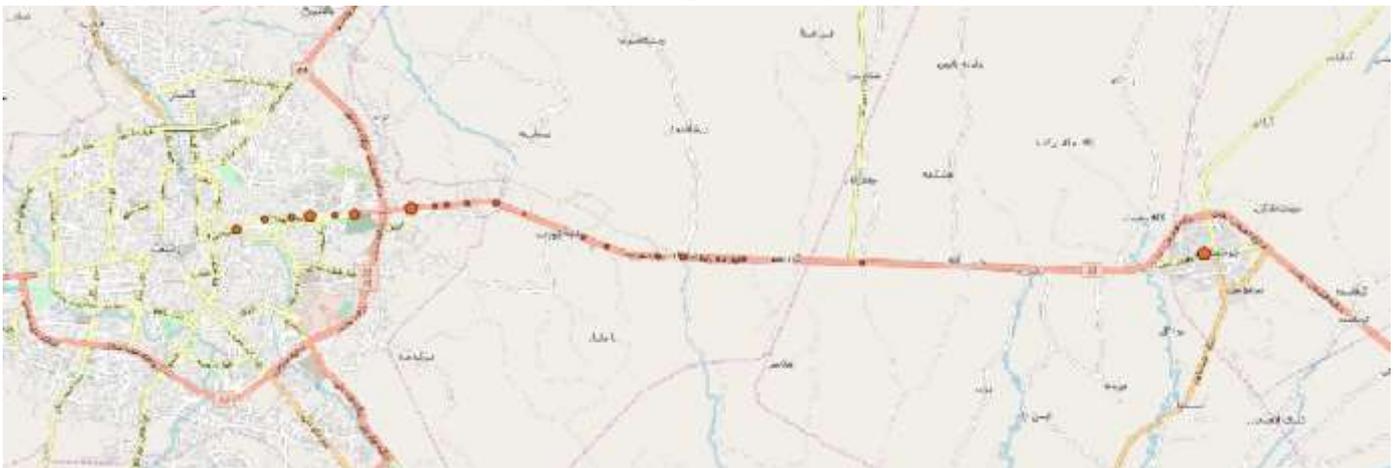


Figure 69 scaled Kouchesfehan (outward) route plan

In general, it is demonstrated that the low number of passengers on this line, which is not widely appreciated by the line, which can be due to the small fleet sizes and the length of the route, which, in total, increases the interval time of this line. It is possible to remove this line and use its fleet in Jafarabad's line to increase potential of that line.

4.1.8.3. Kouchesfehan (inward) route scaled relative to the number of boarded passengers

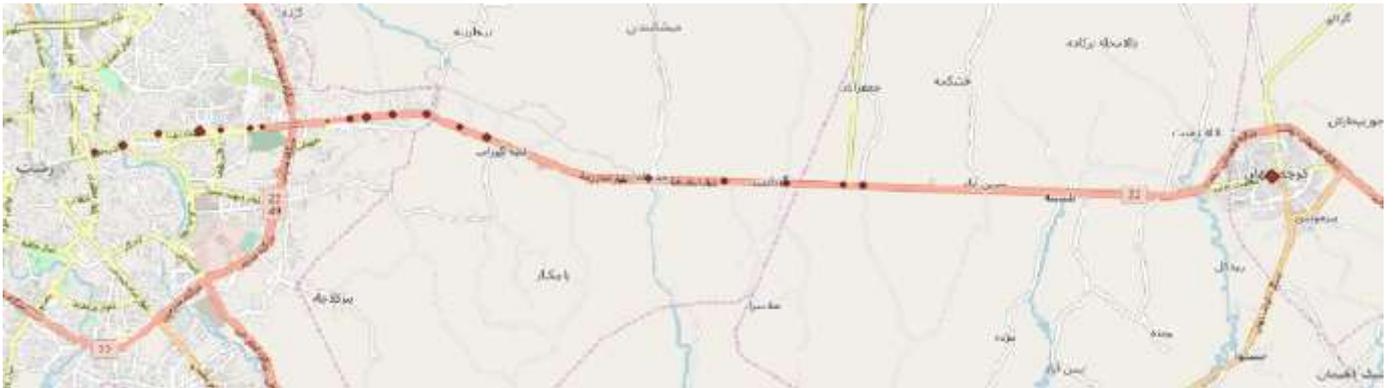


Figure 70 scaled Kouchesfehan (inward) route plan

Figure 70 indicates the largest number of boarded passengers the route at the Pastorizeh Station, which is not significant due to the number of 24 passengers per day.

4.1.8.4. Kouchesfehan (inward) route scaled relative to the number of got off passengers

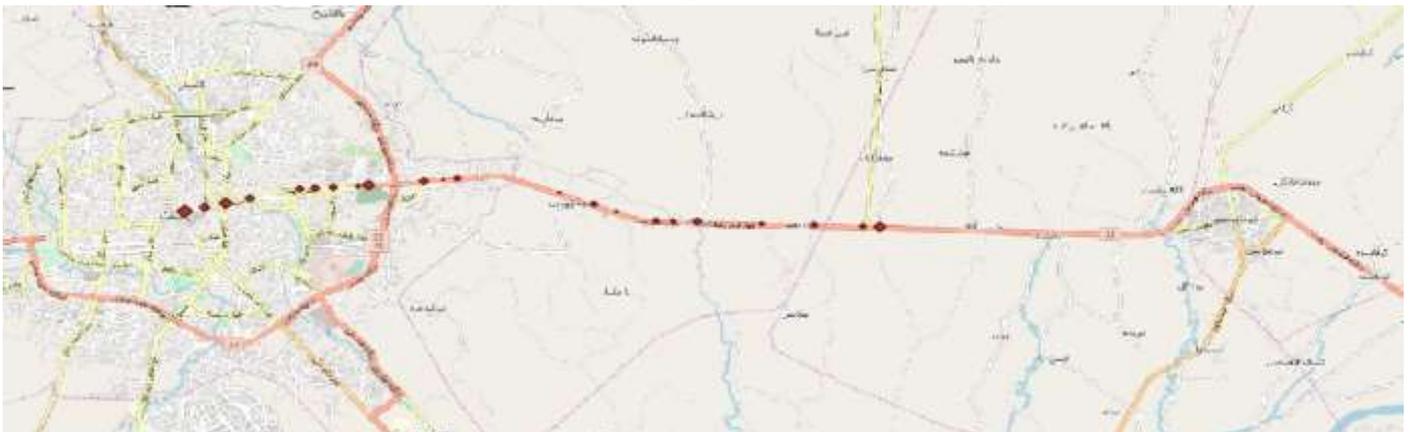


Figure 71 scaled Kouchesfehan (inward) route plan

In general, figure 71 represents the low number of got off passengers on this line, which can be due to the small fleet sizes and the length of the route, which in total, increases the interval time of this line. It is possible to remove this line and use its fleet in jafarabad's line to increase its potential.

4.1.9. Shahrak Saba route

4.1.9.1. Shahrak Saba (outward) route scaled relative to the number of boarded passengers



Figure 72 scaled Shahrak saba(outward) route plan

This line in the city center has the most Boarded passengers and at stations Seyghalan and Zarjob has a greater number of Boarded passengers than the rest of the stations and gradually moving away from the central area of the city witnessed a significant drop in the volume of boarded passengers.

4.1.9.2. Shahrak Saba (outward) route scaled relative to the number of got off passengers

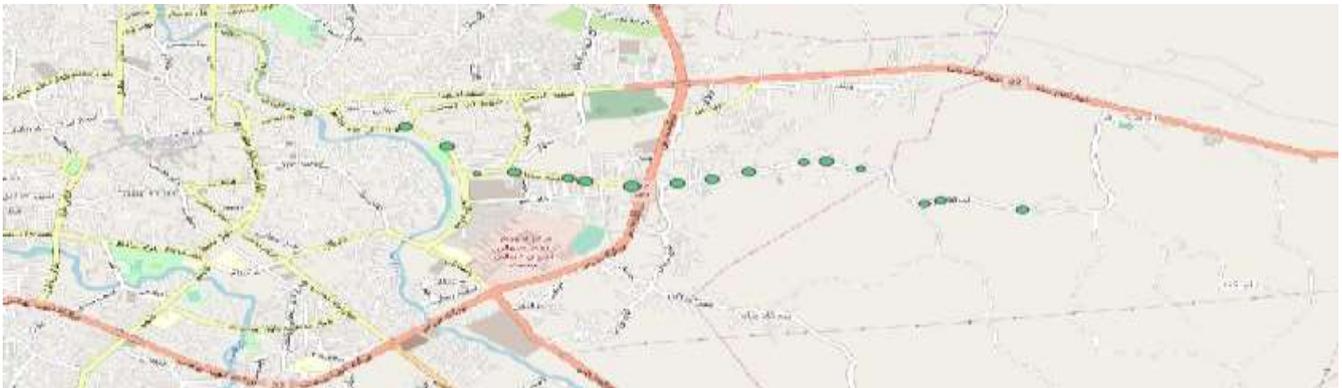


Figure 73 scaled Shahrak saba (outward) route plan

This line is also of little importance, which can be due to the fleet size of this line, which according to the number of bus units for this line can be seen an increased interval time of this line and also significantly reducing the desire of travelers to use this line.

4.1.9.3. Shahrak saba (inward) route scaled relative to the number of boarded passengers



Figure 74 scaled Shahrak saba (inward) route plan

It is shown that the largest number of boarded passengers is at Bagheri Station, which is generally with a total of 70 passengers, so it is not considerable like an important route. And in other stations, there is a relatively constant daily passenger volume.

4.1.9.4. Shahrak Saba (inward) route scaled relative to the number of got off passengers



Figure 75 scaled Shahrak saba (inward) route plan

This line is also of little importance, which can be attributed to the fleet sizes of this line, which according to the number of bus units for this line can be seen an increased interval time of this line and also significantly reducing the desire of travelers to use this line.

4.1.10. Golsar route

4.1.10.1. Golsar (outward) route scaled relative to the number of boarded passengers



Figure 76 scaled Golsar (outward) route plan

This route has the most daily boarded passengers at Shahr-dari Station with 2,760 passengers, which indicate a high rate of passenger pickup on this line, and then the Kaktoos and Moin stations have more passenger volume than the other stations of this line. In the overall view of this line, it can be concluded that this line has a significant daily boarded passenger on most of its stations.

4.1.10.2. Golsar (outward) route scaled relative to the number of got off passengers



Figure 77 scaled Golsar (outward) route plan

The largest number of got off passengers on this line is located at 104 Street, and in general, a large number of passengers can be seen at most of the stations on this line, which is due to the importance of this line and to consider it in subsequent research.

4.1.10.3. Golsar (inward) route scaled relative to the number of boarded passengers



Figure 78 scaled Golsar (inward) route plan

In this route, the largest number of boarded passengers is at the Moin Boulevard that with 355 daily passengers indicates a high rate of bus Usage in this area. How we can see there is not lines overlap in this area, it can be concluded that this station is supporting a lot of residents and needs more attention.

4.1.10.4. Golsar (inward) route scaled relative to the number of got off passenger



Figure 79 Golsar (inward) route plan

It is shown that the most got off passengers on this line is located at the Shahrdari station. And in general, a large number of passengers can be seen at most of the stations on this line, which is due to the importance of this line and to consider it in subsequent research.

4.1.11. Airport route

4.1.11.1. Airport (outward) route scaled relative to the number of boarded passengers



Figure 80 scaled Airport (outward) route plan

Figure 80 indicates the largest number of daily boarded passengers in the terminal of this line at city center. Unfortunately, due to the lack of use of buses that can accommodate passengers' bags and luggage, none of the passengers use this line to go to the airport, and as shown in the photo, most passengers leave the bus before the intersection of Ansari Boulevard and Khorramshahr Highway. But as it is shown at the Golsar station, there is a large volume of daily boarded passengers, which can be a reason for travelers who have changed their bus lines at adjacent stations, further research will be considered and reviewed.

4.1.11.2. Airport (outward) route scaled relative to the number of got off passengers



Figure 81 scaled Airport (outward) route plan

The most got off passengers on this route is located at Anzali Station, which can be caused by changing the line to the Khorramshahr highway.

4.1.11.3. Airport (inward) route scaled relative to the number of boarded passengers



Figure 82 scaled Airport (inward) route plan

It is illustrated that the largest number of daily boarded passengers is located at Golsar Station, which according to the number of 528 passengers, shows that there are a large number of passengers in this area, which should be considered like an important line. And also, high number of daily boarded passengers is at the Ershad station, which can be explained by the existence of a large residential complex in that area and the route back to the airport, it means that a large number of residents of that area use a bus to reach the city center or elsewhere. But the remarkable point of this line after scaling stations according to the number of daily boarded passengers is that this line does not have a high passenger uptake rate on the return route before airport station.

4.1.11.4. Airport (inward) route scaled relative to the number of got off passengers



Figure 83 scaled Airport (inward) route plan

The largest number of passengers on this route is located at the Shahr-dari station, which can be predicted because the station is located in the city center and also the station that is the end of this line.

4.1.12. Caspian route

4.1.12.1. Caspian route scaled relative to the number of boarded passengers



Figure 84 scaled Caspian (outward) route plan



Figure 85 scaled Caspian (inward) route plan

According to the Figure 85, it is possible to see the very low number of passengers on the inwards direction or on the outwards direction of this line, which can be a strong reason for usability of this line and as in the beginning, it is mentioned that the number of buses considered for this line is two, and it can be predicted that the shortage of the fleet of this line along with the length of it is a reason for an increase in the overhead time interval. Because of this, the line does not have a high rate of daily Boarded or got off passengers. It is possible to increase the attraction of the AIRPORT ROUTE passengers by removing this line and placing the fleet of this line at the AIRPORT ROUTE, which has more passengers per day than this line.

4.1.12.2. Caspian route scaled relative to the number of got off passengers



Figure 86 scaled Caspian (outward) route plan



Figure 87 scaled Caspian (inward) route plan

In general, it is demonstrated that the low number of passengers are on this line, which can be due to the fleet sizes and the length of the route, which, in total, increases the interval time in this line. It is possible to remove this line and use its fleet in Airport station to increase potential of that line.

4.1.13. Shahrak imam route

4.1.13.1. Shahrak imam (outward) route scaled relative to the number of boarded passengers



Figure 88 scaled Shahrak imam (outward) route plan

It is shown that the largest number of passengers boarded in this line is at Sam's station can be predicted because of the intersection of Sardar Jangal Street and Taleghani Street, which should be re-examined in subsequent investigations. While moving away from downtown the number of boarded passengers in this line is reduced.

4.1.13.2. Shahrak imam (outward) route scaled relative to the number of got off passengers



Figure 89 scaled Shahrak imam (outward) route plan

As can be seen, the number of passengers and their uniformity in the Hamidian area is due to the residential complexes. And because of the large number of passengers, this line can be considered for further research.

4.1.13.3. Shahrak imam (inward) route scaled relative to the number of boarded passengers



Figure 90 scaled Shahrak imam (inward) route plan

The largest number of boarded passengers this route is at Hamidian Station, which can be predicted that this number is due to existence of the Hamidian residential complex. The number was still high in Hamidian, after leaving Hamidian the volume of the passengers is reduced.

4.1.13.4. Shahrak imam (inward) route scaled relative to the number of got off passengers



Figure 91 scaled Shahrak imam(inward) route plan

The most passengers getting out of the buses are at alam ol hoda station and also the intersection of Taleghani and Rajaee Blvd.

4.1.14. Mirzakochik route

4.1.14.1. Mirzakochik (outward) route scaled relative to the number of boarded passengers



Figure 92 scelad Mirzakochik (outward) route plan

The most frequented passenger on this line is Sam's station, which can be predicted due to the local daily market in this area. There a significant drop in the traveled passenger of this route. As it is indicated by moving away from the terminal of this line and entering Mirzakochik Street the number of Boarded passengers of this line is reduced.

4.1.14.2. Mirzakochik (outward) route scaled relative to the number of got off passengers

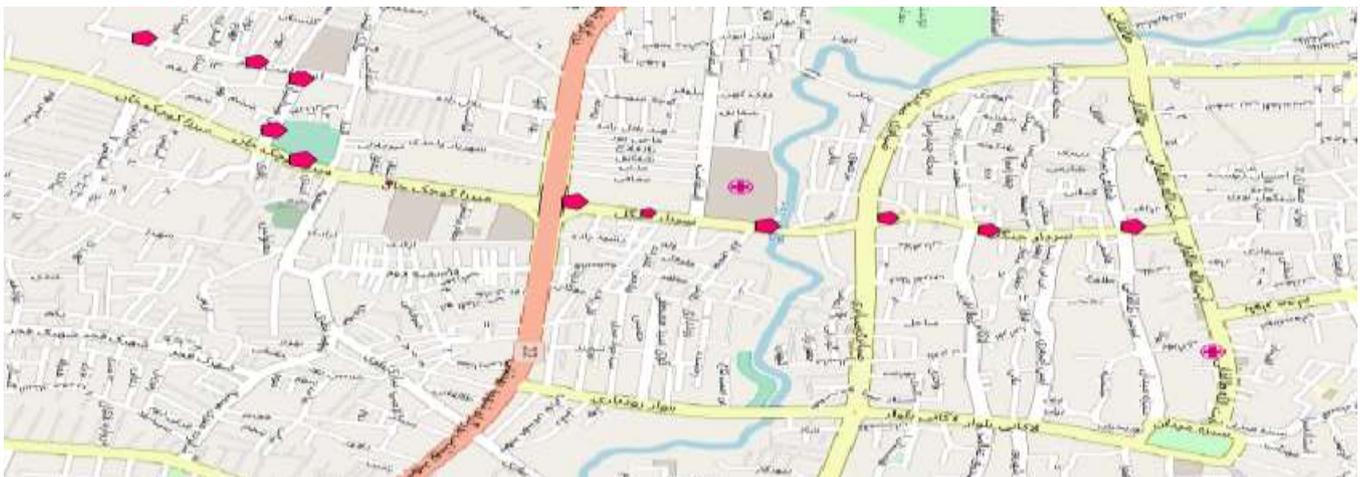


Figure 93 scelad Mirzakochik (outward) route plan

The most got off passengers of this route are located at Soleymandrab Station, which can be due to the existence of a residential area in this area.

4.1.14.3. Mirzakochik (inward) route scaled relative to the number of boarded passengers



Figure 94 scaled Mirzakochik (inward) route plan

Given the backwardness of this route, an impressive number of travelers should be seen in the distant districts of the city, and as it is shown, at Soleimandorab station near the Maloolin residential area, there are 910 daily Boarded passengers, but a significant point is the high number of passengers in Esteghamat and Maloolin. It can be mentioned that many numbers of the residents in this area and usage of the public transport system.

4.1.14.4. Mirzakochik (inward) route scaled relative to the number of got off passengers



Figure 95 scaled Mirzakochik (inward) route plan

The most got off passengers on this route are Sam Station, which can be due to the existence of a daily shopping mall in this area.

4.1.15. Esteghamat route

4.1.15.1. Esteghamat route scaled relative to the number of boarded passengers



Figure 96 scaled Esteghamat route plan

As it is indicated there are fewer daily Boarded passenger on this line, it is possible to predict that station placement is not properly selected. In total, this line is considered as the stations of low importance. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations.

4.1.15.2. Esteghamat route scaled relative to the number of got off passengers



Figure 97 scaled Esteghamat route plan

Figure 97 demonstrates there are fewer daily got off passengers on the line, it can be predicted that station placement is not properly selected, or even the sampling of stations in the appropriate hours has not been taken. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations.

4.1.16. Aliabad route

4.1.16.1. Aliabad route scaled relative to the number of boarded passengers



Figure 98 scaled Aliabad route plan

The largest number of daily Boarded passengers on this line is at Alam al-Hoda station. According to 1362 passengers, this figure shows the high rate of passengers in this line. And as seen, the number of passengers has gradually decreased while go further than the city center area.

It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star icon for the inwards stations.

4.1.16.2. Aliabad route scaled relative to the number of got off passengers



Figure 99 scaled Aliabad route plan

The most got off passengers on this line is at the Hashemi mosque station for outward direction and the most got off passengers are at the Alam-Al-Hadi station in the city center for inward direction. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations.

4.1.18. Pas vishe route

4.1.18.1. Pas vishe (outward) route scaled relative to the number of boarded passengers



Figure 102 scaled Pas vishe (outward) route plan

The largest number of daily Boarded passengers is at Bisotun Station, which is the main terminal of this line; this station is not worth researching because of its low total numbers of passengers which is 166.

4.1.18.2. Pas vishe (outward) route scaled relative to the number of got off passengers

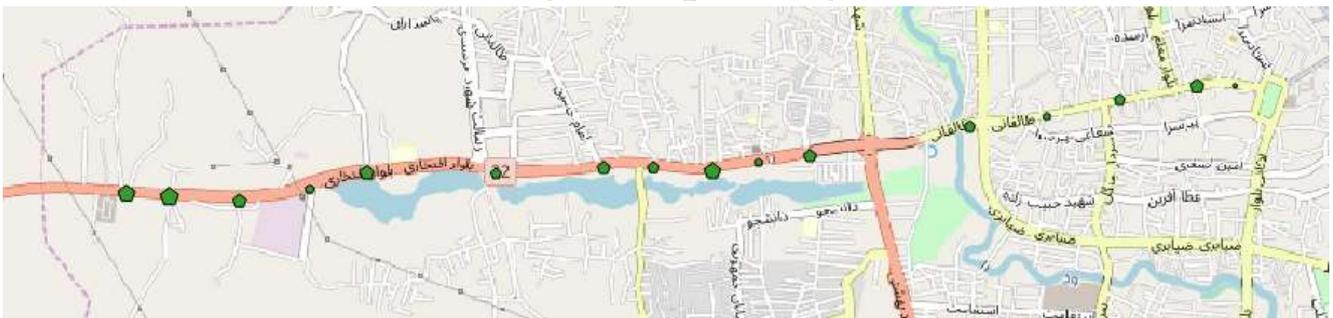


Figure 103 scaled Pas vishe (outward) route plan

As it is indicated, the most got off passengers of this line are at the Mikhak park station, but in general, the low number of passengers on this line can be seen and not studied in the next study.

4.1.18.3. Pas vishe (inward) route scaled relative to the number of boarded passengers



Figure 104 scaled Pas vishe (inward) route plan

This route has a low and steady number of passengers and will be selected as a low priority line.

4.1.18.4. Pas vishe (inward) route scaled relative to the number of got off passengers



Figure 105 scaled Pas vishe (inward) route plan

Figure 99 represents that the largest number of got off passengers on this line is at the Sabze meydan station, but in general, the low number of passengers on this line can be seen and not studied in the next research.

4.1.19. Molasara route

4.1.19.1. Molasara (outward) route scaled relative to the number of boarded passengers



Figure 106 scaled Molasara (outward) route plan

The largest number of daily boarded passengers on this line is at Bisotun Station, which is the main terminal of this line, and with regard to the 1386 passengers on daily basis, indicates the high importance and high passenger level on this line, but gradually moving away from the Bisotun Street, this passenger volume is diminished.

4.1.19.2. Molasara (outward) route scaled relative to the number of got off passengers



Figure 107 scaled Molasara (outward) route plan

Most of the got off passengers on this route are at Voleks, Dokhianat and Ahmad Gorab stations, which can be predicted by the existence of residential areas and the existence of a cigarette factory near the Dokhianat station.

4.1.19.3. Molasara (inward) route scaled relative to the number of boarded passengers



Figure 108 scaled Molasara (inward) route plan

The largest number of daily Boarded passengers in this line is located at Ahmad Gorab station, and then along the way, as it is demonstrated, there is a small amount of tolerance between the stations.

4.1.19.4. Molasara (inward) route scaled relative to the number of got off passengers



Figure 109 scaled Molasara (inward) route plan

The most got off passengers on this route are at the Sabze meydan square, which can be predicted due to its proximity to the city center and being the terminal of the line.

4.1.20. Jirdeh route

4.1.20.1. Jirdeh (outward) route scaled relative to the number of boarded passengers



Figure 110 scaled Jirdeh (outward) Route plan

The largest number of passengers on this line is at the Noghre Dasht Station, while this station has only 170 passengers daily there is dismissed the further research because low number of passengers on this line, this line can be put in the lowest rank.

4.1.20.2. Jirdeh (outward) route scaled relative to the number of got off passengers

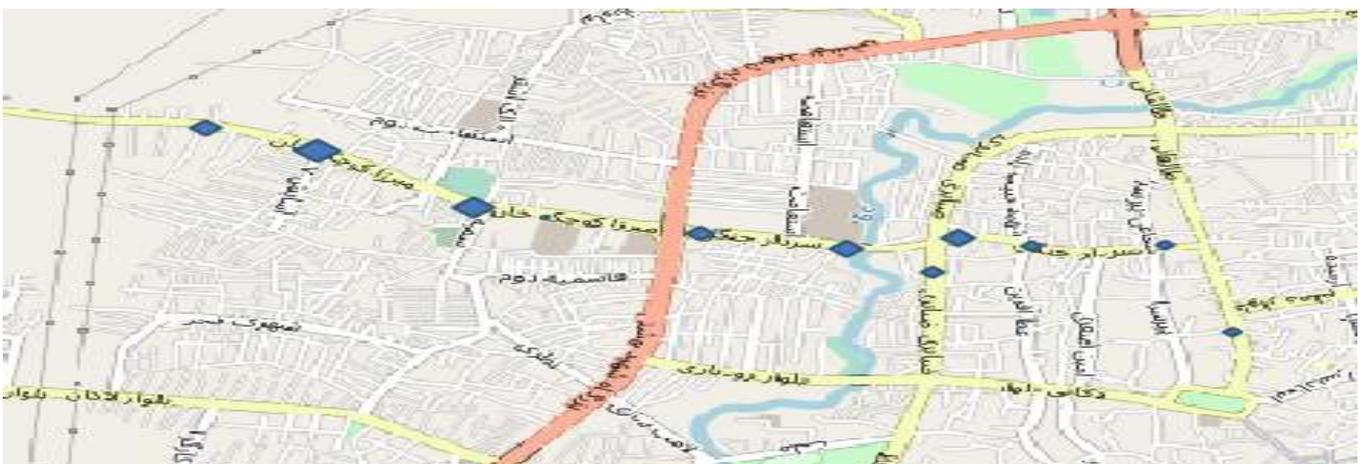


Figure 111 scaled Jirdeh(outward) route plan

As it is demonstrated, the most got off passengers of this line are located at Asayesh Alley Station, but in general, the low number of passengers on this line can be seen and not studied in the next study.

4.1.20.3. Jirdeh (inward) route scaled relative to the number of boarded passengers

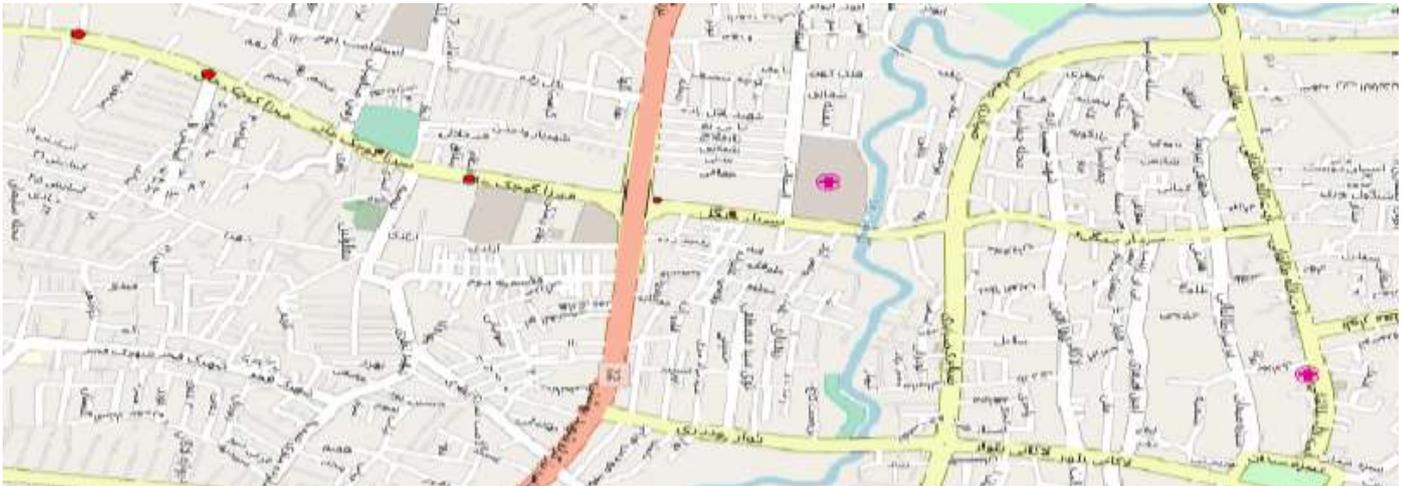


Figure 112 scaled Jirdeh (inward) route plan

The largest number of passengers traveled is at Asayesh 7 station located in the residential area, but in general, due to the low total number of passengers boarded this line, this line can be placed in low priority and further research can be dismissed.

