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Research Article

Public Transport in Rural Roads: Measures to Increase Its Modal Share in Iran

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The supply and demand management of rural public transport has gained an important place in Iran, given its decreasing trend over the last decade. Accordingly, an effective approach is to analyze stakeholders' opinions in this field to identify the effective local