4.1.20.4. Jirdeh (inward) route scaled relative to the number of got off passengers

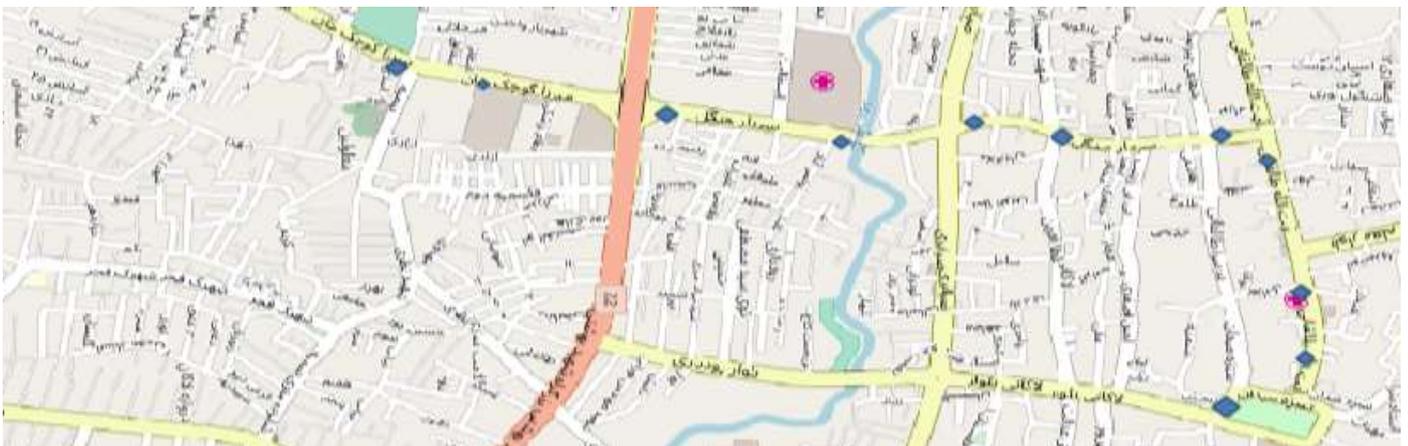


Figure 113 scaled Jirdeh (inward) route plan

As it is shown, the most passengers of this line are located at the Sabze meydan Station, but in general, the number of passengers on this line can be seen and not studied in the next study.

4.1.21. Kamarbandi route

4.1.21.1. Kamarbandi route scaled relative to the number of boarded passengers

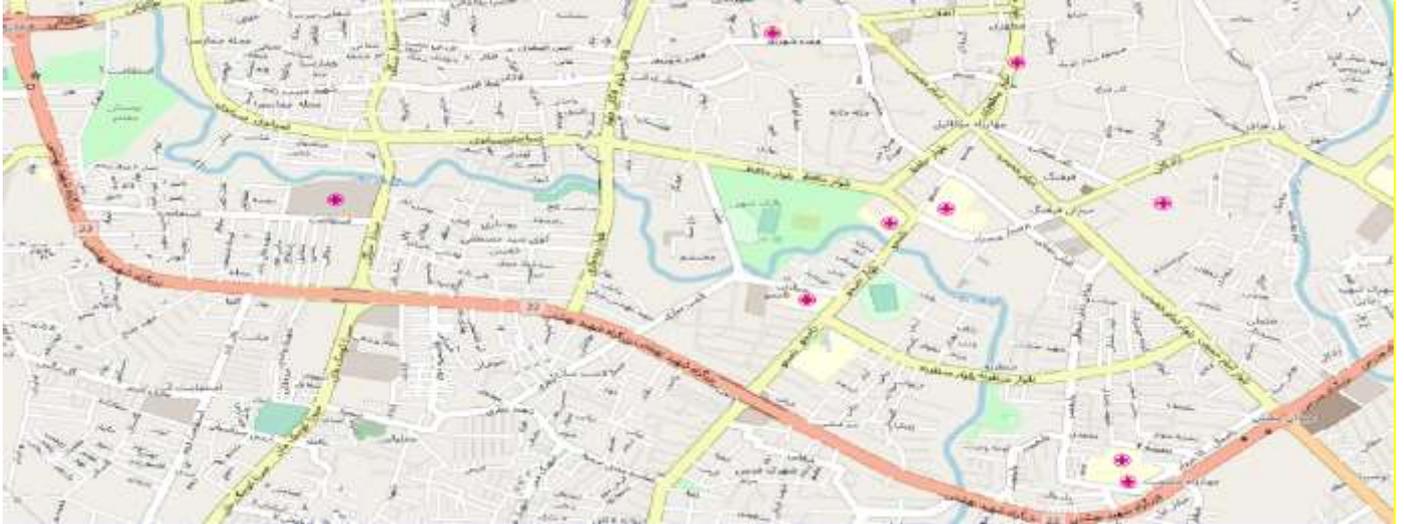


Figure 114 scaled kamarbandi route plan

As it is shown, with the lack of initial data and the number of boarded passengers for this route, evaluating is not available, but there are significant passenger numbers at the two stations of this line. And mentioned before, getting on board or getting off of this line happens at any points of the entire path due to the absence of a predicted station at any location, and for this purpose, it is not possible to properly assess this line. It should be pointed out that there are a lot of residential complex on this route which can be predicted that a lot of passengers will be lost. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star symbol for the inwards stations.

4.1.21.2. Kamarbandi route scaled relative to the number of got off passengers

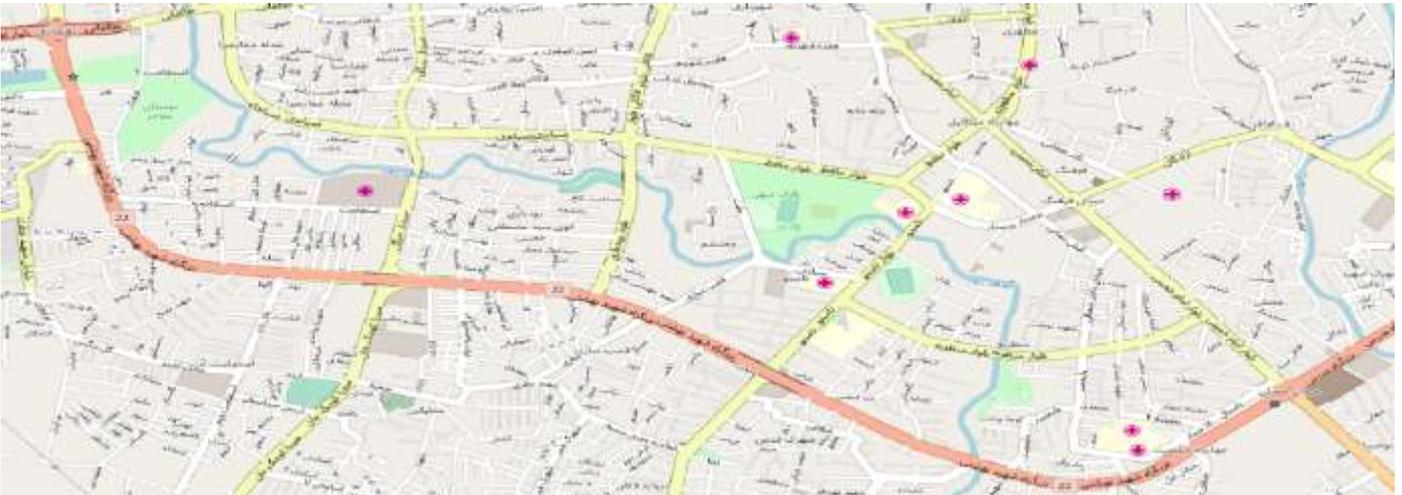


Figure 115 scaled kamarbandi route plan

As it is indicated, with the lack of initial data and the number of boarded passengers for this route, evaluating is not available, but there are significant passenger numbers at the two stations of this line. And as mentioned before, getting on board or getting off of this line happens at any points of the entire path due to the absence of a predicted station at any location, and for this purpose, it is not possible to properly assess this line. It should be pointed out that there are a lot of residential complex on this route which can be predicted that a lot of passengers will be lost. It should be noted that for the convenience of detecting, it was decided to allocate a square symbol for the outwards stations and a star icon for the inwards stations.

4.2 Identification and description of the main interchange areas between different lines

First of all, it is considered that the stations which have more than 100 passengers are more important and then start to see one by one the lines and stations where are overlapped and it is possible to have line changing by passengers. So I consider all lines and with consideration the number of boarded passenger or got off passenger in the stations I choose 6 areas which in these areas there is at least 1 station with boarded or got off passenger more than 100 passengers in day and the difference between these areas and other areas which I don't consider them is that in these areas there is the possibility of line changing.

The area of line changing is shown by  symbol.

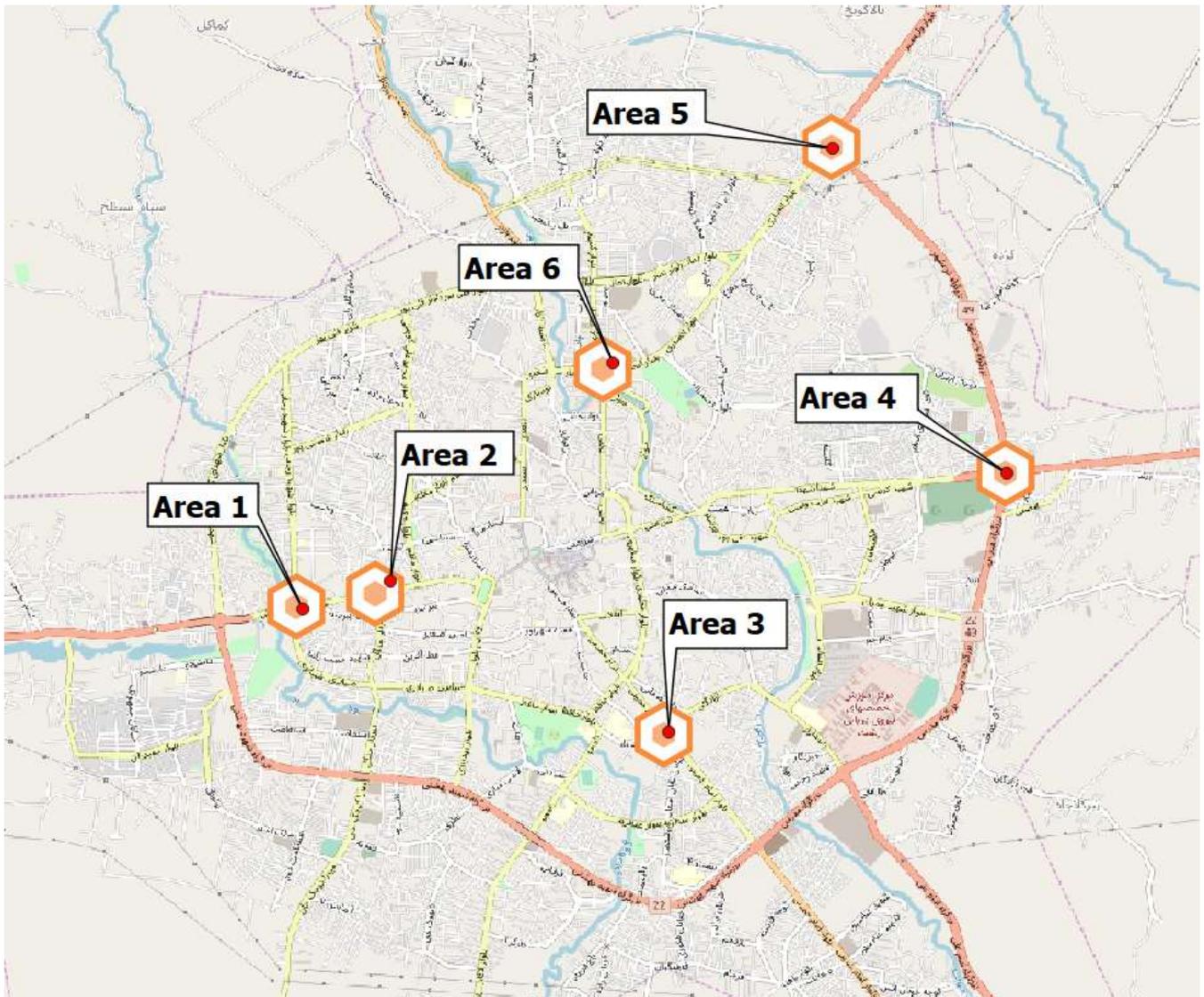


Figure 116 overall view of line changing areas

How it is shown Area1 and Area2 are located near the city center and Area4 and Area5 are located at the border of Rasht and other nearby cities. Area3 and Area6 aren't located at city center and not in the border of Rasht.

It should be noted that I consider all the possibility of line changing but for simplify It is written just those possibility of line changing which have sense for example I don't consider the line changing possibility with the lines which have same destination or same origin or same route.

After finding the areas I considered all the lines in the stops inside the areas regardless of their boarded passenger or get off passenger quantity.

To distinguish better the most important routes from total lines, I decided to choose those lines that have possibility of line changing between them with both of boarded passenger and got of passenger are more than 100 passengers in day.

I bolded the phrase when found the important lines.

I. 1st area of line changing

These are the 4 lines with a significant number of passengers:

- Molasadra (outward) route
- Molasadra (inward) route
- Shahrak Imam (outward) route
- Shahrak Imam (inward) route

This area is located at the intersection of Taleghani street and Shahid rajaie boulevard.



Figure 117 1st area of line changing

The number of passengers gotten out or gotten in in this area can be for these reasons:

- They may get out of the Shahrak imam (inward) line and get in the Rajaie (outward) line.
 - Shahrak imam (inward) line d.p.g.o.....138
 - Rajaie (outward) line d.p.b.....48

- They may get out of the Shahrak imam (inward) line and get in the Pas visheh (outward) line.
 - Shahrak imam (inward) line d.p.g.o.....138
 - Pas visheh (outward) line d.p.b.....11

- **They may get out of the Shahrak imam (inward) line and get in the Mola sara (outward) line.**
 - **Shahrak imam (inward) line d.p.g.o.....138**
 - **Mola sara (outward) line d.p.b.....168**

- They may get out of the Rajaie (inward) line and get in the Mola sara (outward) line.
 - Rajaie (inward) line d.p.g.o.....48
 - Mola sara (outward) line d.p.b.....168

- They may get out of the Rajaie (inward) line and get in the Pas visheh (outward) line.
 - Rajaie (inward) line d.p.g.o.....48
 - Pas visheh (outward) line d.p.b.....25

- They may get out of the Rajaie (inward) line and get in the Shahrak imam (outward) line.
 - Rajaie (inward) line d.p.g.o.....48
 - Shahrak imam (outward) line d.p.b.....288

- They may get out of the Pas visheh (inward) line and get in the Shahrak imam (outward) line.
 - Pas visheh (inward) line d.p.g.o.....2
 - Shahrak imam (outward) line d.p.b.....48

- They may get out of the Pas visheh (inward) line and get in the Rajaie (outward) line.

- Pas visheh (inward) line d.p.g.o.....31
 - Rajaie (outward) line d.p.b.....48
- They may get out of the Mola sara (inward) line and get in the Shahrak imam (outward) line.
- Mola sara (inward) line d.p.g.o.....102
 - Shahrak imam (outward) line d.p.b.....288
- They may get out of the Mola sara (inward) line and get in the Rajaie (outward) line.
- Mola sara (inward) line d.p.g.o.....102
 - Rajaie (outward) line d.p.b.....48

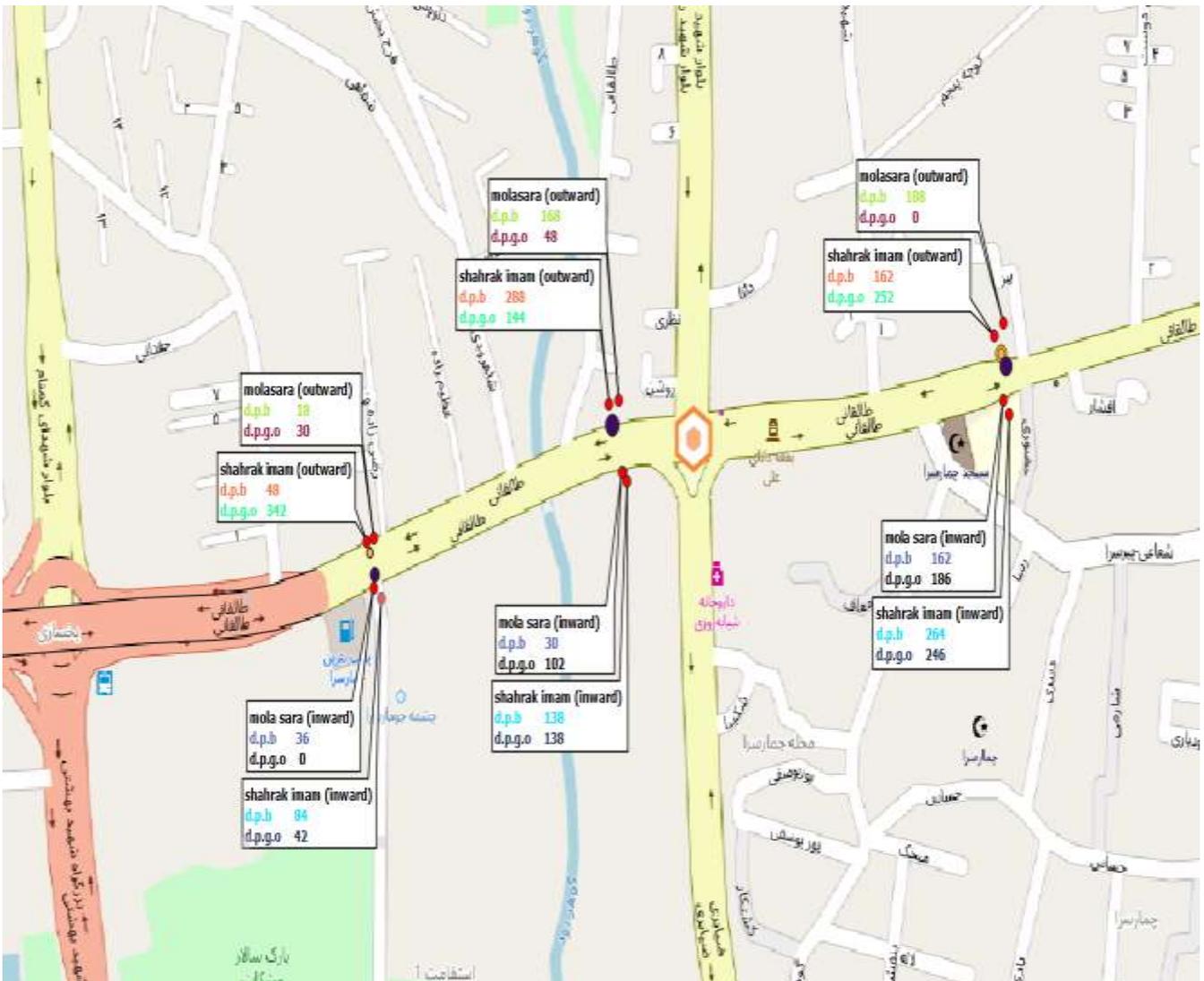


Figure 118 1st area of line changing with most important lines

II. 2nd area of line changing

There are several lines at this intersection that have a large number of passengers who have gotten in and get out of the line, which can be a reason for switching between lines. Important lines include:

- Mirzakochik (inward) route
- Molasara (outward) route
- Rajaie route
- Shahrak imam (outward) route
- Shahrak imam (inward) route
- Molasara (inward) route
- Mirzakochik (outward) route

This area is located at the intersection of Taleghani street and Sardar jangal street

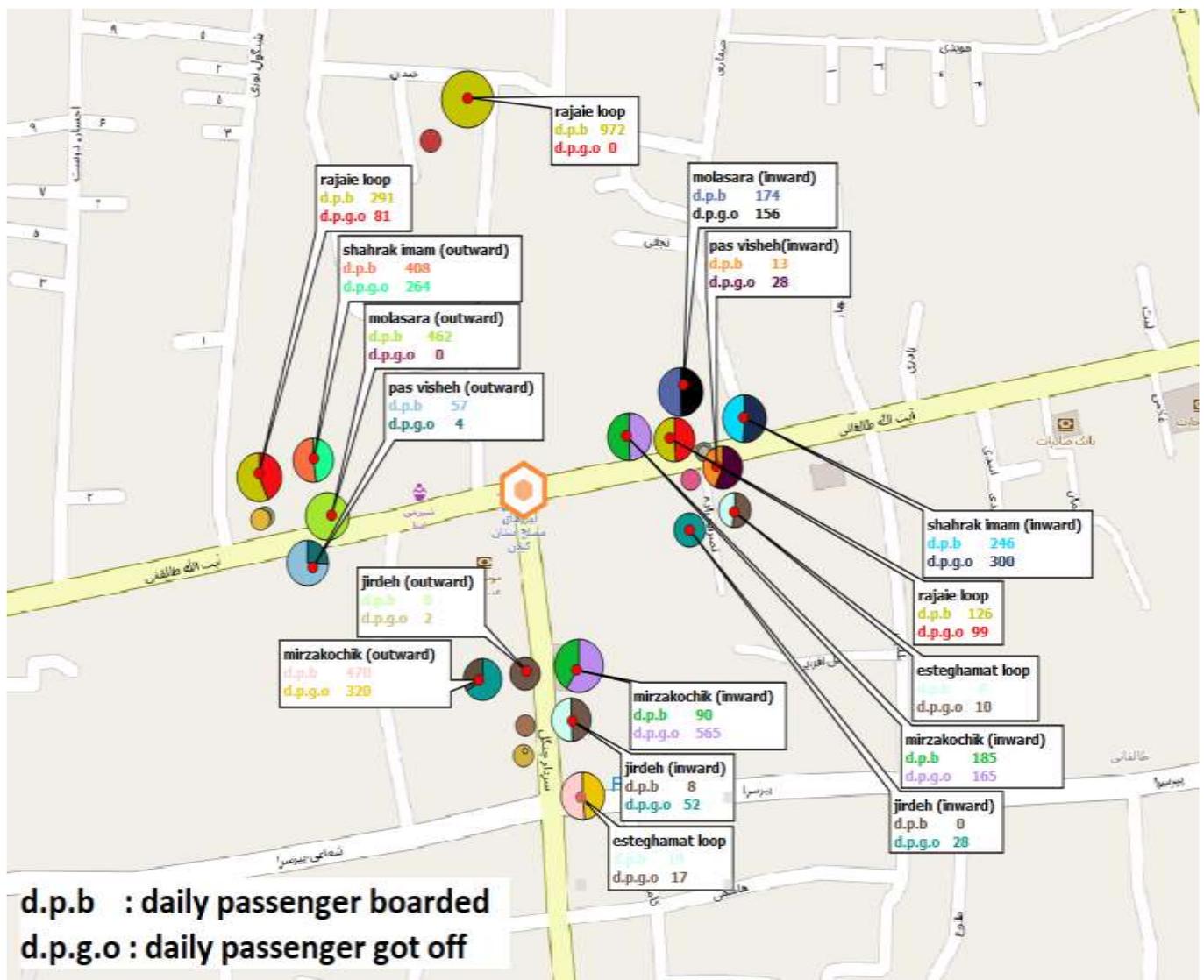


Figure 119 2nd area of line changing

The high number of passengers gotten out or gotten in in this area can be for several reasons:

- **They may get out of the Rajaie (inward) line and get in the Mirzakochik (outward) line.**
 - **Rajaie (inward) line d.p.g.o.....99**
 - **Mirzakochik (outward) line d.p.b.....470**

- They may get out of the Rajaie (inward) line and get in the Jirdeh (outward) line.
 - Rajaie (inward) line d.p.g.o.....99
 - Jirdeh (outward) line d.p.b.....0

- They may get out of the Rajaie (inward) line and get in the Esteghamat (outward) line.
 - Rajaie (inward) line d.p.g.o.....99
 - Esteghamat (outward) line d.p.b.....19

- They may get out of the Pas visheh (inward) line and get in the Mirzakochik (outward) line.
 - Pas visheh (inward) line d.p.g.o.....28
 - Mirzakochik (outward) line d.p.b.....470

- They may get out of the Pas visheh (inward) line and get in the Jirdeh (outward) line.
 - Pas visheh (inward) line d.p.g.o.....28
 - Jirdeh (outward) line d.p.b.....0

- They may get out of the Pas visheh (inward) line and get in the Esteghamat (outward) line.
 - Pas visheh (inward) line d.p.g.o.....28
 - Esteghamat (outward) line d.p.b.....19

- **They may get out of the Molasara (inward) line and get in the Mirzakochik (outward) line.**
 - **Molasara (inward) line d.p.g.o.....156**
 - **Mirzakochik (outward) line d.p.b.....470**

- They may get out of the Molasara (inward) line and get in the Esteghamat (outward) line.
 - Molasara (inward) line d.p.g.o.....156
 - Esteghamat (outward) line d.p.b.....19

- They may get out of the Molasara (inward) line and get in the Jirdeh (outward) line.
 - Molasara (inward) line d.p.g.o.....156
 - Jirdeh (outward) line d.p.b.....0

- **They may get out of the Mirzakochik (inward) line and get in the Rajaie (outward) line.**
 - **Mirzakochik (inward) line d.p.g.o.....565**
 - **Rajaie (outward) line d.p.b.....1263 (291+972)**

- **They may get out of the Mirzakochik (inward) line and get in the Molasara (outward) line.**
 - **Mirzakochik (inward) line d.p.g.o.....565**
 - **Molasara (outward) line d.p.b.....462**

- They may get out of the Mirzakochik (inward) line and get in the Pas visheh (outward) line.
 - Mirzakochik (inward) line d.p.g.o.....565
 - Pas visheh (outward) line d.p.b.....57

- **They may get out of the Mirzakochik (inward) line and get in the Shahrak imam (outward) line.**
 - **Mirzakochik (inward) line d.p.g.o.....565**
 - **Shahrak imam (outward) line d.p.b.....408**

- They may get out of the Jirdeh (inward) line and get in the Shahrak imam (outward) line.
 - Jirdeh (inward) line d.p.g.o.....52
 - Shahrak imam (outward) line d.p.b.....408

- They may get out of the Jirdeh (inward) line and get in the Rajaie (outward) line.
 - Jirdeh (inward) line d.p.g.o.....52
 - Rajaie (outward) line d.p.b.....1263 (291+972)

- They may get out of the Jirdeh (inward) line and get in the Molasara (outward) line.
 - Jirdeh (inward) line d.p.g.o.....52
 - Molasara (outward) line d.p.b.....462

- They may get out of the Jirdeh (inward) line and get in the Pas visheh (outward) line.
 - Jirdeh (inward) line d.p.g.o.....52
 - Pas visheh (outward) line d.p.b.....57

- They may get out of the Esteghamat (inward) line and get in the Shahrak imam (outward) line.
 - Esteghamat (inward) line d.p.g.o.....10
 - Shahrak imam (outward) line d.p.b.....408

- They may get out of the Esteghamat (inward) line and get in the Rajaie imam (outward) line.
 - Esteghamat (inward) line d.p.g.o.....10
 - Rajaie imam (outward) line d.p.b.....1263 (291+972)

- They may get out of the Esteghamat (inward) line and get in the Pas visheh (outward) line.
 - Esteghamat (inward) line d.p.g.o.....10
 - Pas visheh (outward) line d.p.b.....57

- They may get out of the Esteghamat (inward) line and get in the Molasara (outward) line.
 - Esteghamat (inward) line d.p.g.o.....10
 - Molasara (outward) line d.p.b.....462

- **They may get out of the Shahrak imam (inward) line and get in the Mirzakochik (outward) line.**
 - **Shahrak imam (inward) line d.p.g.o.....300**
 - **Mirzakochik (outward) line d.p.b.....470**

- They may get out of the Shahrak imam (inward) line and get in the Jirdeh (outward) line.
 - Shahrak imam (inward) line d.p.g.o.....300
 - Jirdeh (outward) line d.p.b d.p.b.....0
- They may get out of the Shahrak imam (inward) line and get in the Esteghamat (outward) line.
 - Shahrak imam (inward) line d.p.g.o.....300
 - Esteghamat (outward) line d.p.b.....19

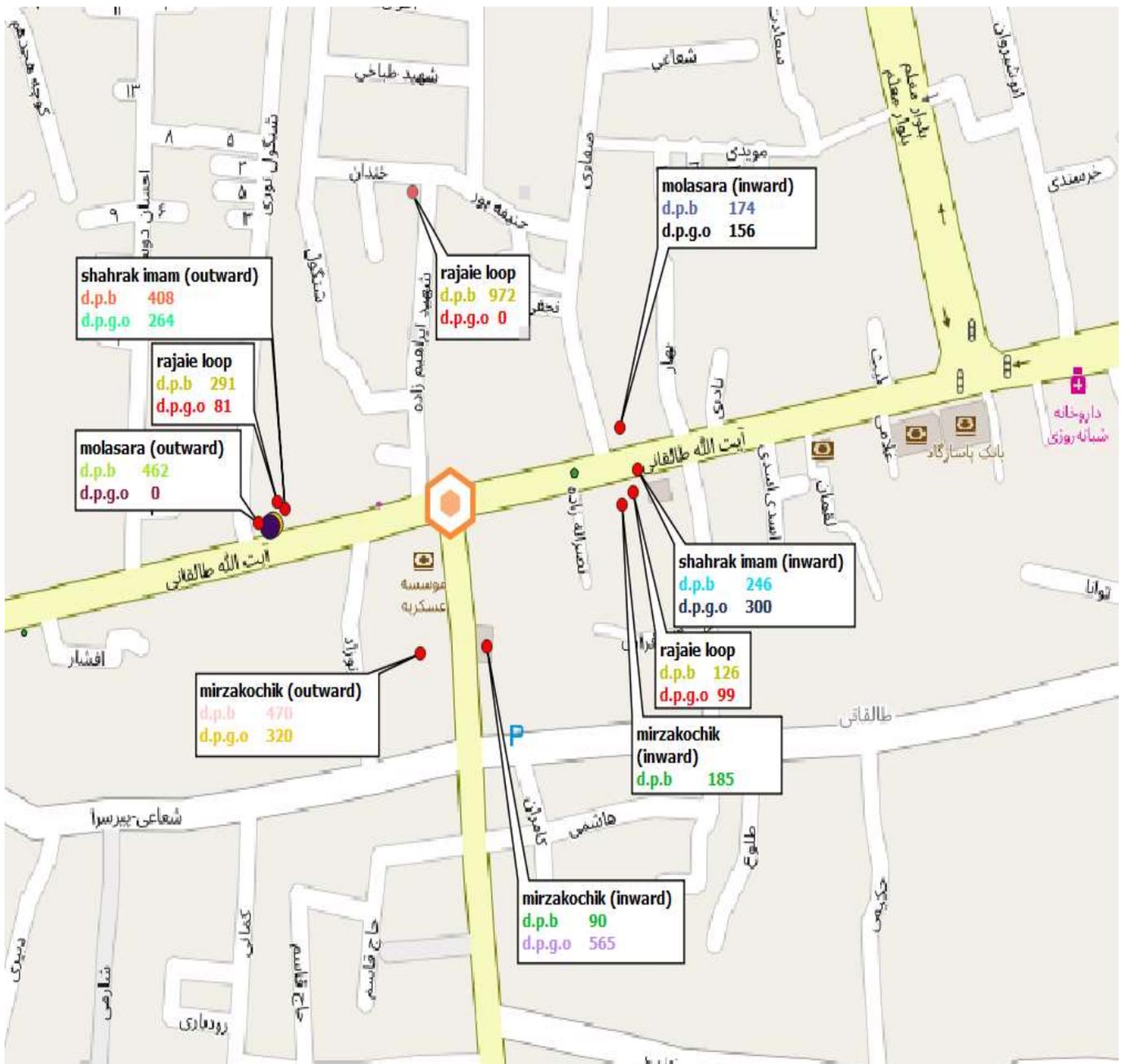


Figure 120 2nd area of line changing with most important lines

III. 3rd area of line changing

There are several lines at this intersection that have a large number of passengers who have gotten in and get out of the line, which can be a reason for switching between lines. Important lines include:

- Lakan Shahr (inward) route
- Terminal line (outward) route
- Terminal line (inward) route
- Around city3 route
- Around city4 route

This area is located at the intersection of Azadegan street and Imam khomeini boulevard and Parastar street.

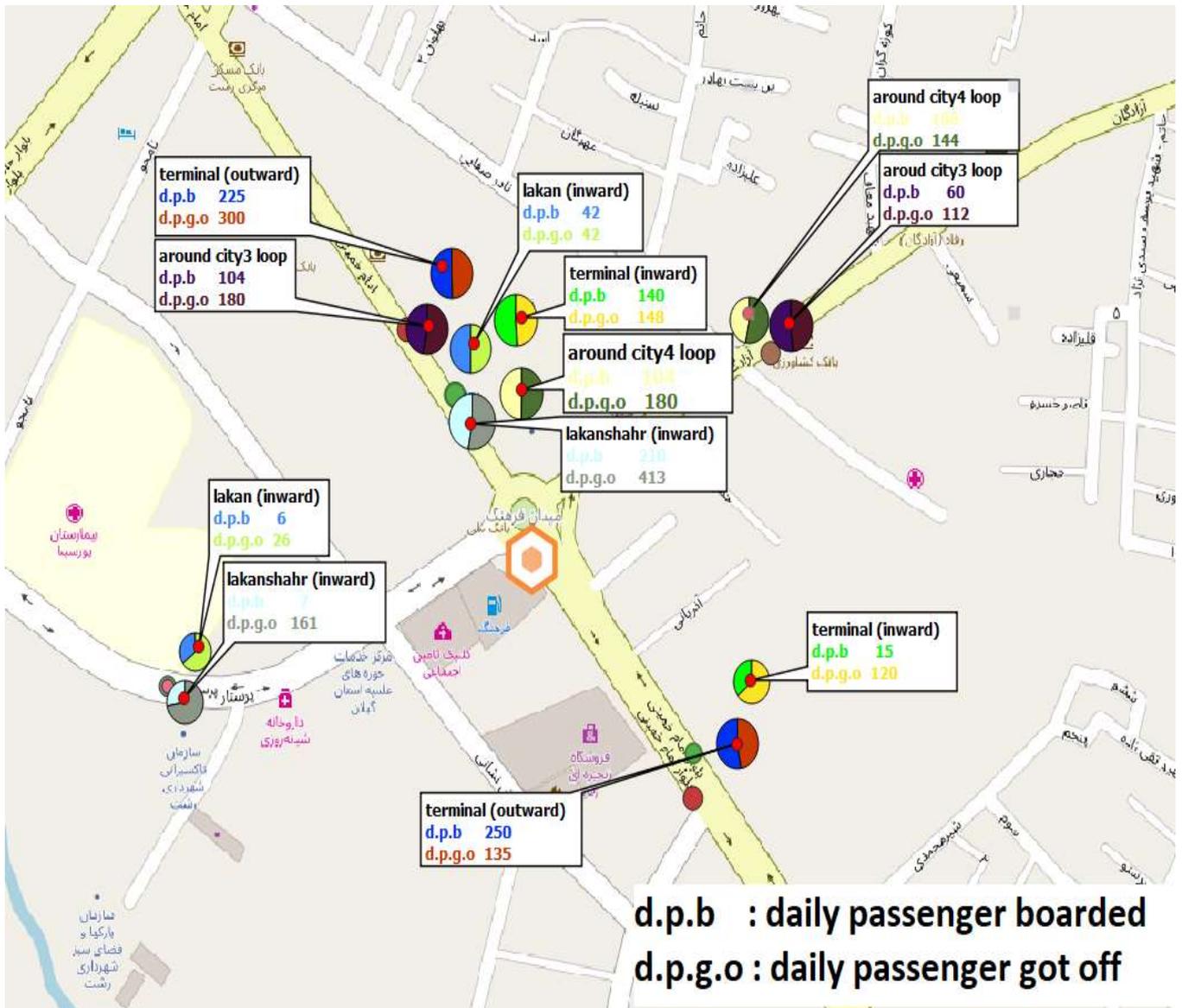


Figure 121 3rd area of line changing

The high number of passengers gotten out or gotten in in this area can be for several reasons:

- They may get out of the Terminal (inward) line and get in the Lakan (outward) line.
 - Terminal (inward) line d.p.g.o.....148
 - Lakan (outward) line d.p.b.....6

- They may get out of the Terminal (inward) line and get in the Lakanshahr (outward) line.
 - Terminal (inward) line d.p.g.o.....148
 - Lakanshahr (outward) line d.p.b.....7

- **They may get out of the Terminal (inward) line and get in the Around city3 (outward) line.**
 - **Terminal (inward) line d.p.g.o.....148**
 - **Around city3 (outward) line d.p.b.....104**

- They may get out of the Lakan (inward) line and get in the Around city3 (outward) line.
 - Lakan (inward) line d.p.g.o.....42
 - Around city3 (outward) line d.p.b.....104

- They may get out of the Lakan (inward) line and get in the Terminal (outward) line.
 - Lakan (inward) line d.p.g.o.....42
 - Terminal (outward) line d.p.b.....225

- **They may get out of the Lakanshar (inward) line and get in the Terminal (outward) line.**
 - **Lakanshar (inward) line d.p.g.o.....161**
 - **Terminal (outward) line d.p.b.....250**

- **They may get out of the Lakanshahr (inward) line and get in the Around city3 (outward) line.**
 - **Lakanshahr (inward) line d.p.g.o.....161**
 - **Around city3 (outward) line d.p.b.....104**

- They may get out of the Around city4 (inward) line and get in the Terminal (outward) line.
 - Around city4 (inward) line d.p.g.o.....180
 - Terminal (outward) line d.p.b.....250

- They may get out of the Around city4 (inward) line and get in the Lakan (outward) line.
 - Around city4 (inward) line d.p.g.o.....180
 - Lakan (outward) line d.p.b.....6

- They may get out of the Around city4 (inward) line and get in the Lakanshahr (outward) line.
 - Around city4 (inward) line d.p.g.o.....180
 - Lakanshahr (outward) line d.p.b.....7



Figure 122 3rd area of line changing with most important lines

IV. 4th area of line changing

There are several lines at this intersection that have a large number of passengers who have gotten in and get out of the bus, which can be a reason for switching between lines. Important lines include:

- Jafarabad (outward) route
- Jafarabad (inward) route
- Around city3 route
- Imam route
- Kouchesfahan (inward) route

This area is located at the intersection of Imam reza boulevard and Modares highway

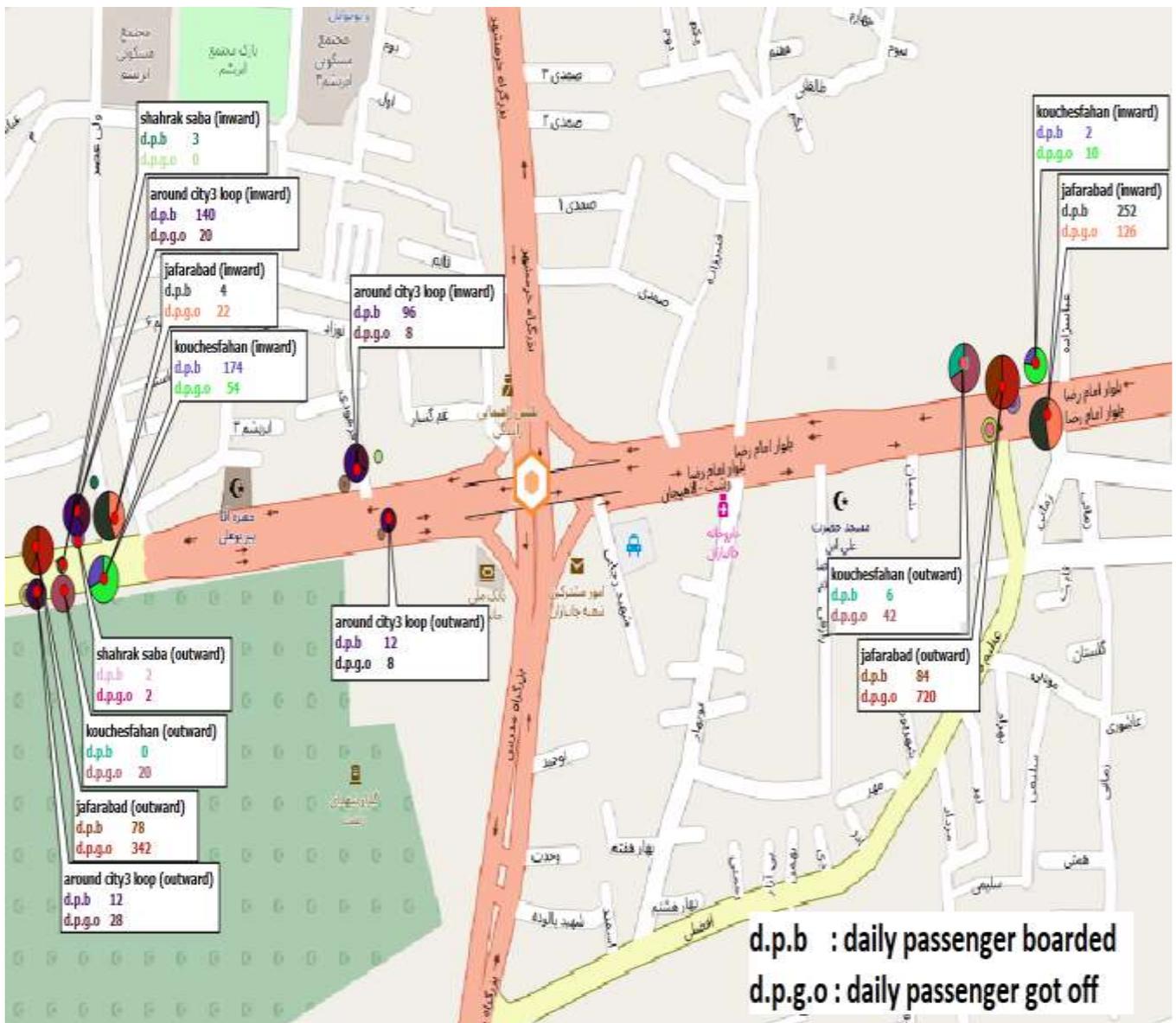


Figure 123 4th area of line changing

There is no stop on the Imam's station and the passengers can get in or get out at any desired point along the way, and so they were not able to collect data at the time of gathering information from SARZAMIN AMAYESH GROUP. It should be mentioned that this large number of passengers who got out or got in the line is a reason of the existence of residential complexes in this area. 720 passengers getting out of the station could be due to the existence of the passenger terminal to the east of Gilan, but there is no solid reason to prove this theory.

The high number of passengers gotten out or gotten in in this area can be for several reasons:

- They may get out of the Kouchesfahan (inward) line and get in the Imam (inward) line.
 - Kouchesfahan (inward) line d.p.g.o.....54
 - Imam (inward) line d.p.bThere isn't data for Imam line how it is explained before but I consider it more than 100 got off passenger because of existence a lot of residential zones in complex in Imam route.

- They may get out of the Kouchesfahan (inward) line and get in the Imam (outward) line.
 - Kouchesfahan (inward) line d.p.g.o.....54
 - Imam (outward) line d.p.b..... There isn't data for Imam line how it is explained before but I consider it more than 100 got off passenger because of existence a lot of residential zones in complex in Imam route.

- **They may get out of the Jafarabad (inward) line and get in the Imam (inward) line.**
 - **Jafarabad (inward) line d.p.g.o.....126**
 - **Imam (inward) line d.p.b.....There isn't data for Imam line how it is explained before but I consider it more than 100 got off passenger because of existence a lot of residential zones in complex in Imam route.**

- **They may get out of the Jafarabad (outward) line and get in the Imam (outward) line.**
 - **Jafarabad (outward) line d.p.g.o.....1062 (720+342)**
 - **Imam (outward) line d.p.b.....There isn't data for Imam line how it is explained before but I consider it more than 100 got off passenger because of existence a lot of residential zones in complex in Imam route.**

- **They may get out of the Imam line and get in the Jafarabad (inward).**
 - **Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.**
 - **Jafarabad (inward) line d.p.b.....252**

- **They may get out of the Imam line and get in the Jafarabad (inward) line.**
 - **Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.**
 - **Jafarabad (inward) line d.p.b.....162**

- **They may get out of the Imam line and get in the Kouchesfahan (outward) line.**
 - **Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.**
 - **Kouchesfahan (outward) line d.p.b.....6**

- **They may get out of the Imam line and get in the Kouchesfahan (outward) line.**
 - **Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.**
 - **Kouchesfahan (outward) line d.p.b.....6**

- They may get out of the Imam line and get in the Around city3 line.
 - Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.
 - Around city3 line d.p.b.....96≈100

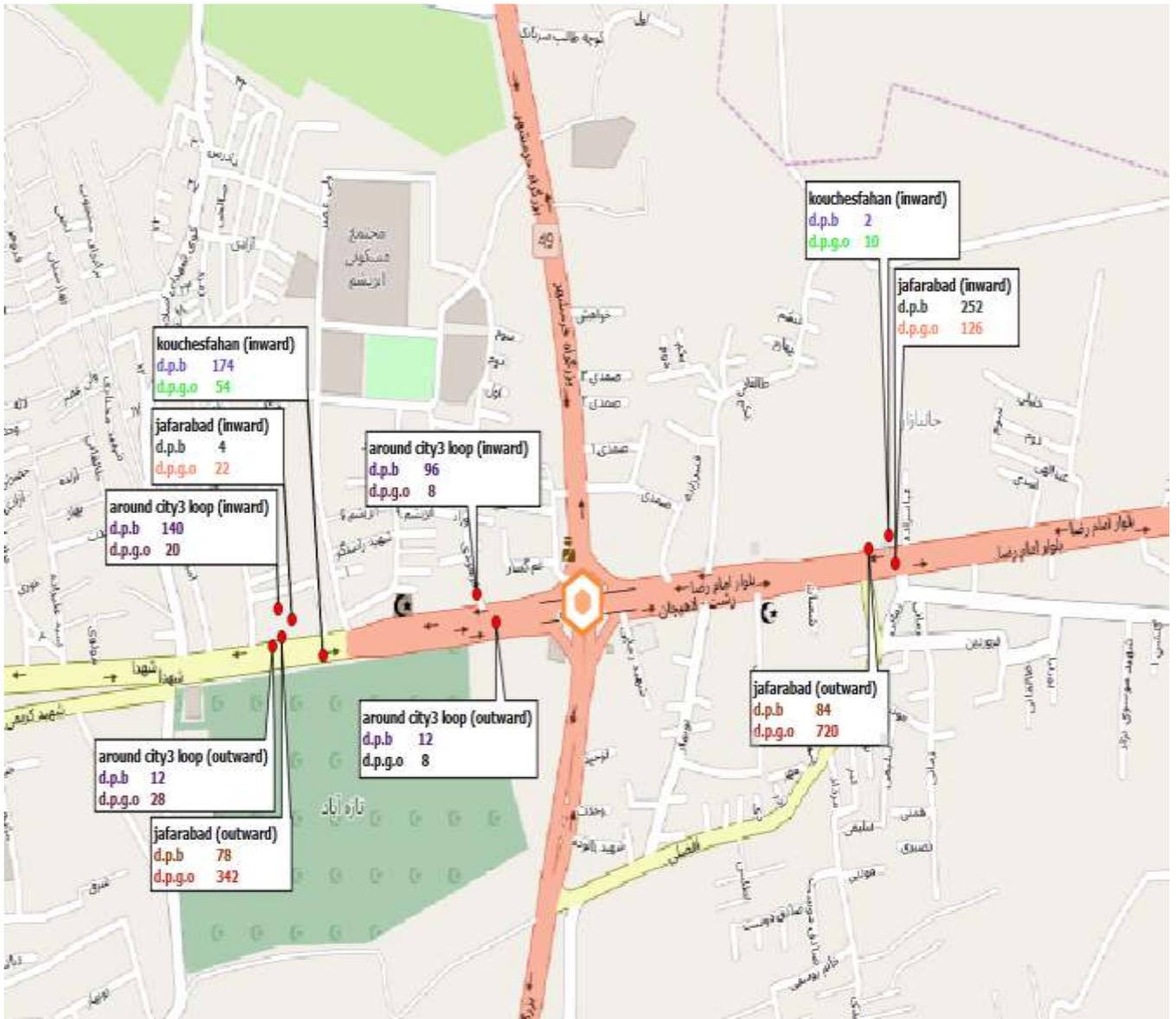


Figure 124 4th area of line changing with most important lines

V. 5th area of line changing

There are several lines at this intersection that have a large number of passengers who have gotten in and get out of the line, which can be a reason for switching between lines. Important lines include:

- Imam line
- Airport line (outward) route
- Airport line (inward) route

This area is located at the intersection of Ansari boulevard and Khoramshahr highway and valiasr boulevard.

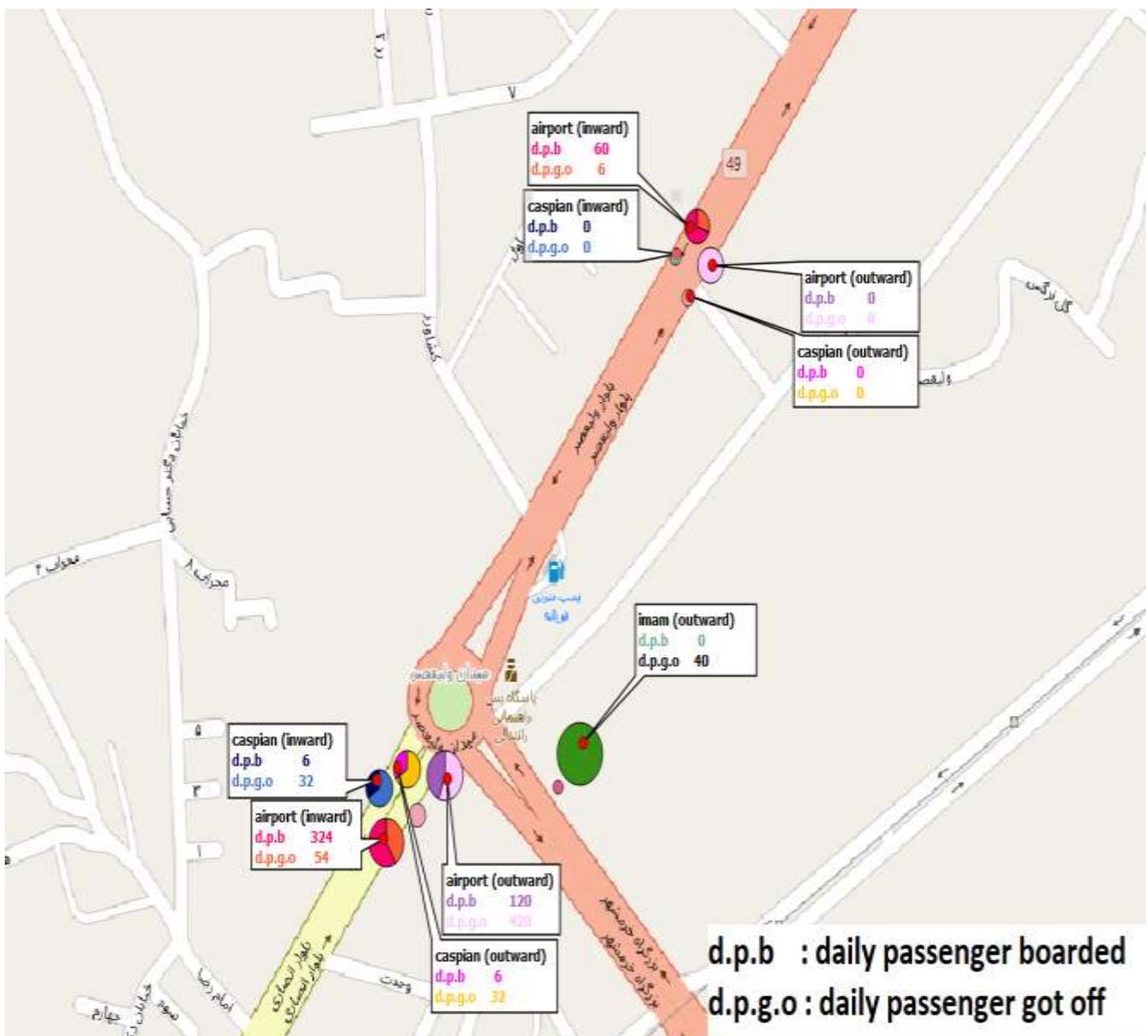


Figure 125 5th area of line changing

The number of passengers gotten out or gotten in in this area can be for several reasons:

- **Passengers who get out of the Airport line (inward) and get in the Imam line.**
 - Airport line (inward) d.p.g.o.....54
 - Imam (outward) line d.p.b.....There isn't data for Imam line how it is explained before but I consider it more than 100 got off passenger because of existence a lot of residential zones in complex in Imam route.

- **Passengers who get out of the Airport line (outward) and get in the Imam line.**
 - Airport line (outward) d.p.g.o.....420
 - Imam (outward) line d.p.b.....There isn't data for Imam line how it is explained before but I consider it more than 100 got off passenger because of existence a lot of residential zones in complex in Imam route.

- **Passengers who get out of the Imam line and get in Airport (inward) line.**
 - Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.
 - Airport (inward) line d.p.b.....324

- **Passengers who get out of the Imam line and get in Airport (outward) line.**
 - Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.
 - Airport (outward) line d.p.b.....0

- **Passengers who get out of the Imam line and get in Caspian (inward) line.**
 - Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.
 - Caspian (inward) line d.p.b.....6

- Passengers who get out of the Imam line and get in Caspian (outward) line.
 - Imam line d.p.g.o..... There isn't data for Imam line how it is explained before but I consider it more than 100 boarded passenger because of existence a lot of residential zones in complex in Imam route.
 - Caspian (outward) line d.p.b.....0

- But there is also a Caspian line in this area, while there is small number of passengers in this area, there will be not a change of line.

- And finally, because of the passenger terminal headed to Anzali, it can be predicted that a number of passengers traveling in this area will enter Rasht Public Transportation from outside of Rasht.

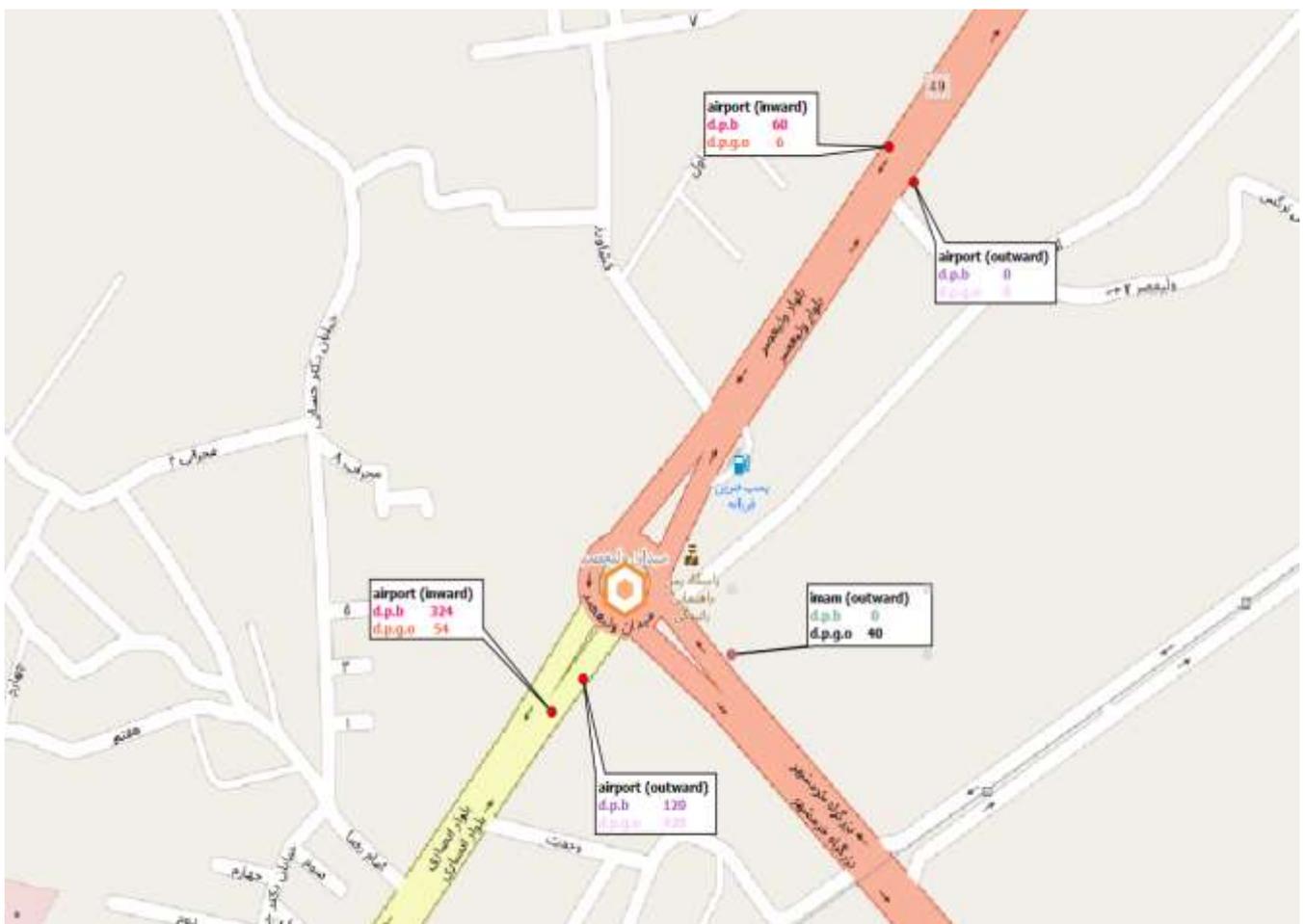


Figure 126 5th area of line changing with most important lines

VI. 6th area of line changing

There are several lines at this intersection that have a large number of passengers who have gotten in and get out of the line, which can be a reason for switching between lines. Important lines include:

- Golsar (outward) route
- Golsar (inward) route
- Airport (inward) route

This area is located at the intersection of Ansari boulevard and Takhti street and Golsar boulevard

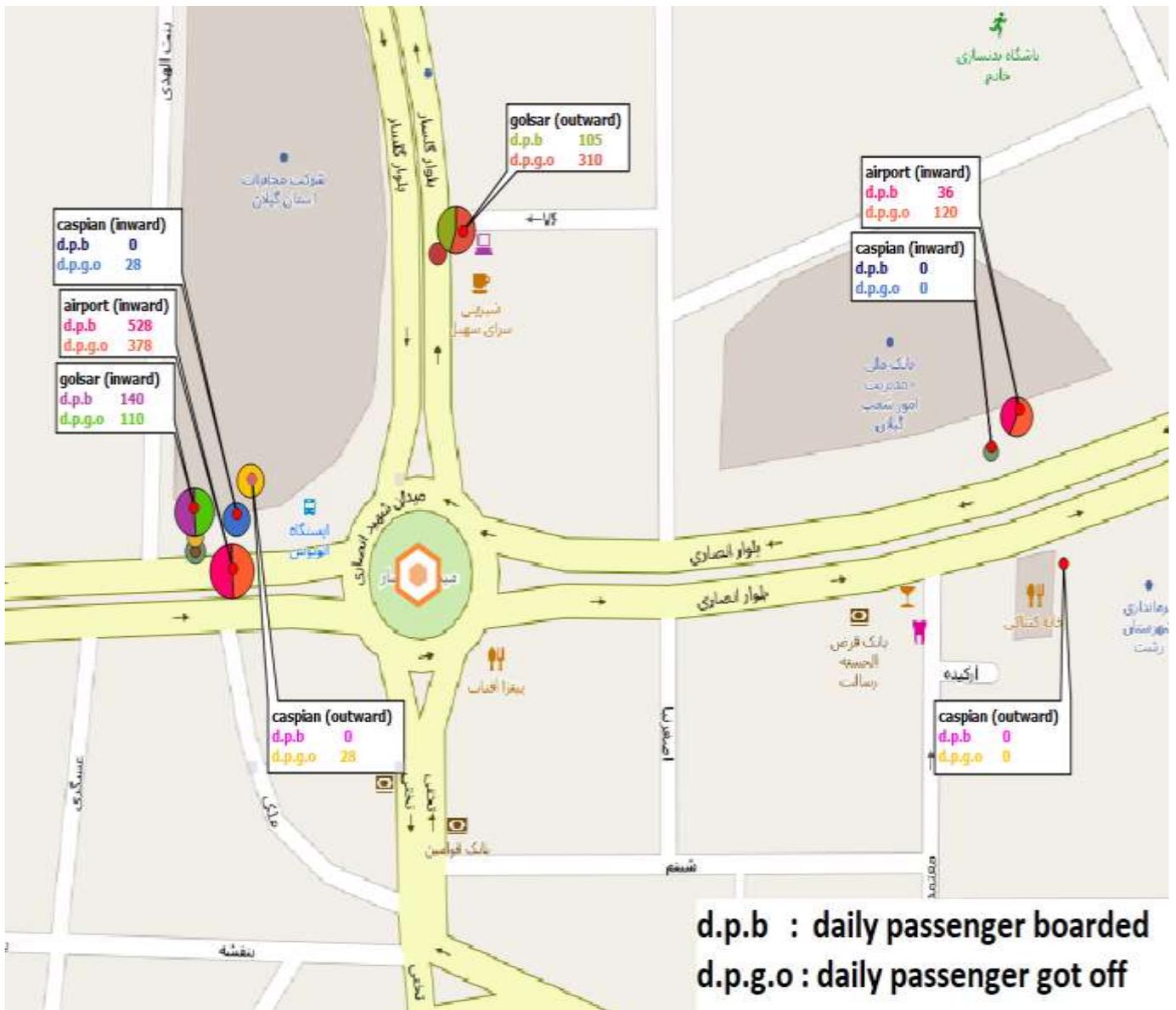


Figure 127 6th area of line changing

4.3 Identification of the lines between which most of the changes occur

After finding the areas where there is the possibility to line changing I decided to choose a minimum threshold of 100 passenger to make line changing, It is important to know that all those people who get out in the stop may be don't take another line and don't make line changing. Choose the threshold of 100 people is a way to identify the lines with line changing more frequent. After which I have analyzed all the lines with their possibility of line changing I created this map with the 6 areas and their most important lines in the specific area.

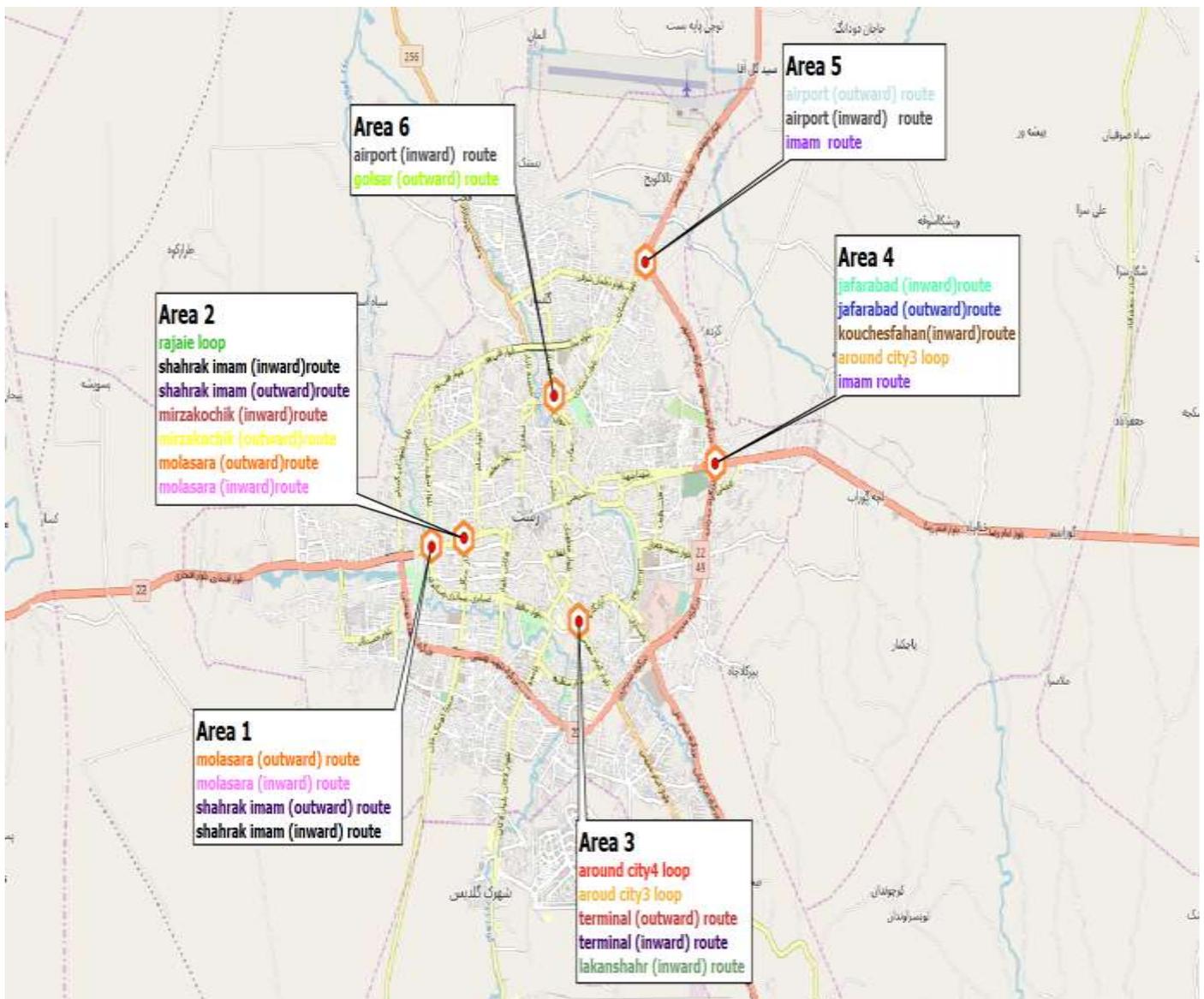


Figure 129 overall view of line changing areas with most important line

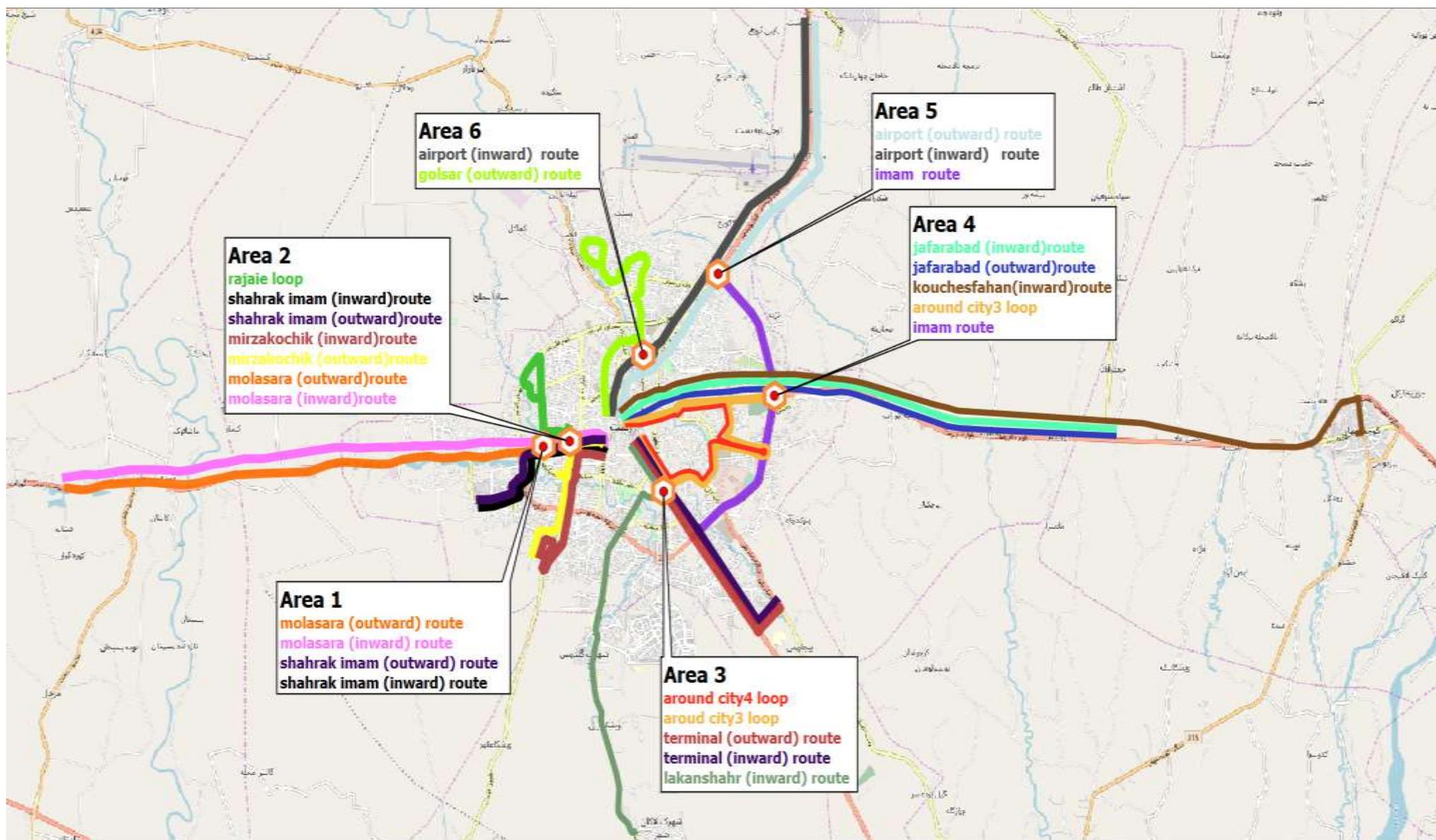


Figure 130 overall view of line changing areas with most important line

5 Chapter 5: Passenger loading on different lines and subsequent proposal of reallocation of the bus fleet

Amayesh Sarzamin group has published the number of boarded and got off passengers at peak hour. This information is taken from Third report¹⁷. Peak hour is defined by Amayesh Sarzamin from 12pm to 13pm or from 18pm to 19pm. It is decided to use overcrowding analysis for controlling the capacity of the lines. For this purpose, for each station number of got off passenger are subtracted from number of boarded passengers to calculate the number of passengers who remain in the bus, to check with maximum possible number of boarded passengers in 1 hour (peak hour) by fleet of the route. For calculate the maximum number of boarded passengers this formula is used:

$$\text{total capacity} = \text{fleet number of line} \times \text{capacity of 1 bus}$$

Equation 1 formula for total capacity calculating

This data collected in 2012 and the buses of Rasht network system in 2012 were manufactured in 2000 and 1996 which had 36 and possibility to boarding extra 22 passengers without seating so the capacity of each bus is considered 58 totally. This information was collected by asking the bus service officer of Rasht city.

¹⁷ Institute of AMAYESH SARZAMIN. Third report. Nov 2012. (مطالعات ساماندهی شبکه اتوبوسرانی و امکان سنجی مسیرهای ویژه اتوبوس) p. 36 – 71



Figure 131 bus of rasht network system in 2012

In order to do this analysis, 3 columns are added in the attribute table (paragraph 3.8) , which is explained as below:

p.h.d : difference between boarded and got off passengers in each station

PAX : sum of p.h.d of the current and previous columns

Total capacity: maximum possible number of boarded passengers in peak hour

For simplify our analysis it is considered that all of the fleets are working in peak hour. For example, if terminal route has 6 buses, it is considered that all 6 buses are working during peak hour.

5.1 Overcrowding analysis of each line of the network

5.1.1 Terminal route

5.1.1.1 Terminal (outward) route

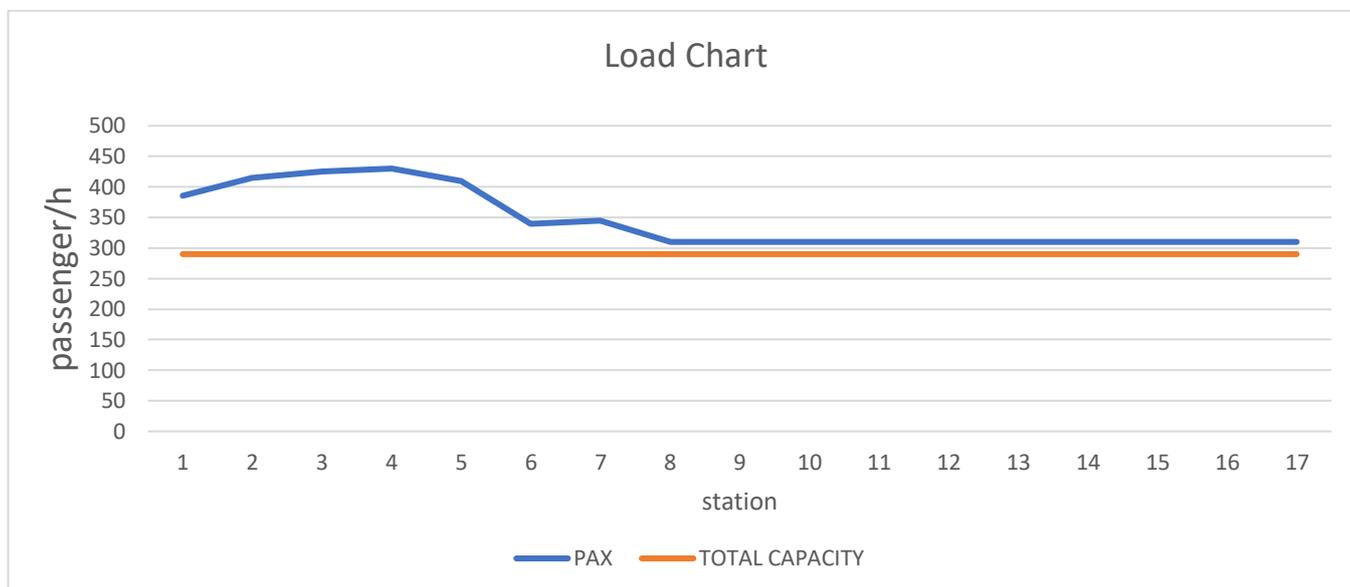


Figure 132 Load Chart of Terminal (outward) route

As it is shown in the figure, this line is crowded, and it needs at least 7 buses for complete service coverage. Currently this line has 5 buses.

5.1.1.2 Terminal(inward) route

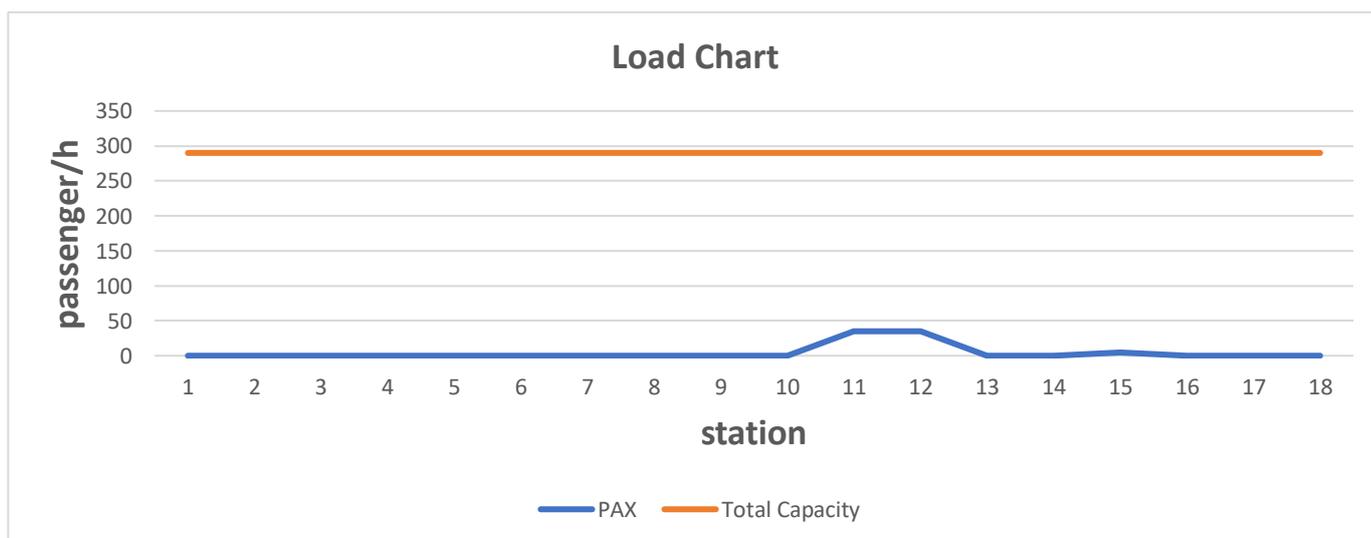


Figure 133 Load Chart of Terminal(inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 5 buses.

5.1.2. Lakan shahr route

5.1.2.1. Lakan shahr(outward) route

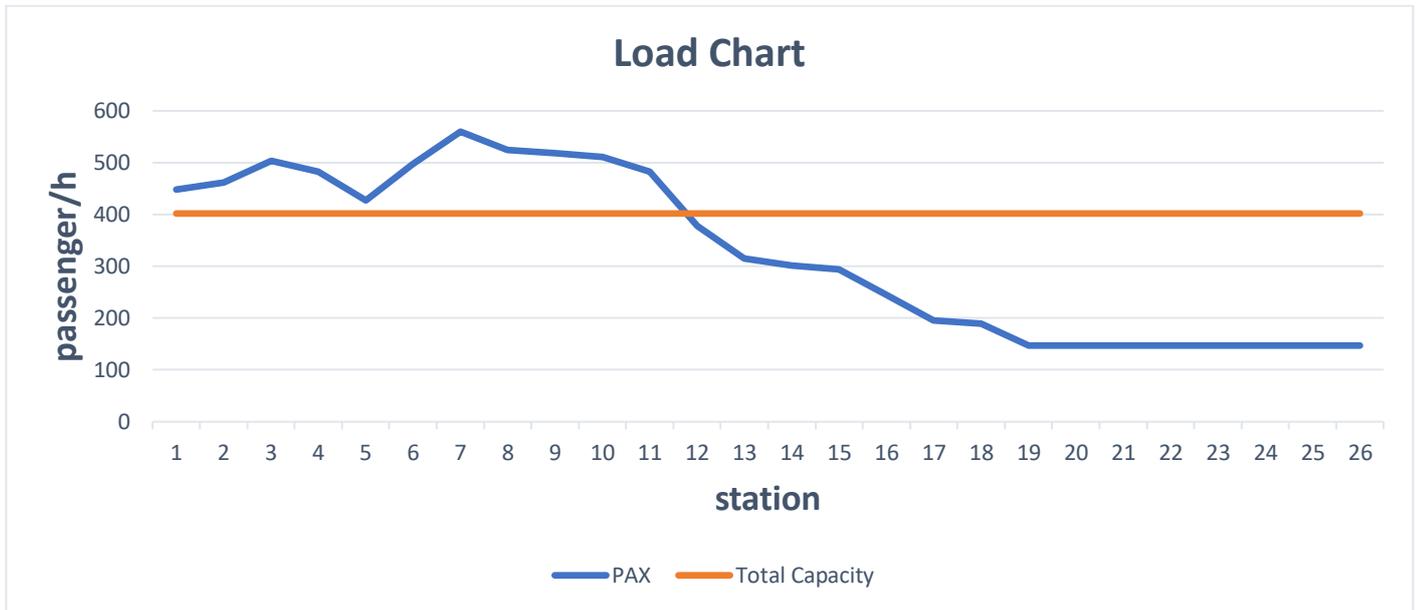


Figure 134 Load chart of Lakan shahr(outward) route

As it is shown in the figure, this line is crowded, and it needs at least 8 buses for completing service coverage. Currently this line has 7 buses.

5.1.2.2. Lakan shahr (inward) route

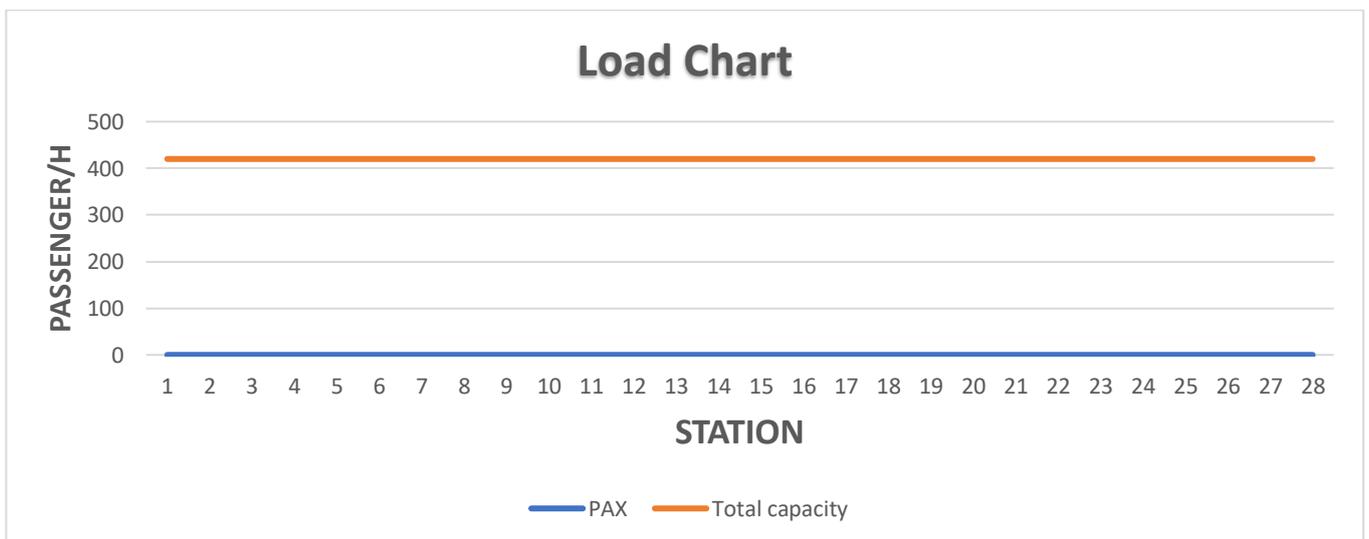


Figure 135 Load chart of Lakan shahr (inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 7 buses.

5.1.3 Around city3 route

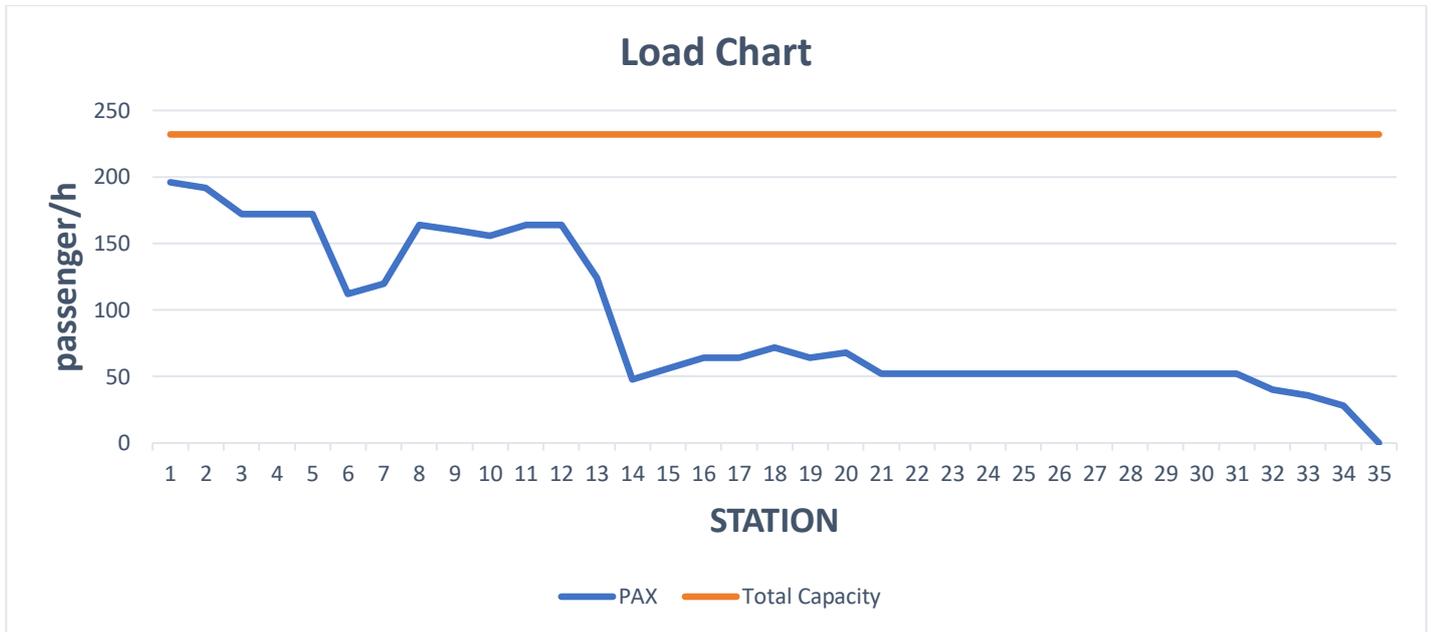


Figure 136 Load Chart of Around city3 route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 4 bus.

5.1.4 Lakan route

5.1.4.1. Lakan (outward) route

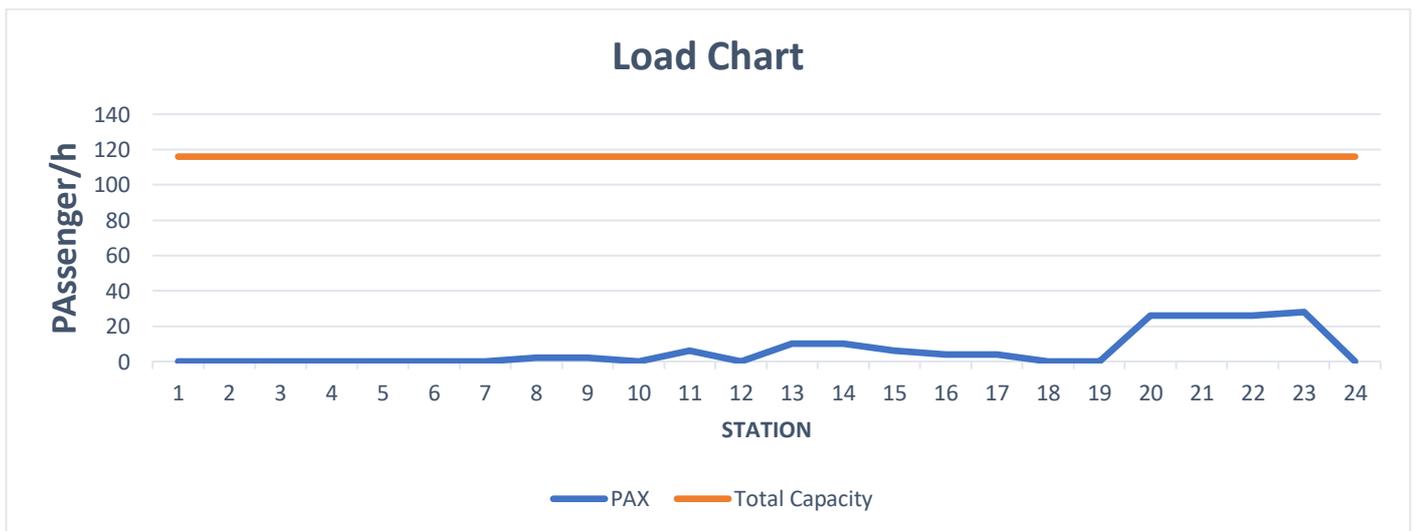


Figure 137 Load Chart of Lakan (outward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 2 buses.

5.1.4.2 Lakan (inward) route

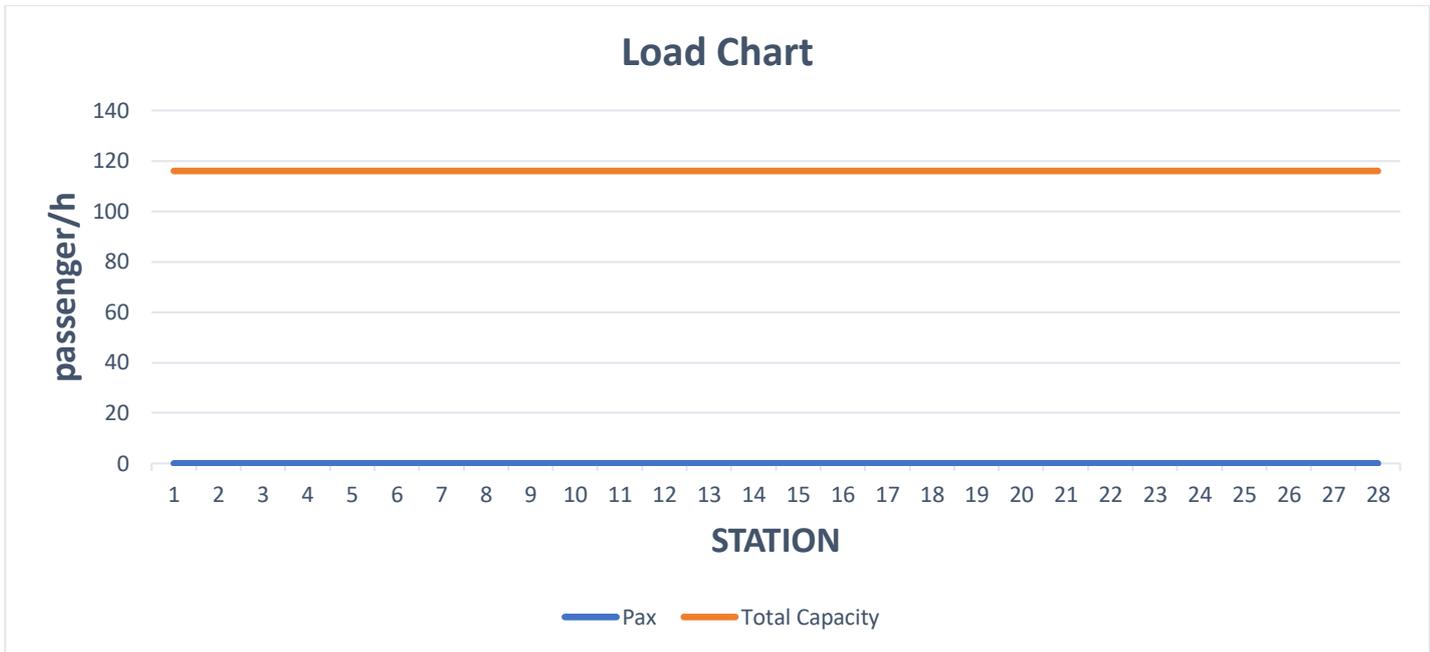


Figure 138 Load Chart of Lakan (inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 2 buses.

5.1.5 Imam route

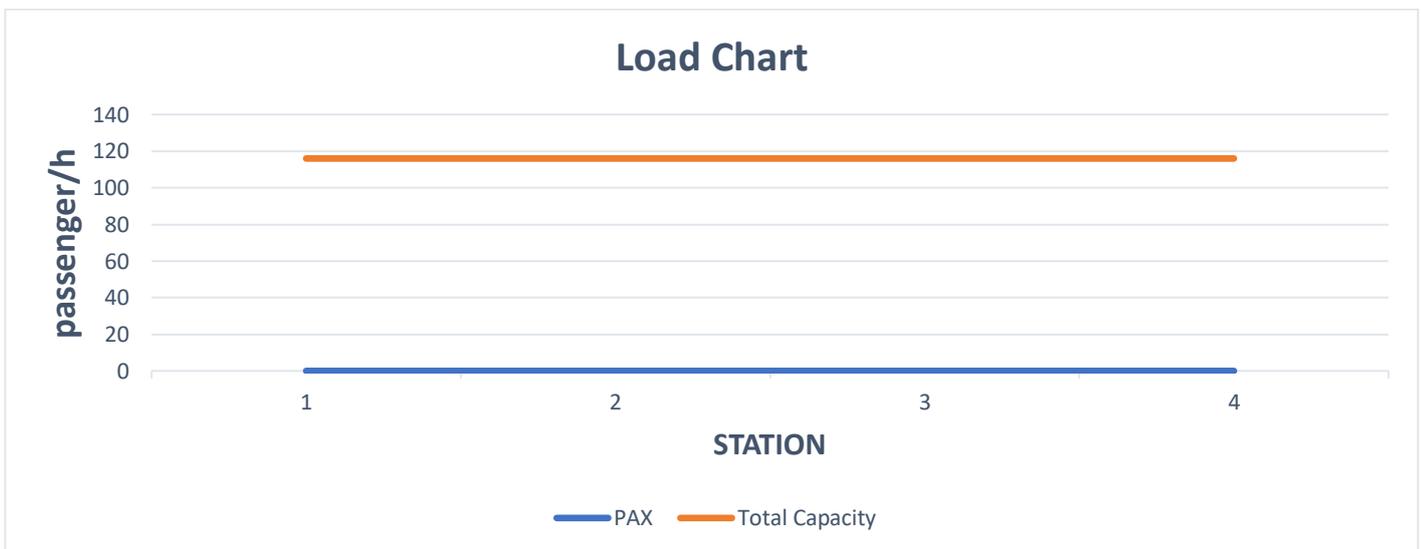


Figure 139 Load Chart of Imam route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 2 buses.

5.1.6 Around city4 route

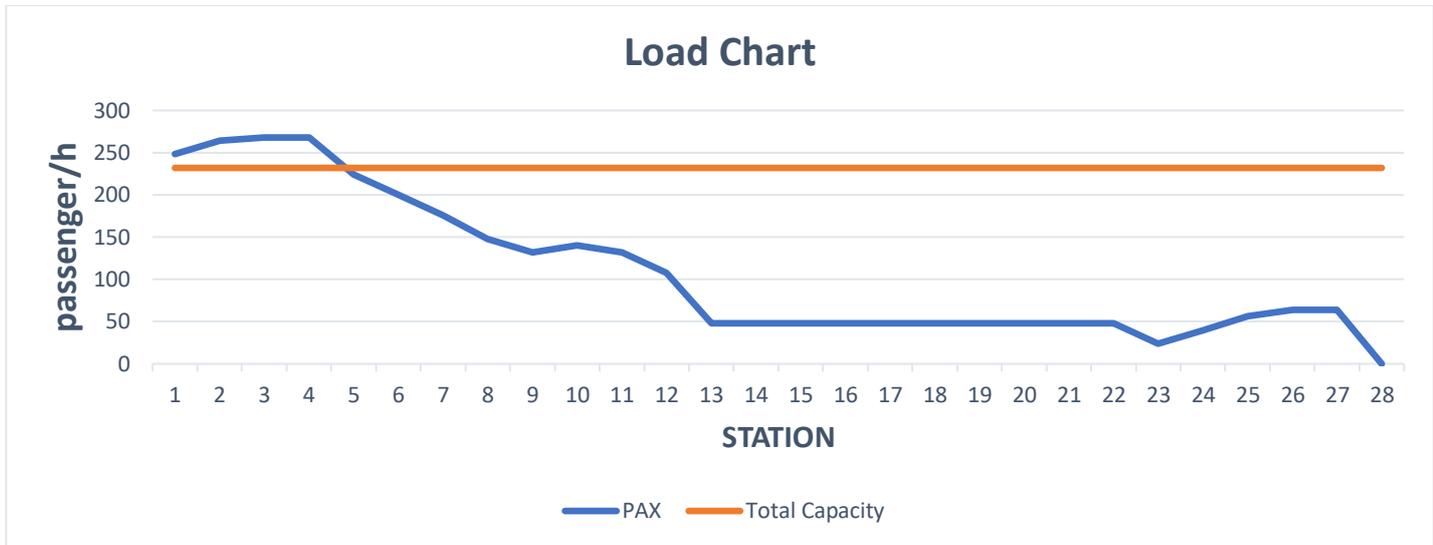


Figure 140 Load Chart of Around city4 route

As it is shown in the figure, this line is crowded, and it needs at least 5 buses for completing service coverage. Currently this line has 4 buses.

5.1.7 Jafarabad route

5.1.7.1 Jafarabad (outward) route

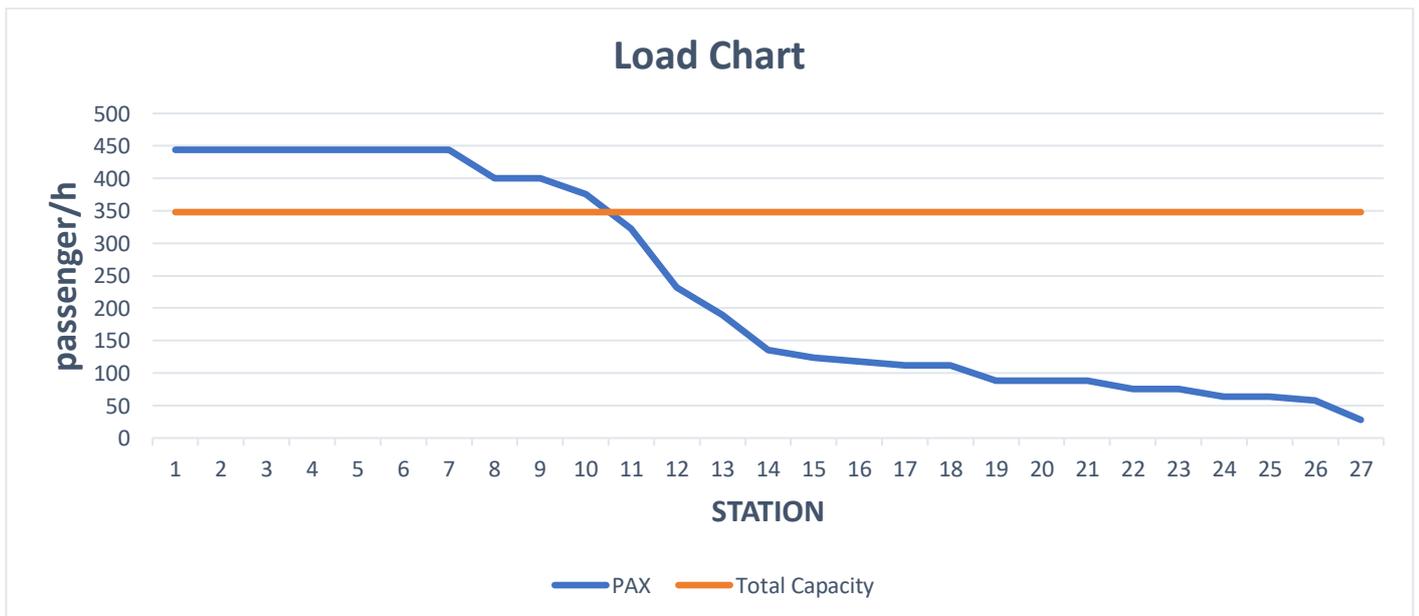


Figure 141 Load Chart of Lakan (inward) route

As it is shown in the figure, this line is crowded, and it needs at least 8 buses for completing service coverage. Currently this line has 6 buses.

5.1.7.2 Jafarabad (inward) route

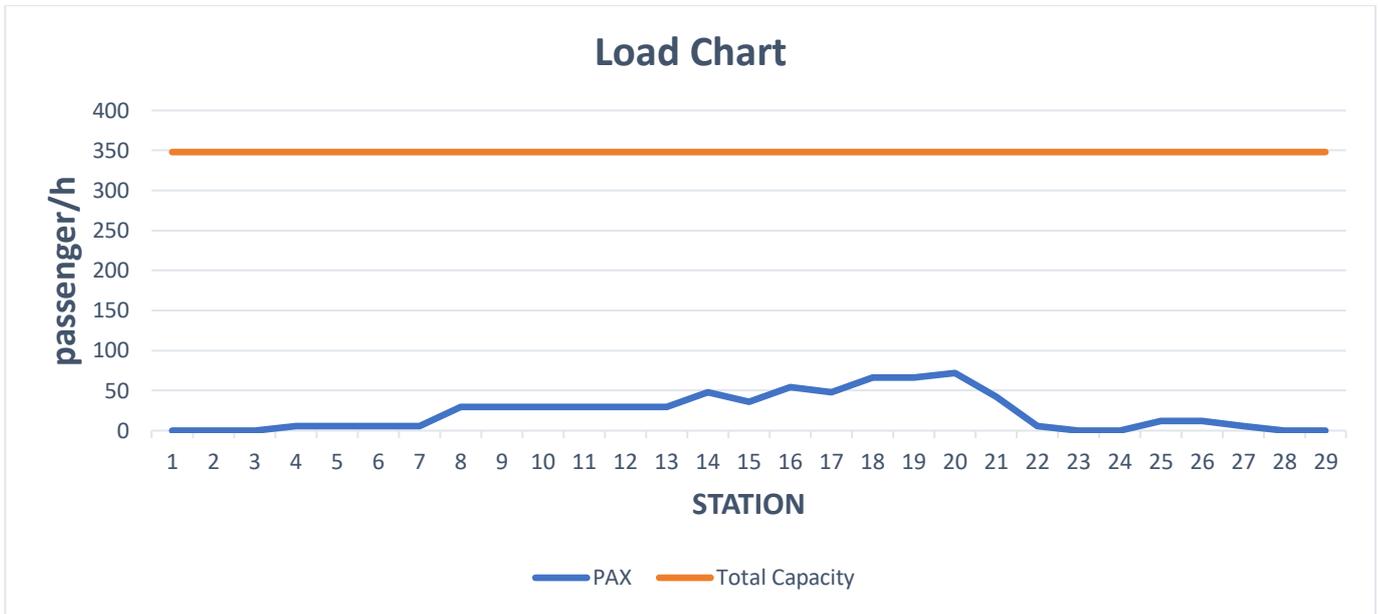


Figure 142 Load Chart of Jafarabad (inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 6 buses.

5.1.8 Kouchesfehan route

5.1.8.1 Kouchesfehan (outward) route

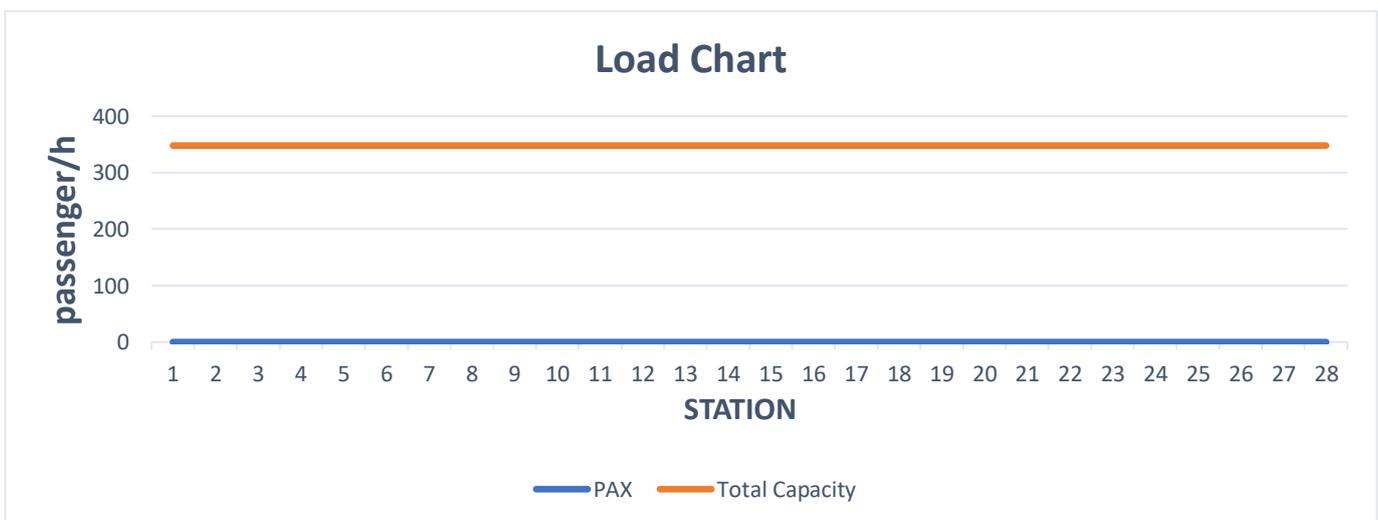


Figure 143 Load Chart of Kouchesfehan (outward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 6 buses.

5.1.8.2 Kouchesfehan (inward) route

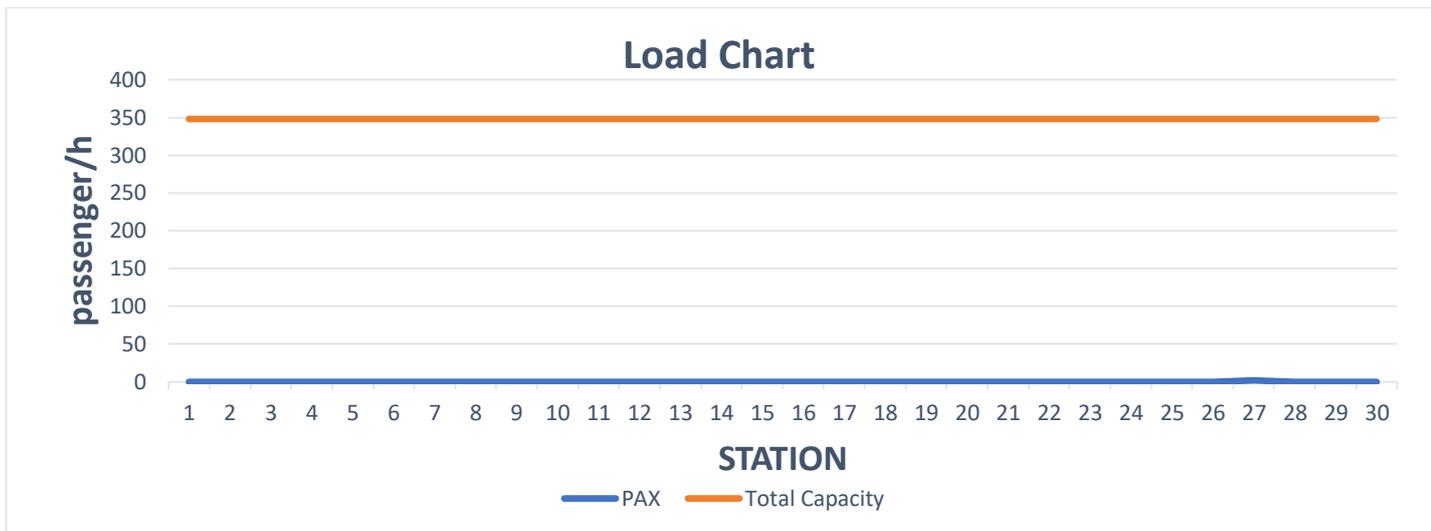


Figure 144 Load Chart of Kouchesfehan (inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 6 buses.

For improvement and coverage of the service it would be a good idea to decrease size of fleet in this route and add it to another route which is crowded in peak hour

5.1.9 Shahrak Saba route

5.1.9.1 Shahrak Saba (outward) route

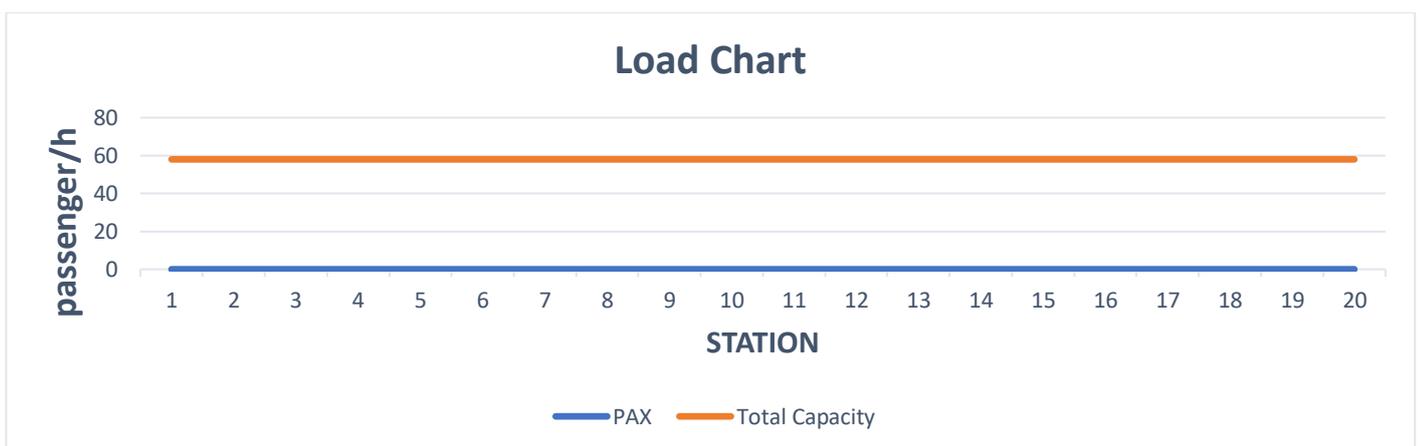


Figure 145 Load Chart of Shahrak Saba (outward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 1 bus.

5.1.9.2 Shahrak saba (inward) route

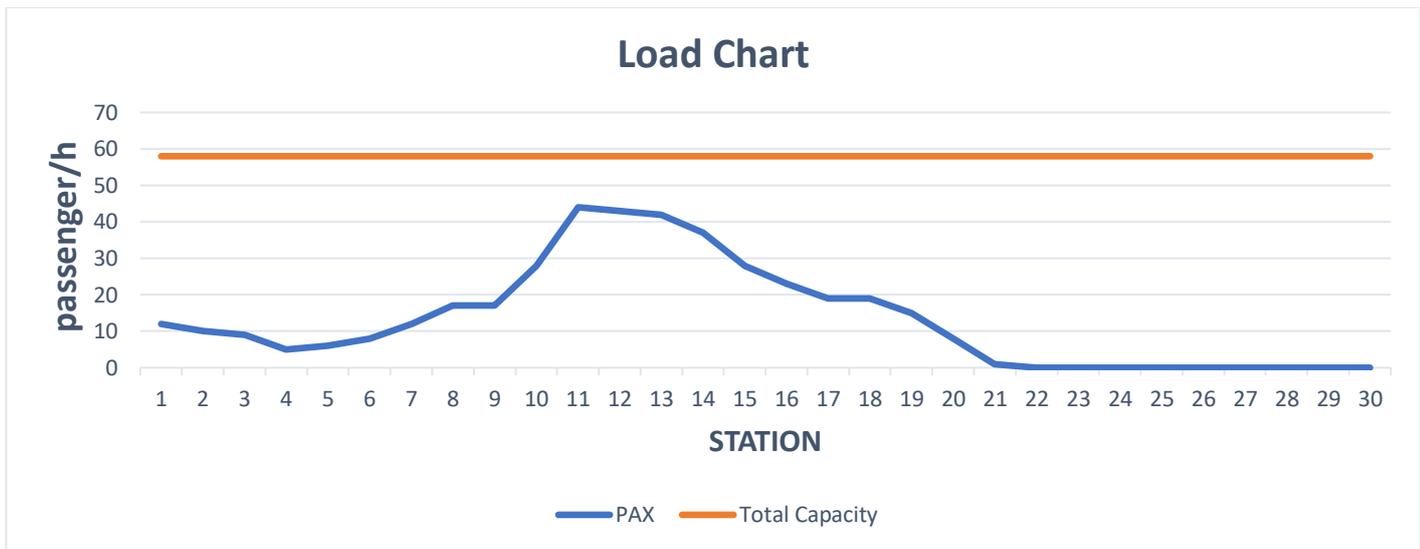


Figure 146 Load Chart of Shahrak saba (inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 1 bus.

5.1.10 Golsar route

5.1.10.1 Golsar (outward) route

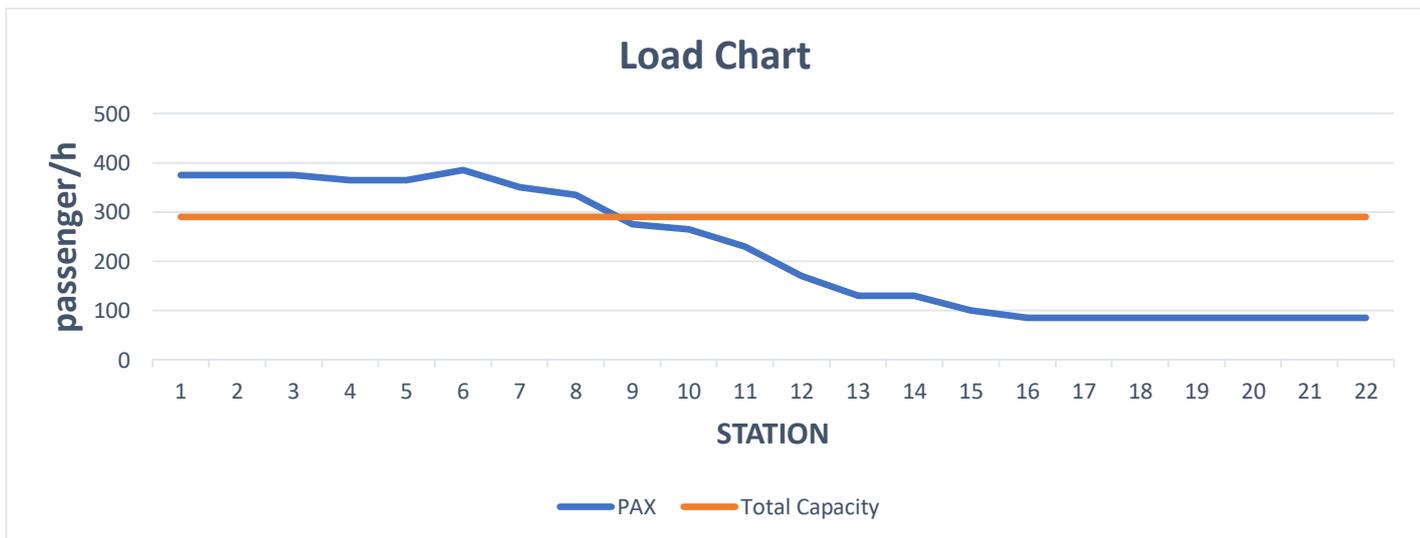


Figure 147 Load Chart of Golsar (outward) route

As it is shown in the figure, this line is crowded, and it needs at least 7 buses for complete service coverage. Currently this line has 5 buses.

5.1.10.2 Golsar (inward) route

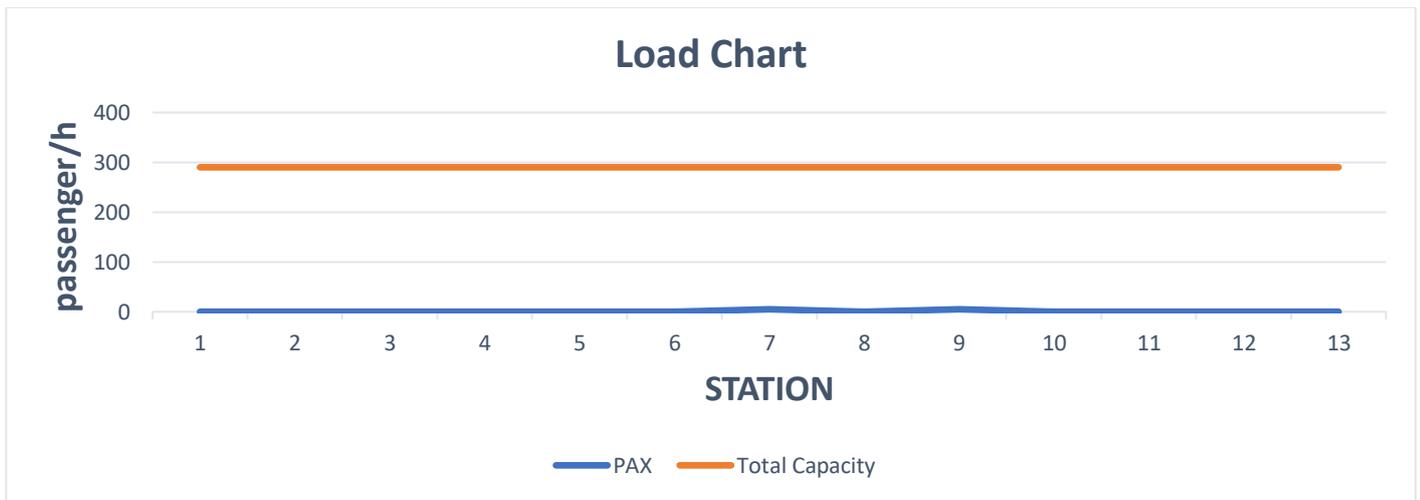


Figure 148 Load Chart of Golsar (inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 5 buses.

5.1.11 Airport route

5.1.11.1 Airport (outward) route

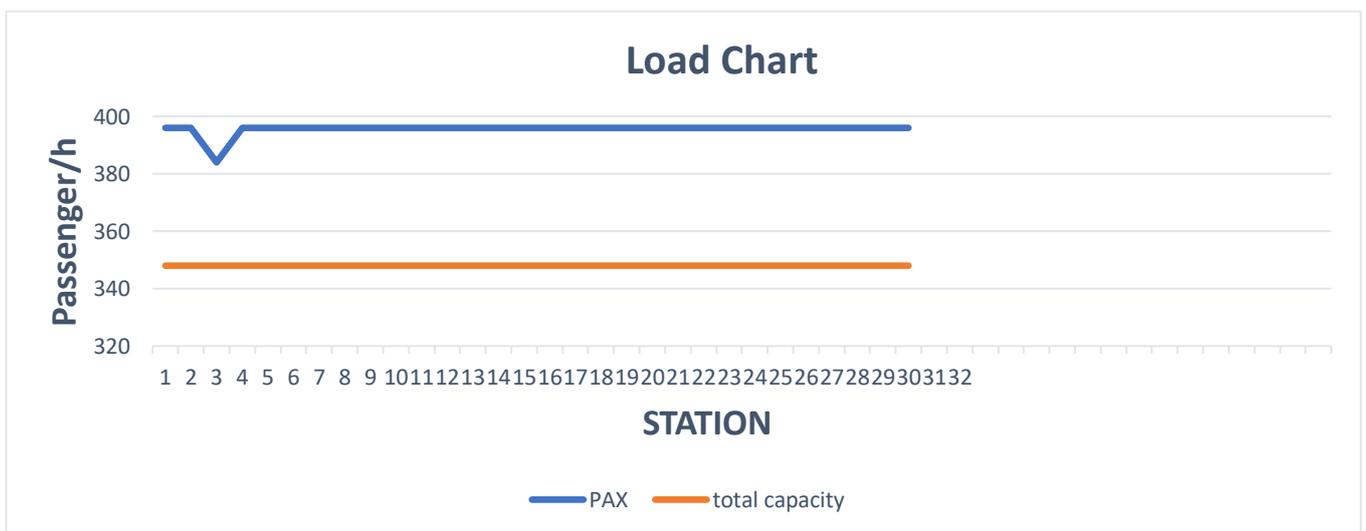


Figure 149 Load Chart of Airport (outward) route

As it is shown in the figure, this line is crowded, and it needs at least 7 buses for completing service coverage. Currently this line has 6 buses.

5.1.11.2 Airport (inward) route

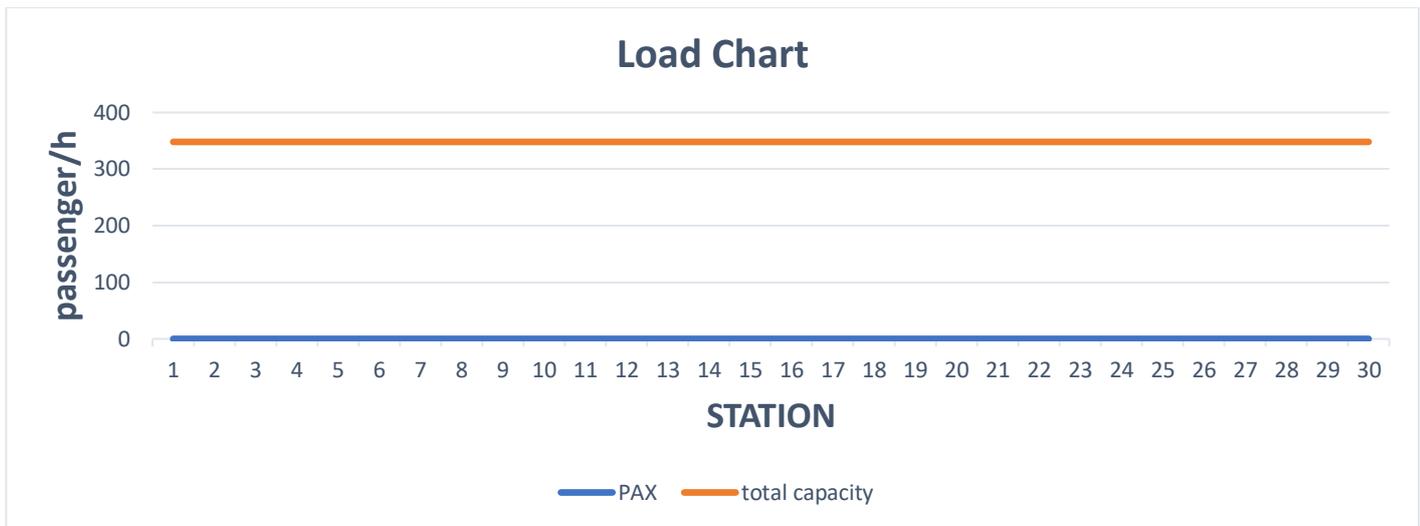


Figure 150 Load Chart of Airport (inward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 6 buses.

5.1.12 Caspian route

5.1.12.1 Caspian (outward) route

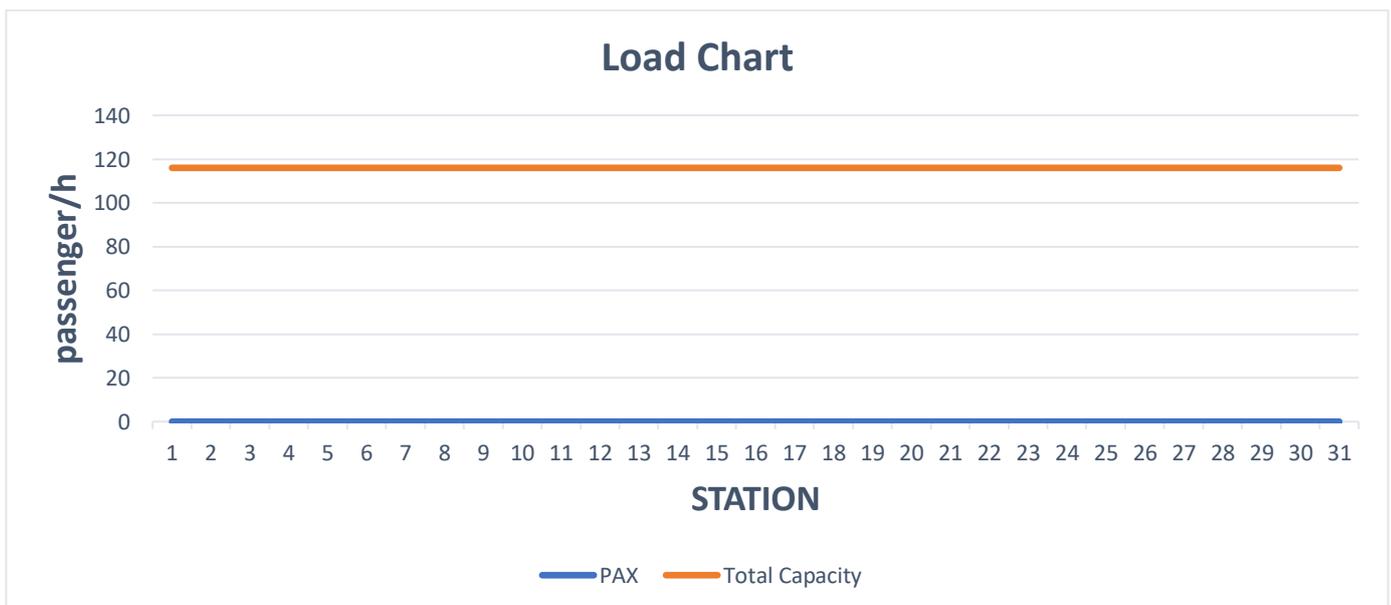


Figure 151 Load Chart of Caspian (outward) route

As it is shown in the figure, service in this direction is sufficient. Currently this line has 2 buses.

5.1.12.2 Caspian (inward) route

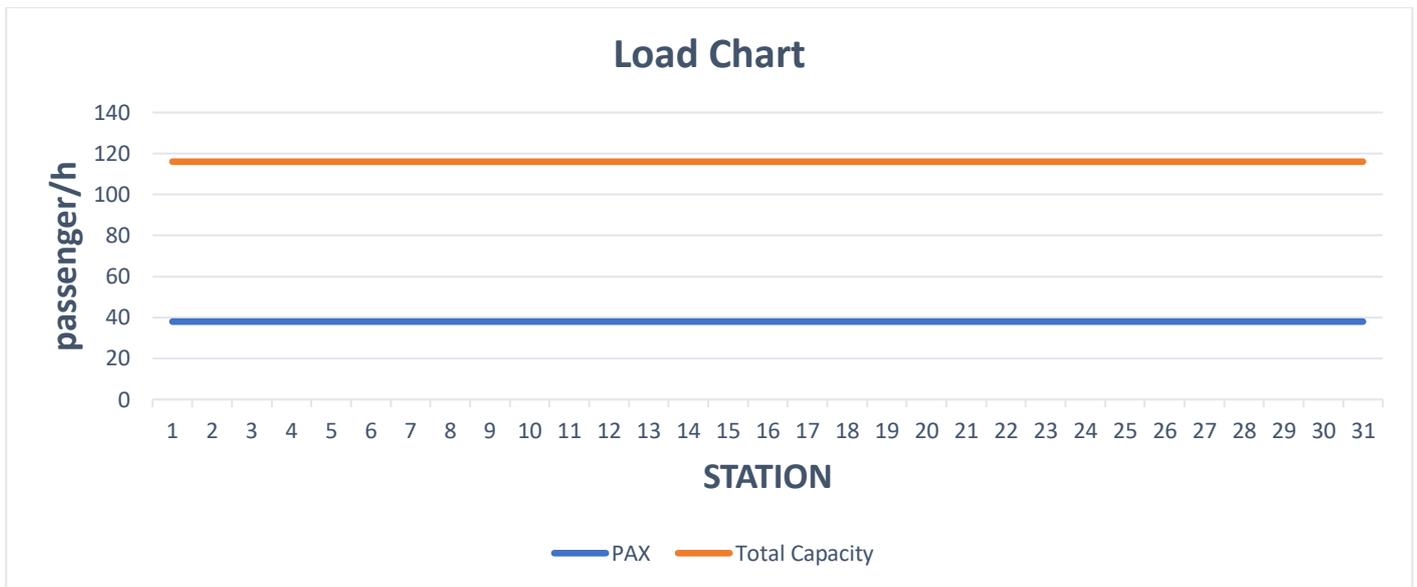


Figure 152 Load Chart of Caspian (inward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 2 buses.

5.1.13 Shahrak imam route

5.1.13.1 Shahrak imam (outward) route

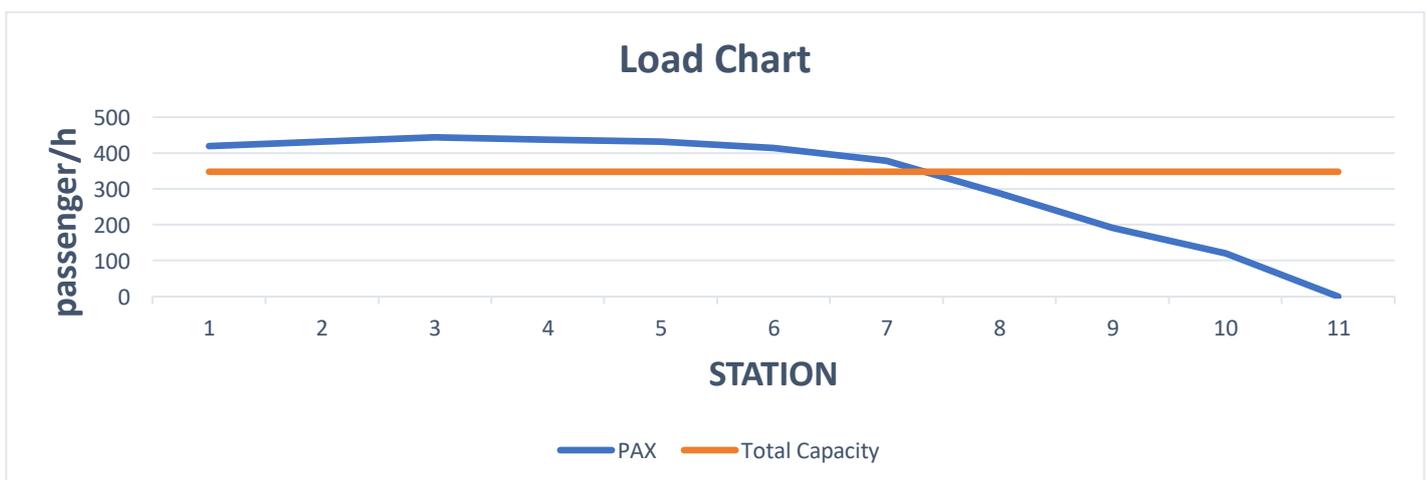


Figure 153 Load Chart of Shahrak imam (outward) route

As it is shown in the figure, this line is crowded, and it needs at least 8 buses for completing service coverage. Currently this line has 6 buses.

5.1.13.2 Shahrak imam (inward) route

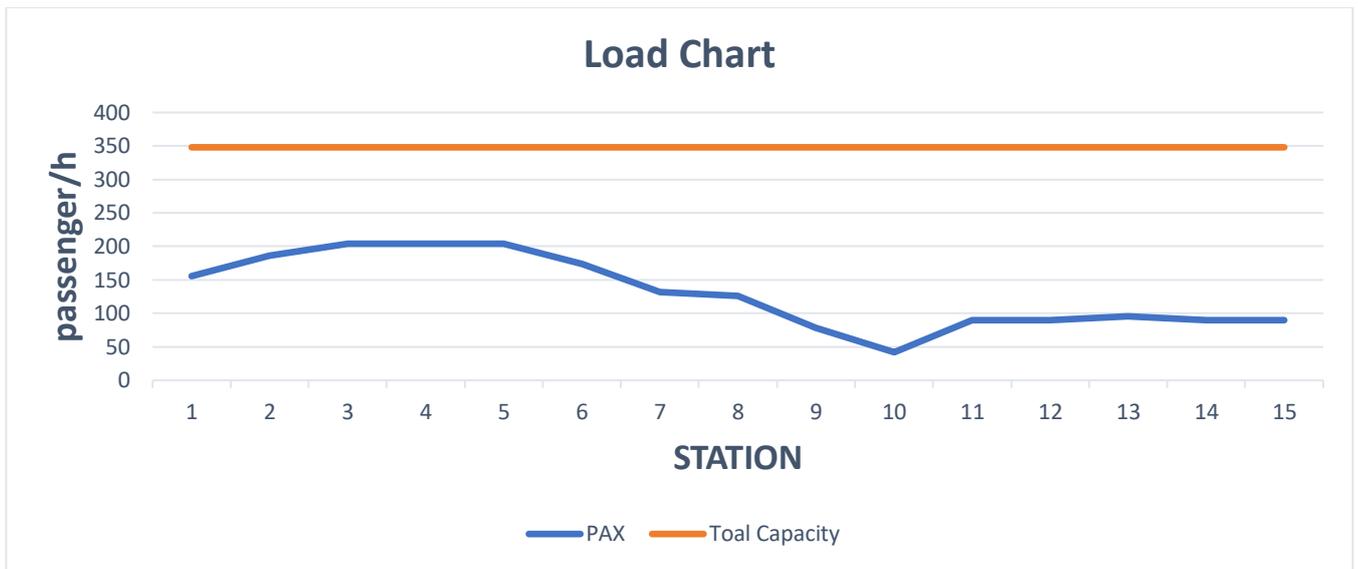


Figure 154 Load Chart of Shahrak imam (inward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 6 buses.

5.1.14 Mirzakochik route

5.1.14.1 Mirzakochik (outward) route

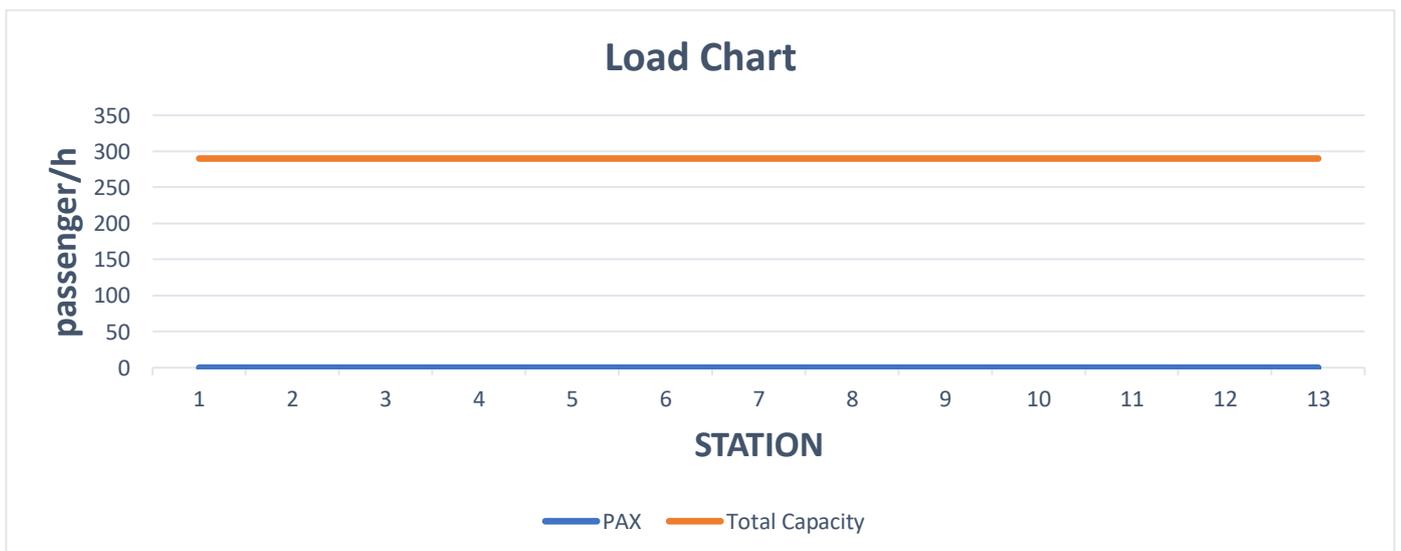


Figure 155 Load Chart of Mirzakochik (outward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 5 buses.

5.1.14.2 Mirzakochik (inward) route

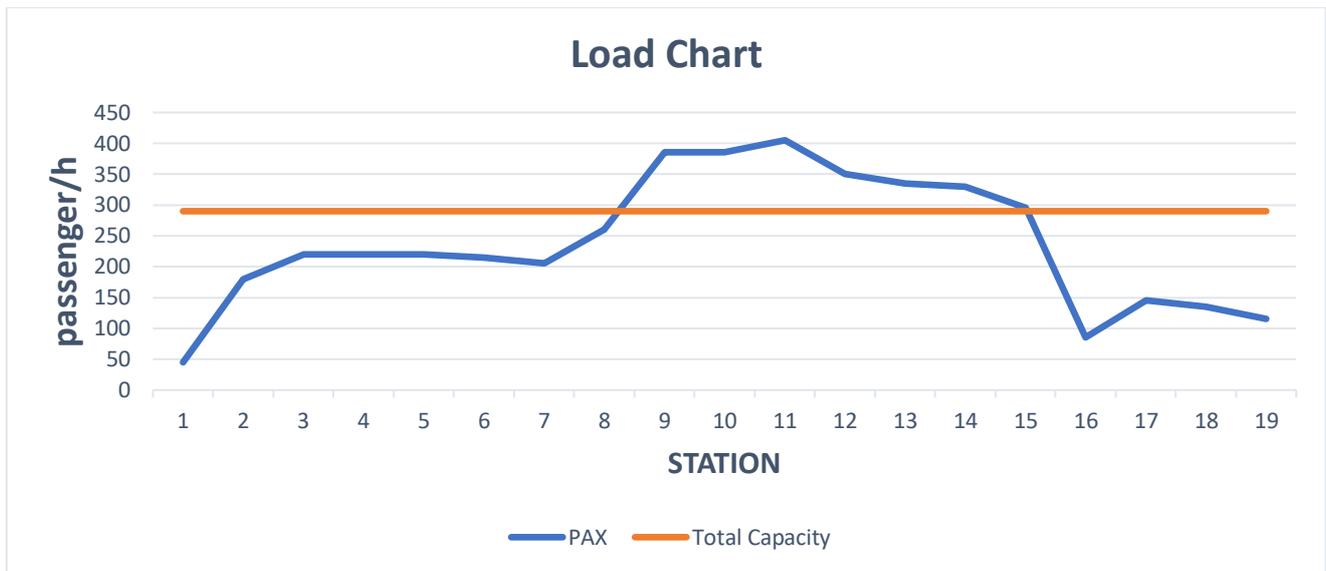


Figure 156 Load Chart of Mirzakochik (inward) route

As it is shown in the figure, this line is crowded, and it needs at least 7 buses for completing service coverage. Currently this line has 5 buses.

5.1.15 Esteghamat route

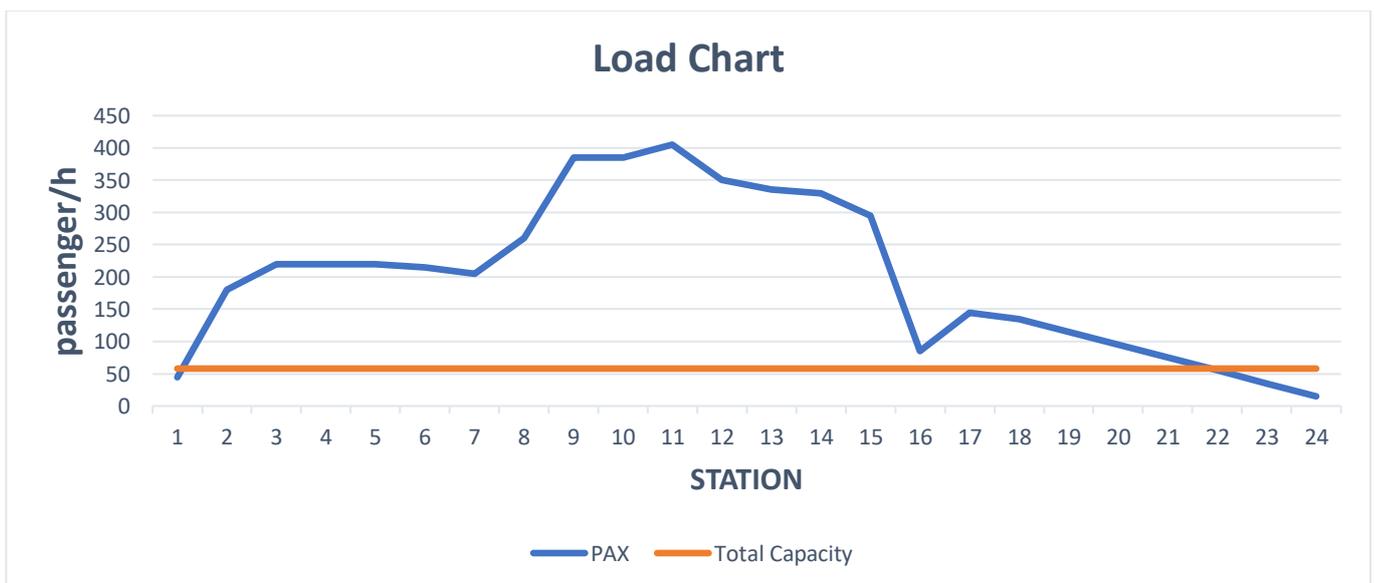


Figure 157 Load Chart of Esteghamat route

As it is shown in the figure, this line is crowded, and it needs at least 3 buses for complete service coverage. Currently this line has 1 buse.

5.1.16 Aliabad route

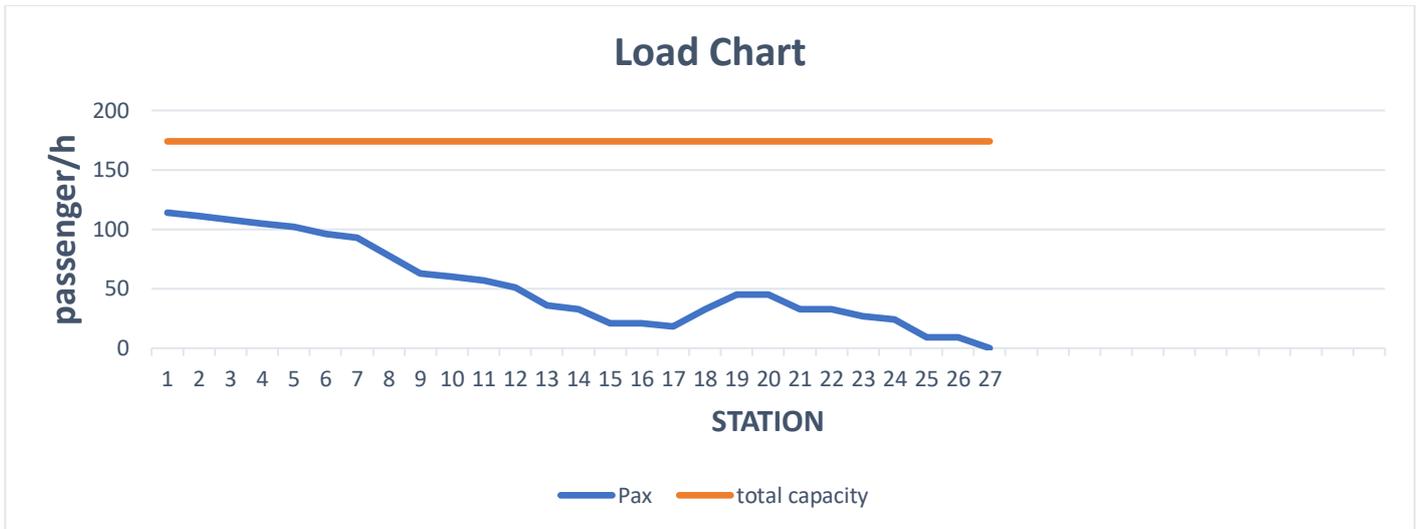


Figure 158 Load Chart of Aliabad route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 1 bus.

5.1.17 Rajaie route

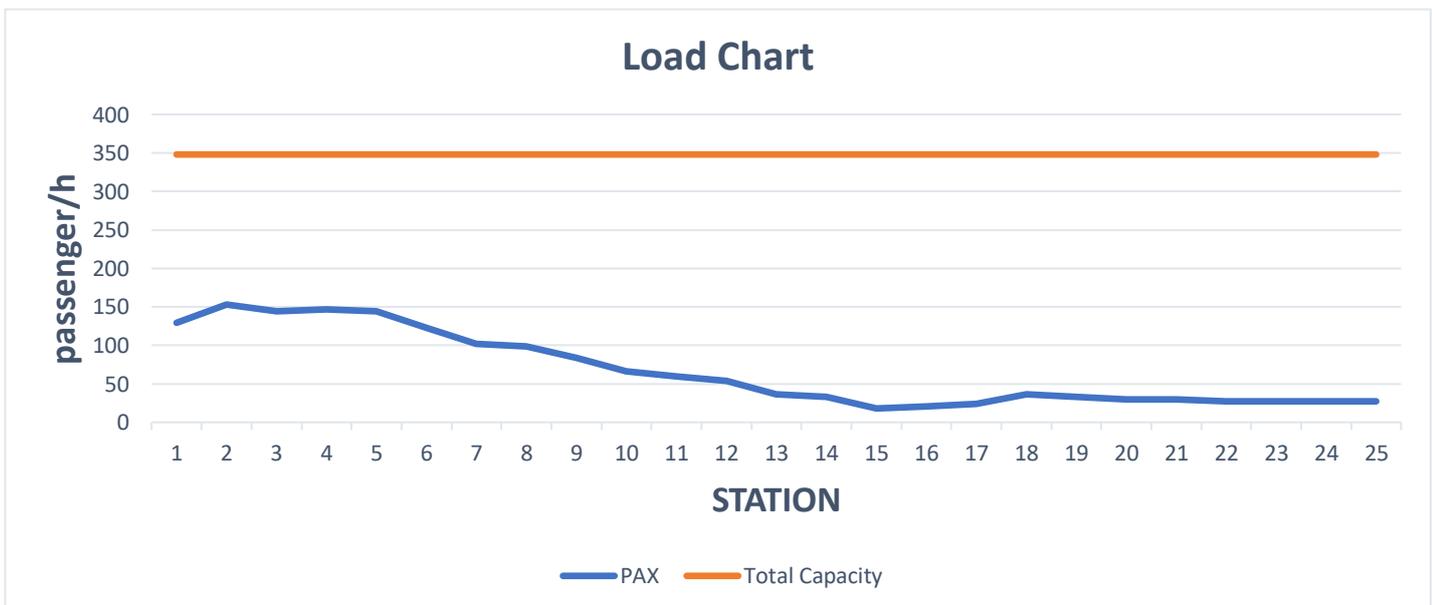


Figure 159 Load Chart of Rajaie route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 6 buses.

5.1.18 Pas vishe route

5.1.18.1 Pas vishe (outward) route

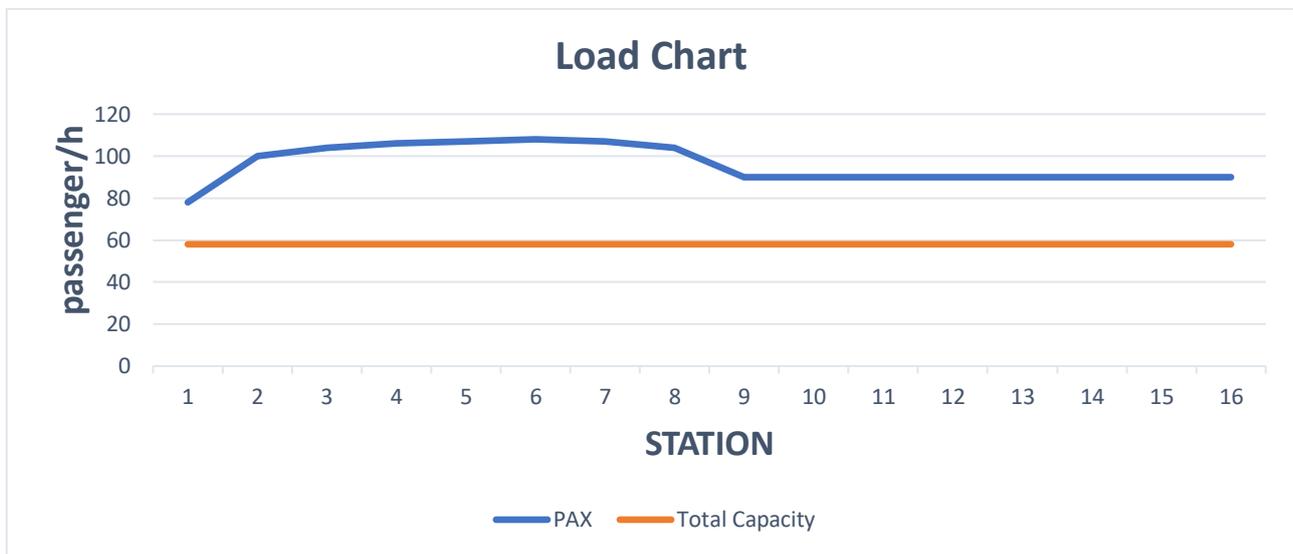


Figure 160 Load Chart of Pas vishe (outward) route

As it is shown in the figure, this line is crowded, and it needs at least 2 buses for completing service coverage. Currently this line has 1 bus.

5.1.18.2 Pas vishe (inward) route

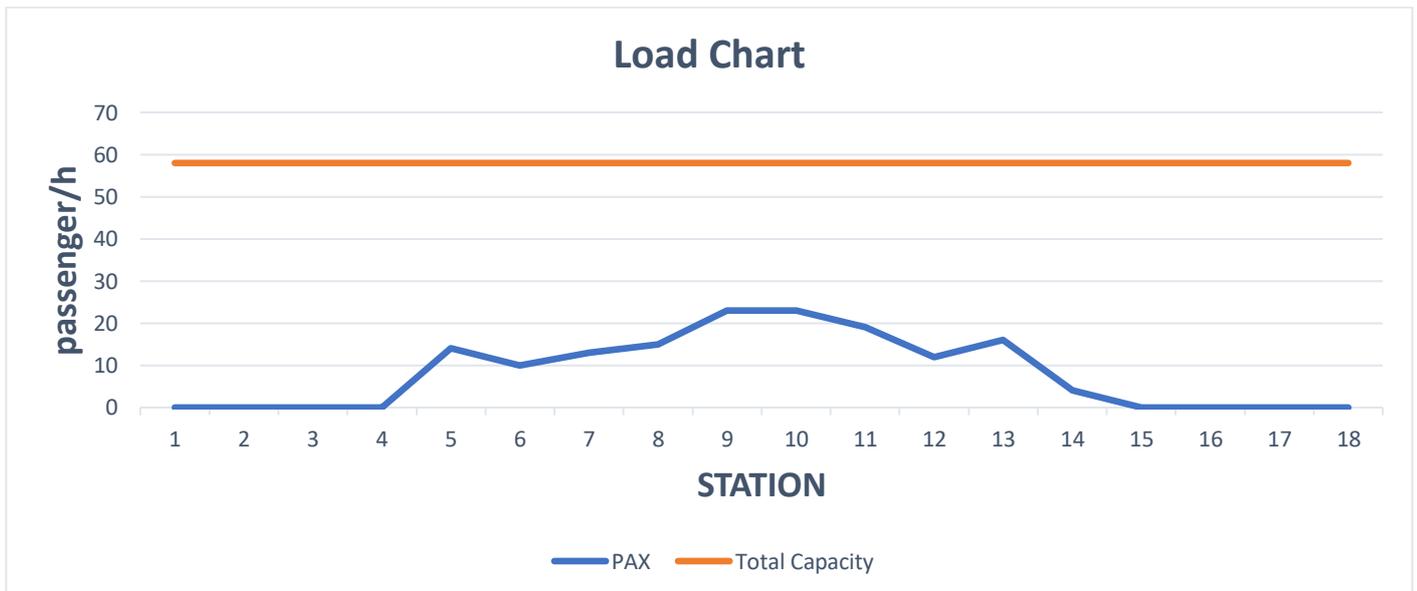


Figure 161 Load Chart of Pas vishe (inward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 1 bus.

5.1.19 Molasara route

5.1.19.1 Molasara (outward) route

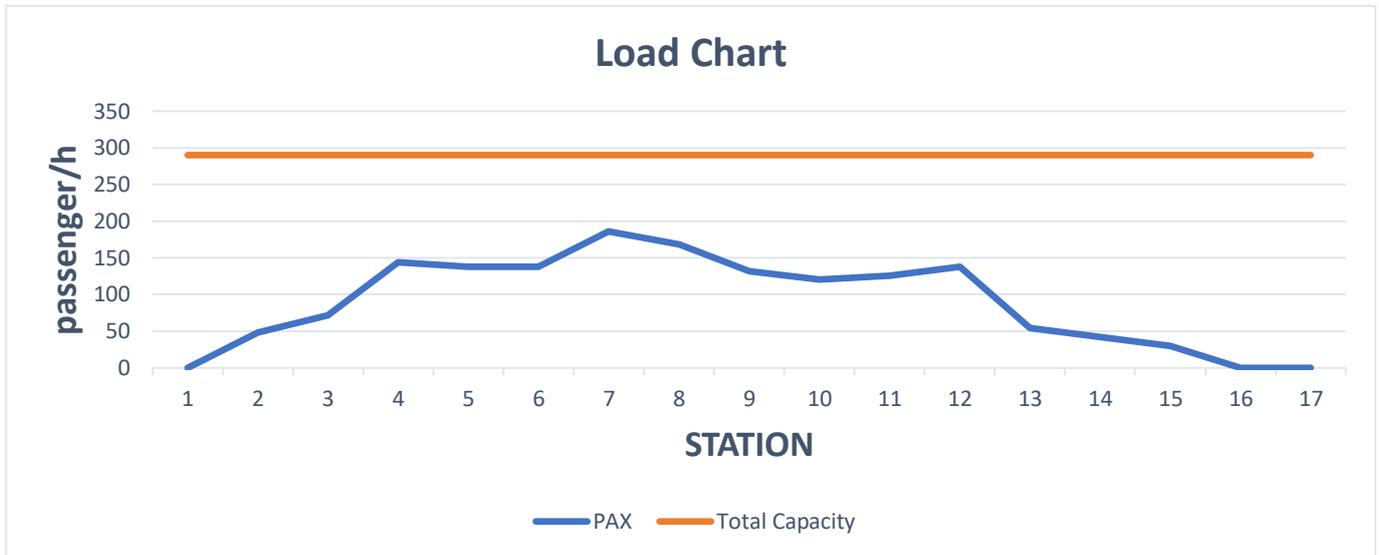


Figure 162 Load Chart of Molasara (outward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 5 buses.

5.1.19.2 Molasara (inward) route

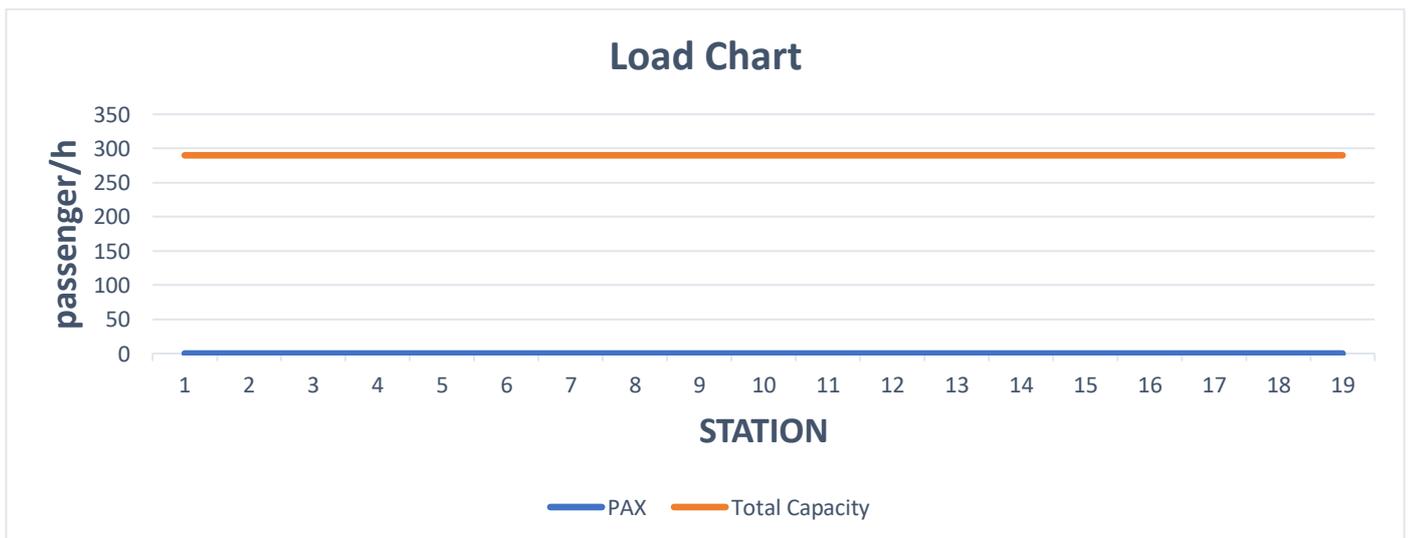


Figure 163 Load Chart of Molasara (inward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 5 buses.

5.1.20 Jirdeh route

5.1.20.1 Jirdeh (outward) route

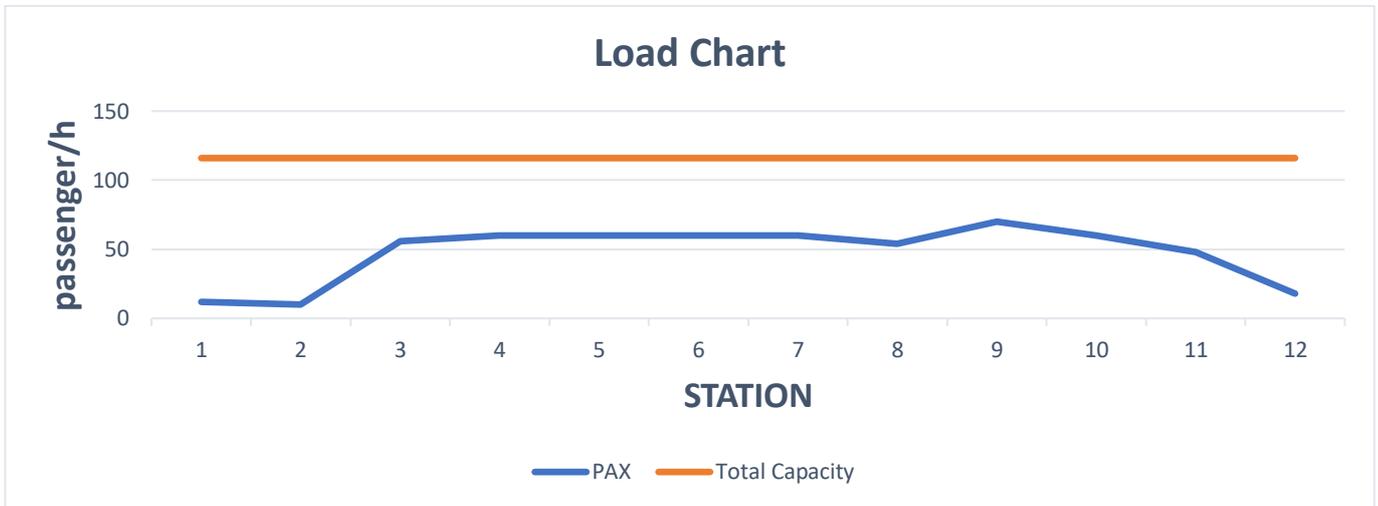


Figure 164 Load Chart of Jirdeh (outward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 2 buses.

5.1.20.2 Jirdeh (inward) route

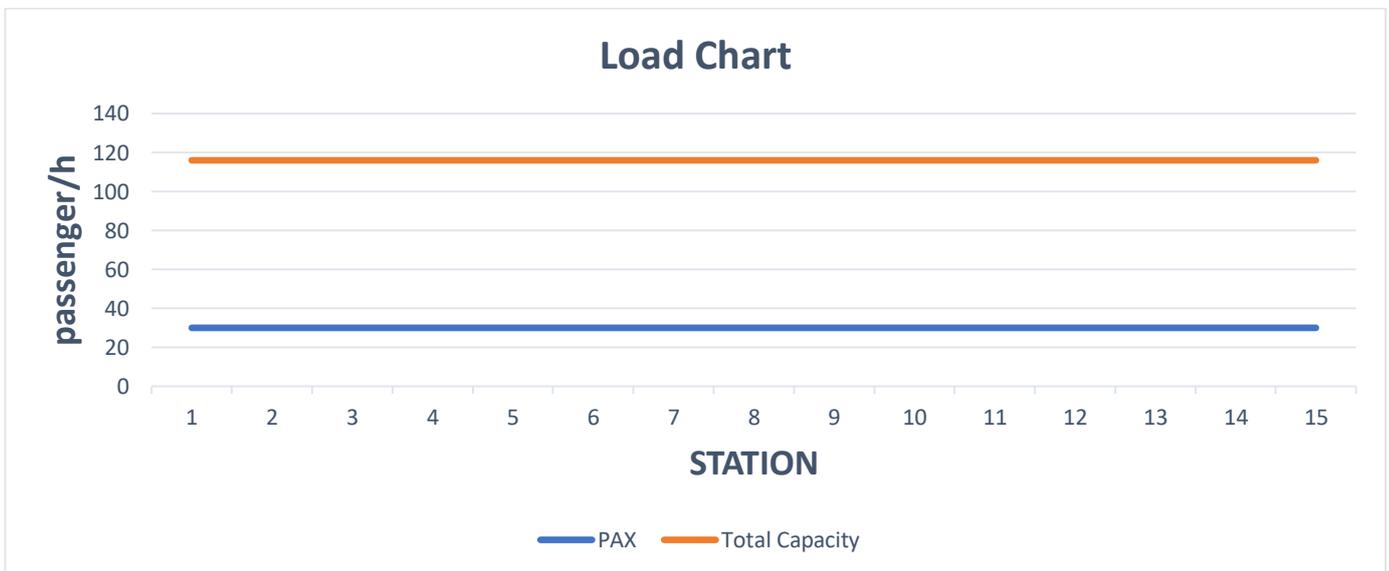


Figure 165 Load Chart of Jirdeh (inward) route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 2 buses.

5.1.21 Kamarbandi route

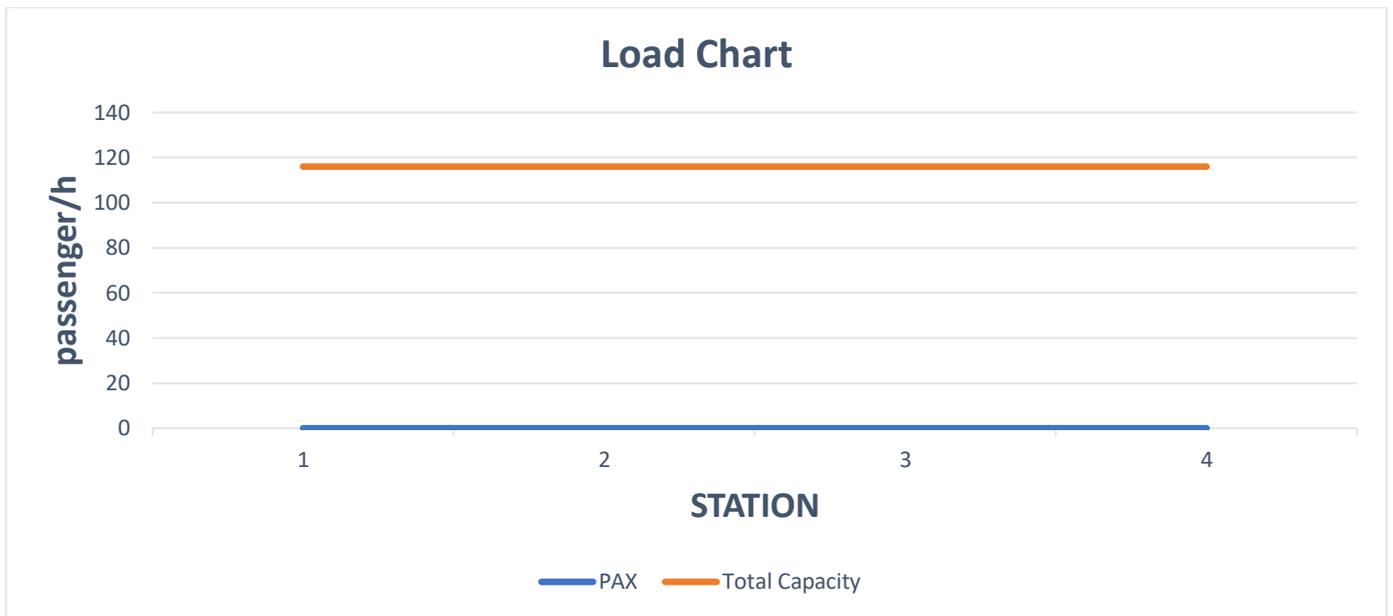


Figure 166 Load Chart of Kamarbandi route

As it is shown in the figure, service in this direction is satisfactory. Currently this line has 2 buses.

5.2 Reallocation of the bus fleet among different lines

The following table shows the results of the overcrowding analysis:

fleet quantity indicates the number of vehicles of the line.

Capacity indicates the status of the line.

max boarded passenger is the greatest number of boarded passengers on the line.

total capacity is the number of vehicles of the line multiplied to the capacity of 1 bus (58passengers)

IOD** indicates the possibility of decreasing or increasing the number of vehicles on the line

line name	fleet quantity	capacity	max boarded passenger	total capacity	IOD	comment
Terminal route	5	crowded	430	290	2	it should be added at least 2 buses
Lakan shahr route	7	crowded	560	406	2	it should be added at least 2 bus
Around city3 route	4	satisfied	196	232	-1	1 fleet of this line can be removed and be added to another route
Lakan route	2	satisfied	28	116	-1	1 fleet of this line can be removed and be added to another route
Imam route	2	satisfied	0	116	-1	1 fleet of this line can be removed and be added to another route
Around city4 route	4	crowded	268	232	1	it should be added at least 1 bus
Jafarabad route	6	crowded	444	348	2	it should be added at least 2 buses
Kouchesfehan route	6	satisfied	52	348	-5	5 fleet of this line can be removed and be added to another route
Shahrak saba route	1	satisfied	44	58	0	we can not decrease fleet size of this route*
Golsar route	5	crowded	385	290	2	it should be added at least 2 buses
Airport route	6	crowded	396	348	1	it should be added at least 1 bus
Caspian route	2	satisfied	38	116	-1	1 fleet of this line can be removed and be added to another route
Shahrak imam route	6	crowded	444	348	2	it should be added at least 2 buses
MirzaKochik route	5	crowded	405	290	2	it should be added at least 2 buses
Esteghamat route	1	crowded	305	58	4	it should be added at least 4 buses
Aliabad route	3	satisfied	114	174	-1	1 fleet of this line can be removed and be added to another route
Rajaie route	6	satisfied	153	348	-4	4 fleet of this line can be removed and be added to another route
Pas vishe route	1	crowded	108	58	1	it should be added at least 1 bus
Molasara route	5	satisfied	186	290	-2	2 fleet of this line can be removed and be added to another route
Jirdeh route	2	satisfied	70	116	-1	1 fleet of this line can be removed and be added to another route
kamarbandi route	2	satisfied	0	116	-1	1 fleet of this line can be removed and be added to another route
	total 81					

Table 24 result of overcrowding analysis

* the lines cannot be deleted so at least 1 vehicle should remain for each line

In conclusion, by consideration of overcrowding analysis we have 10 crowded routes and we should add more fleet for these routes to satisfy the network particularly in peak hour and also we have 11 sufficient routes which we can remove some fleet from these routes and add them to the crowded routes. By controlling the needed fleet for crowded routes, it is illustrated that in the peak hour with a true planning, Rasht network system could be satisfying. In order to do this, the fleet sizes of the routes could be modified specifically in peak hour.

line name	fleet quantity	capacity
Terminal route	7	sufficient
Lakan shahr route	9	sufficient
Around city3 route	3	sufficient
Lakan route	1	sufficient
Imam route	1	sufficient
Around city4 route	5	sufficient
Jafarabad route	8	sufficient
Kouchesfehan route	1	sufficient
Shahrak saba route	1	sufficient
Golsar route	7	sufficient
Airport route	7	sufficient
Caspian route	1	sufficient
Shahrak imam route	8	sufficient
MirzaKochik route	7	sufficient
Esteghamat route	5	sufficient
Aliabad route	2	sufficient
Rajaie route	2	sufficient
Pas vishe route	2	sufficient
Molasara route	3	sufficient
Jirdeh route	1	sufficient
kamarbandi route	1	sufficient
	total 81	

Table 25 new fleet size plan for peak hour

5.3 Vehicles headway

5.3.1 Vehicles headway in current situation

Due to the lack of information concerning the potential demand to be served, to estimate interval it is decided to use an average value. To find an average it is calculated Total Travel Time for each line and then by considering the fleet size which are mentioned in the chapter3, is found interval for each line. After calculating interval for every line, is calculated an average value of all intervals to estimate a realistic value of interval for our new line by consideration of existent lines information. As it is shown in the following table, the estimated value for interval is 15 minutes which means every 15 minutes pass one fleet from the stations, and we can consider it for our new line to calculating needed fleet size. It should be noted this value is an approximate relative to the information about existent lines. For calculating the headway, the average weighted method is used to have more proportional value, where the weights are passengers of lines.

$$\text{average weighted of Headway} = 15 \text{ minutes}$$

Line Name	Travel Time			Line Travel Time (M)	fleet size	total daily passenger	line headway	weighted average of headway
	outward direction travel time (S)	inward direction travel time (S)	stop time in terminal (S)					
Terminal route	1529	1440	381	56	5	7090	11	79172
Lakan shahr route	1932	2143	509	76	7	10934	11	119338
Around city3 route	2687	0	691	56	4	4960	14	69809
Lakan route	1470	1835	306	60	2	1622	30	48806
Imam route	2591	0	697	55	2	64	27	1754
Around city4 route	2345	0	1202	59	4	4488	15	66338
Jafarabad route	2052	2030	785	81	6	7374	14	99679
Kouchesfehan route	2598	3167	666	107	6	492	18	8789
Shahrak saba route	1397	2104	582	68	1	853	68	58047
Golsar route	1590	1174	668	57	5	5410	11	61890
Airport route	1854	2097	521	75	6	7914	12	98319
Caspian route	1475	1475	3453	107	2	826	53	44068
Shahrak imam route	1257	1485	578	55	6	7758	9	71552
MirzaKochik route	1209	1514	460	53	5	6810	11	72244
Esteghamat route	2314	0	499	47	1	299	47	14017
Aliabad route	2090	0	623	45	3	3129	15	47162
Rajaie route	2360	0	630	50	6	2640	8	21924
Pas vishe route	1895	2044	778	79	1	710	79	55817
Molasara route	3254	2182	1189	110	5	4632	22	102281
Jirdeh route	2224	3799	562	110	2	1126	55	61791
kamarbandi route	2509	0	565	51	2	44	26	1127
total average								15

Table 26 Headway of lines in current situation

5.3.2 Vehicles headway after reallocation

With consideration of possibility of reducing or increasing the number of vehicles in paragraph 5.2 it is decided to reallocate fleet size for all lines. As it is shown in the following table, the headway of Rasht bus network increased to 17 minutes. For calculating the headway, the average weighted method is used to have more proportional value, where the weights are passengers of lines.

Line Name	Travel Time			Line Travel Time (M)	fleet size	total daily passenger	line headway	weighted average of headway
	outward direction travel time (S)	inward direction travel time (S)	stop time in terminal (S)					
Terminal route	1529	1440	381	56	7	7090	8	56551
Lakan shahr route	1932	2143	509	76	9	10934	8	92819
Around city3 route	2687	0	691	56	3	4960	19	93078
Lakan route	1470	1835	306	60	1	1622	60	97613
Imam route	2591	0	697	55	1	64	55	3507
Around city4 route	2345	0	1202	59	5	4488	12	53070
Jafarabad route	2052	2030	785	81	8	7374	10	74759
Kouchesfehan route	2598	3167	666	107	1	492	107	52736
Shahrak saba route	1397	2104	582	68	1	853	68	58047
Golsar route	1590	1174	668	57	7	5410	8	44207
Airport route	1854	2097	521	75	7	7914	11	84273
Caspian route	1475	1475	3453	107	1	826	107	88137
Shahrak imam route	1257	1485	578	55	7	7758	8	61330
MirzaKochik route	1209	1514	460	53	7	6810	8	51603
Esteghamat route	2314	0	499	47	5	299	9	2803
Aliabad route	2090	0	623	45	2	3129	23	70744
Rajaie route	2360	0	630	50	2	2640	25	65771
Pas vishe route	1895	2044	778	79	2	710	39	27908
Molasara route	3254	2182	1189	110	3	4632	37	170469
Jirdeh route	2224	3799	562	110	1	1126	110	123582
kamarbandi route	2509	0	565	51	1	44	51	2254
total average								17

Table 27 Headway of lines after reallocation

5.3.3 comparing before reallocation and after reallocation

The headway of Rasht bus network increased 2 minutes after reallocation, however the system is improved. The histogram below shows the number of passengers using lines with headways between certain ranges of time and it compares this amount before and after reallocation. For instant, in the previous mode the system in 10 minutes headway could cover 10,000 passengers which can cover 45,000 passengers now.

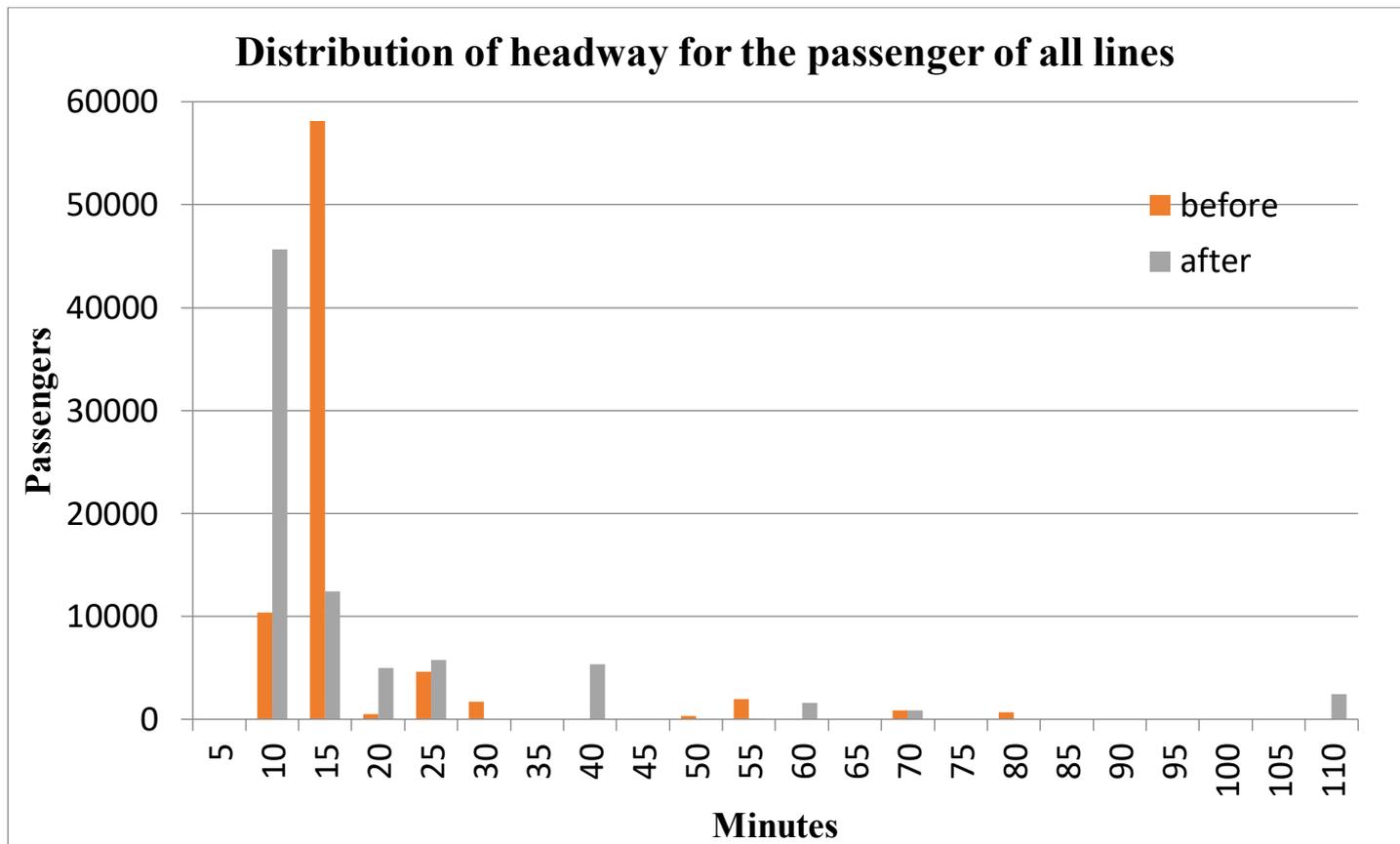


Figure 167 Distribution of headway for the passenger of all lines

to better understand how much passengers earn or lose from the proposal of reallocation of fleet the table below is presented. And for verifying the calculation process the check part is added at the end.

status	Equal or better than before	Worse than before	Worse up to 5 min than before	Worse 5-15 min than before	Worse more than 15 min than before
percentage of passengers	75,3%	24,7%	6,3%	9,8%	8,6%
check					8,6%

Table 28 earned and lost amount from the proposal of reallocation

6 Chapter 6: Proposal for a new line for Rasht bus network

According to the analysis of line changing by passengers in paragraph 4.2, it is found that six points of the city have the high rate of daily line changing and these specific points are the most remarkable ones for attracting the daily passengers. As it mentioned in Chapter 2, Ms. pronello and Bargegol, the best solution for designing a new bus route can be circular one. They limited their research to a particular area by assuming a hypothetical circular region in the central part of the city and their data analysis process shows that it is inevitably needed to suppose a specific area for the study.

Although, for locating new stations, the priority was passing new line through the mentioned points and for reducing the traffic volume caused by busses it is suggested to choose routes which have greater width and less traffic jam.

Because of the large number of passengers in central part of the city, it is determined to adjust this new line in a way that can also get service to central area passengers and be more beneficial.



Figure 168 new desinged line

6.1 Stations of new line

The position of the stations in new line are chosen according to usage of existent station in Rasht bus network.

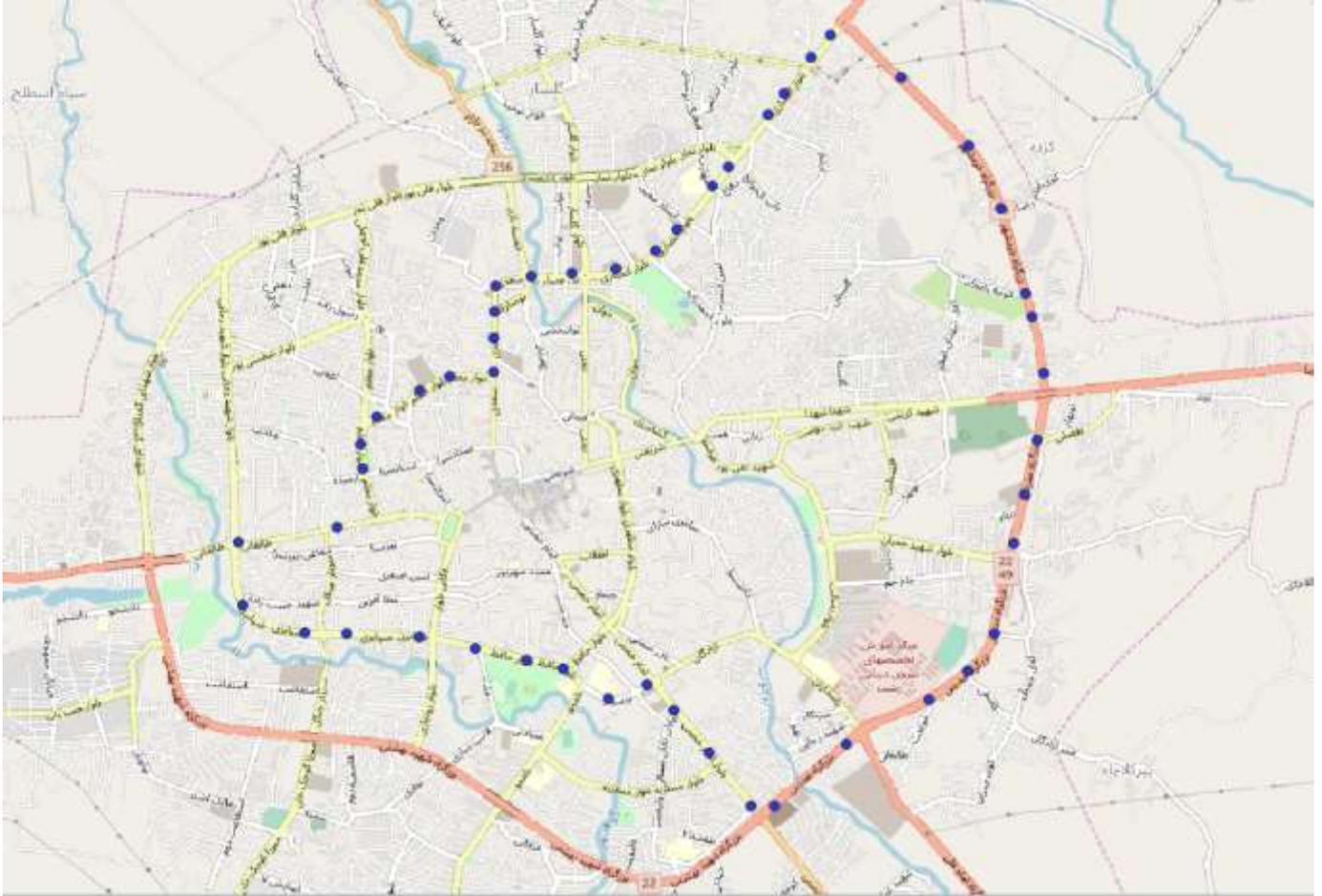


Figure 169 stations of new line

The new line to cross from central zone of the city which has more traffic in confront of other zones, pass by Moalem street. According to lack of existent station in Moalem street, it is decided to locate new station in this street. For locating new station these parameters are considered:

- Residential population concentration
- Offices and commercial centers
- Possibility of line changing for passengers

In Moalem 3 new station street are positioned. Station number 1 in Moalem street is positioned for supporting residential area around Vahdat alley and Sedghi alley. Station number 2 is positioned for coverage of Secretary of State's Office. And the station number 3 is positioned near Madar square for passengers who want to go to Qulipour boulevard direction.

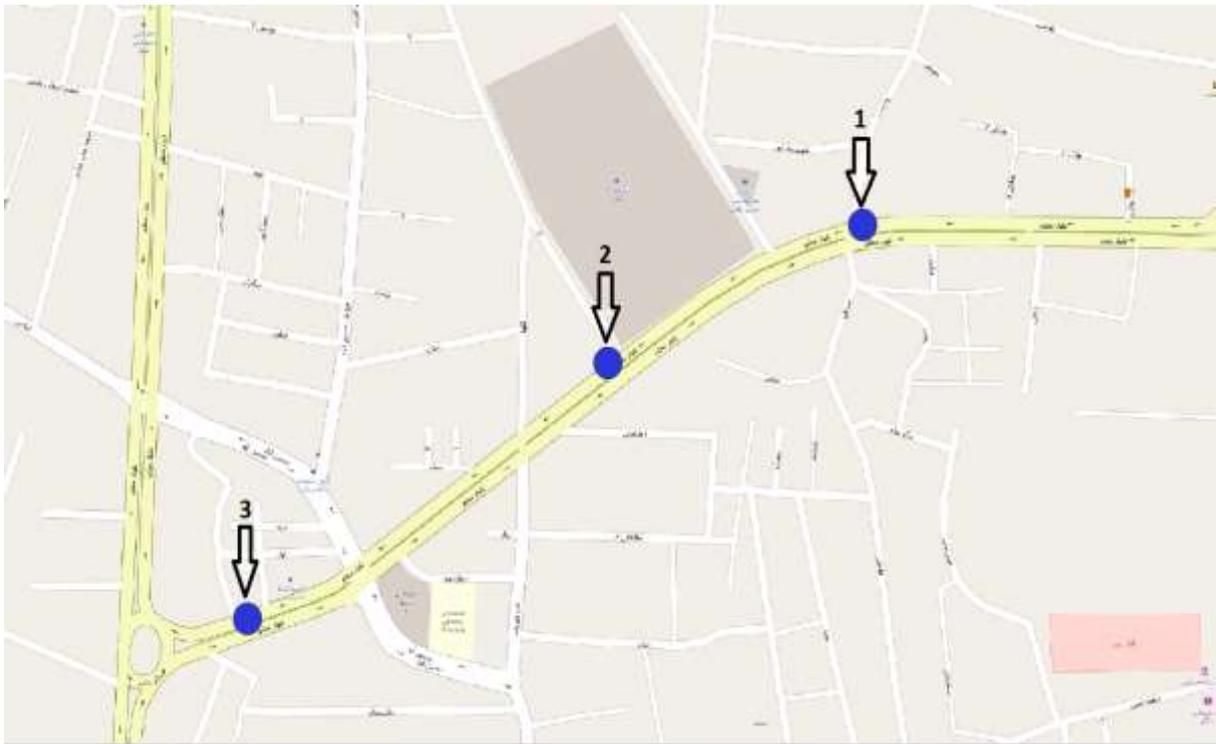


Figure 170 new stations in Moalem stree

Also, the new line pass from Ziabary street and Hafez boulevard which have not stations in entire route. In Ziabary street the first station is positioned in front of Gohari alley which indicate a big residential area around it. And the second station is positioned near Defa Moghadas square for passengers who want to go to Lakani boulevard direction.

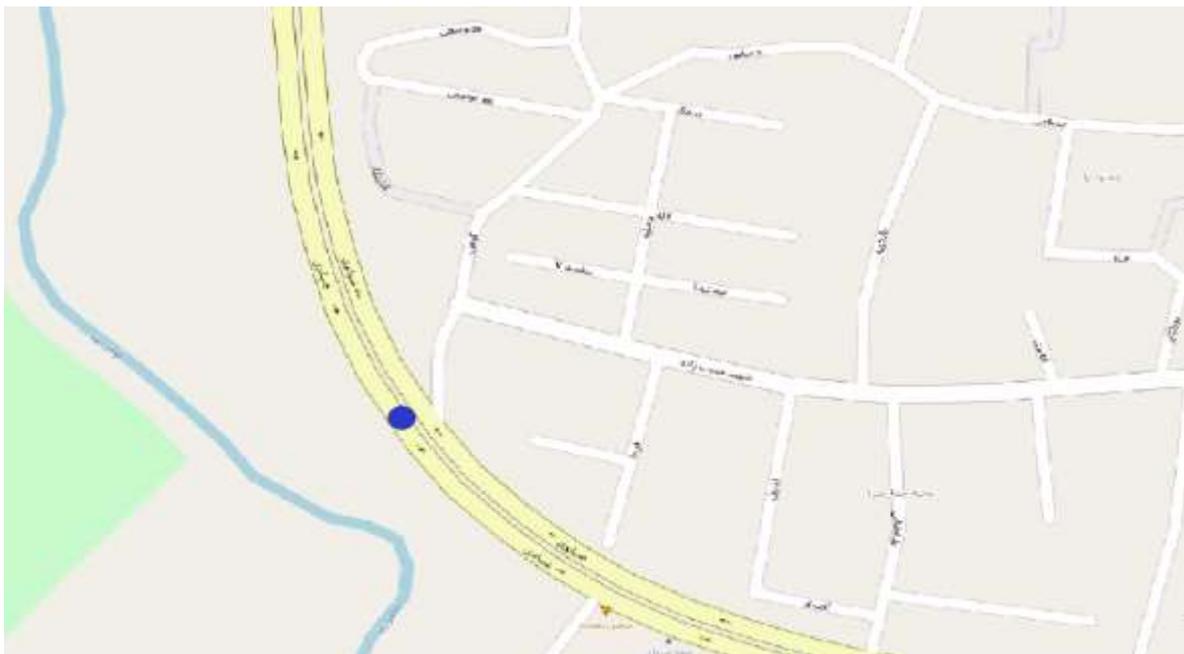


Figure 171 Position of First station in Ziabary street

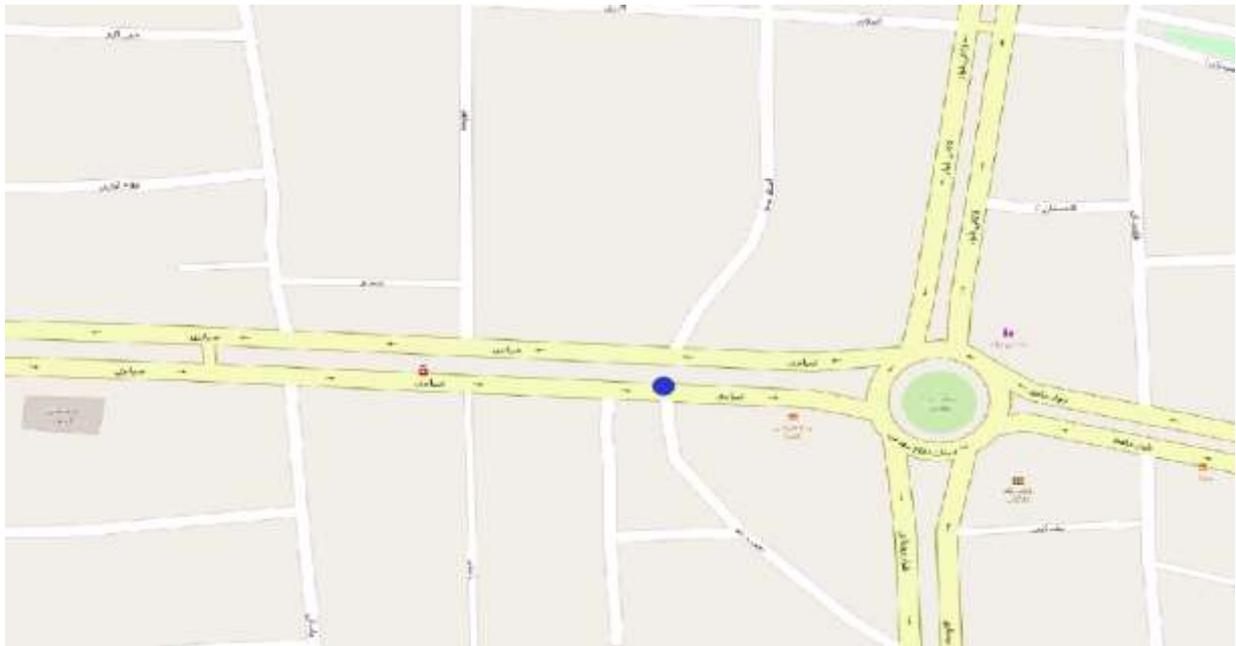


Figure 172 Position of second station in Ziabary street

In Hafez boulevard 3 new stations are located. The station number 1 is positioned near Amozegar alley for supporting residential area around it. The station number 2 is positioned in front of Rasht Park and the third one is positioned before intersection for passengers who want to go to Imam Khomeini street direction.



Figure 173 new stations in Hafez boulevard

6.2 Total travel time of new line

To estimate total travel time, following equation is used:

$$\text{Total Travel Time} = \text{Travel Time} + \text{Stop Time in Stations} + \text{Stop Time in Terminal}$$

6.2.1 Travel time

To estimate travel time, google map site is used. The origin point, destination point of the stations, the related trip time and related trip distance are found on the google map site. To be more realistic the time to collect the data by google map site is chosen between 18 and 19, so the same traffic that there is at peak hour can be simulated.

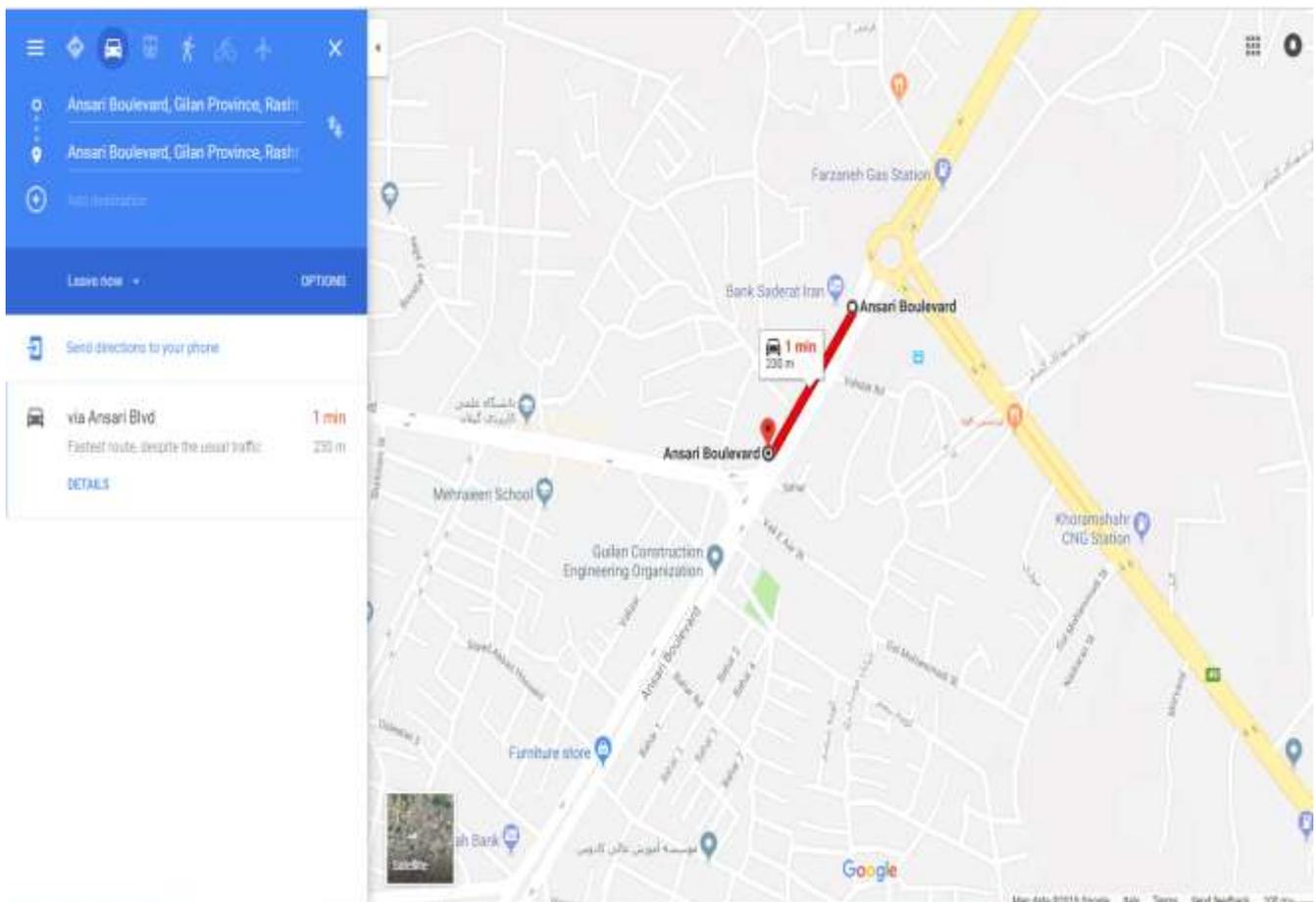


Figure 174 example of data collecting from google map site

travel time and distance between every 2 stations are reported in the table 28

Station Number	Travel time to next station(m)	distance to next station(m)
1		-
2	1	230
3	1	260
4	1	170
5	2	450
6	1	150
7	1	350
8	1	220
9	1	290
10	1	280
11	1	280
12	1	240
13	1	160
14	1	170
15	1	230
16	1	300
17	1	210
18	2	350
19	1	280
20	1	160
21	3	300
22	1	270
23	1	200
24	1	220
25	1	220
26	2	600
27	2	550
28	1	190
29	1	500
30	1	350
31	1	350
32	1	250
33	2	350
34	1	270
35	1	260
36	1	350
37	2	450
38	1	250
39	2	600
40	2	600
41	1	300
42	1	300
43	2	600
44	1	350
45	1	350
46	3	450
47	1	400
48	1	160
49	1	550
50	1	500
51	2	550
total	64	16420

Table 29 travel time and distance between stations of new line

For controlling the calculation process of travel time is decided to consider travel time between each 10 stations to checking the total travel time and total distance.

In the following table the result of the controlling is shown. The yellow part is related to the calculation of station by station and the red part is related to the calculation of 10 stations by 10 stations and finally the confront of total value for distance and travel time are shown. As it is shown that the result of travel time for every 10 stations are more than result of travel time for station to stations. It should be noted in every 10 station's approach there are not the stop time and time for acceleration and deceleration of the vehicle.

controlling				
	station to station		every 10 stations	
	distance	travel time	distance	travel time
1 to 10	2400	10	2400	16
10 to 20	2380	11	2500	13
20 to 30	3400	14	3300	15
30 to 40	3730	14	3800	17
40 to 51	4510	15	4800	14
total	16420	64	16800	75

Table 30 controlling of travel time and distance calculated by tow different path

6.2.2 Stop Time in Stations

To estimate the stop time in the stations it is decided to use an average value. For this reason, in the first step the average of stop time of all stations for outward direction and inward direction are calculated and then in the second step average of stop time between tow direction is calculated. For loop routes just one direction is considered. And in the third step an average of stop time of all lines is calculated.

It should be noted to calculate the value of stop time, Kamarbandi route and Imam route are not considered, because of data losing problem as it is mentioned in the chapter3.

Line name	Stop Time Average		
	Outward	Inward	Total Stop Time Average
Terminal route	24.71	24.4	24.555
Lakan shahr route	82.92	28.32	55.62
Around city3 route	19.87	19.87	19.87
Lakan route	11.92	17.8	14.86
Imam route	non-considered	non-considered	0
Around city4 route	23.64	23.64	23.64
Jafarabad route	21.44	19.62	20.53
Kouchesfehan route	21.04	28.77	24.905
Shahrak saba route	21	23.8	22.4
Golsar route	19.27	17	18.135
Airport route	18.2	23.53	20.865
Caspian route	7	12	9.5
Shahrak imam route	28.64	30.67	29.655
MirzaKochik route	22	23.72	22.86
Esteghamat route	25.35	25.35	25.35
Aliabad route	21.48	21.48	21.48
Rajaie route	25.2	25.2	25.2
Pas vishe route	15.6	17.94	16.77
Molasara route	25	27.47	26.235
Jirdeh route	15.42	55	35.21
kamarbandi route	non-considered	non-considered	0
Total	23.66842105	24.50421053	24.08631579

Table 31 stop time in Station

At the end the value chosen for Stop Time in the Station is 24.08 seconds or 0.40 minute.

6.2.3 Stop Time in Terminal

To estimate the stop time in the stations it is decided to use an average value. In the first step stop time in terminal for each line is reported and then an average of stop time in terminal of all lines are calculated.

It should be noted for calculating the value of stop time Kamarbandi route and Imam route are not considered because lack of data problem as it is mentioned in the chapter3.

	terminal stop time time
Line name	
Terminal route	381
Lakan shahr route	3283
Around city3 route	691
Lakan route	306
Imam route	0
Around city4 route	1202
Jafarabad route	785
Kouchesfehan route	666
Shahrak saba route	582
Golsar route	668
Airport route	521
Caspian route	320
Shahrak imam route	578
MirzaKochik route	460
Esteghamat route	499
Aliabad route	623
Rajaie route	630
Pas vishe route	778
Molasara route	1189
Jirdeh route	562
kamarbandi route	0
total	774.9473684

Table 32 Stop Time in Terminal

At the end the value chosen for Stop Time in Terminal is 774.95 seconds or 13 minutes.

6.2.4 Calculating of Total Travel Time

After finding necessary values it is possible to estimate Total Travel Time of new line

$$\text{Total Travel Time} = 64 + (50 * 0.40) + 13$$

$$T.T.T = 96 \text{ minutes}$$

6.3 Estimation of the required number of vehicles

To estimate needed fleet size following equation is used:

$$\text{fleet number} = \frac{\text{Total Travel Time}}{\text{Interval}}$$

6.3.1 Calculate of Requirement fleet size

$$\text{fleet number} = \frac{96}{26}$$

$$\text{fleet number} = 3.7$$

So, for having an interval same as to the other line, at least 4 number of buses are needed.

6.4 General information of new line

The following table shows the new line information.

length of line	16.4 KM
number of stations	51
travel time	64 minutes
stop time in stations	0.4 minute
stop time in terminal	12.91 minutes
total travel time	96 minutes
interval of passing	26 minutes
fleet size	4

Table 33 new line general information

7 Chapter 7: Conclusion

Two analyses are illustrated in this dissertation. The first analysis done in this thesis is Overcrowding analysis. Concept of this analysis is controlling the sufficiency of fleet size for existent lines. After analyzing it is found that some lines have more passengers than their actual capacity, in other words, there are overcrowded ones. On the other hand, some lines have less passengers than it was predicted. It would be therefore possible to reduce fleet size of some less usable lines and add them to the high demanded routes in order to improve the function of public transport. Therefore, the allocation of the fleet among different lines of Rasht bus network is changed and fleet size in some lines reduced and they were added to the other line as a solution of Overcrowding problem. It should be noted that the total fleet size of Rasht network system after new planning remained unchanged.

In the second analysis stations of bus network system are scaled according to the number of boarded passengers and got off passengers. The concept of this analyzing was reviewing the stations by QGIS application. Then in the QGIS application some points are defined which had more boarded passengers or got of passenger in comparison to the other points. And finally, 6 areas are represented which have possibility of line changing by passenger and also have more than 100 passengers in both case of boarding and getting out.

After finding these six areas, a new line was designed for transporting the passengers among these points. According to the result of previous researches relative to Rasht city, a circular line has more feasibility in comparison to radial lines or other solution. The proposed new line goes around the central part of Rasht which pass through all the above six important points. Then the Travel Time, headway and required number of vehicles are calculated for our new line. In order to have a service quality in line with the existing network it is decided to calculate an average value for stop time in stations, stop time in terminal and headway. Then with these average values proportional to all lines, total travel time and requirement fleet size are calculated.

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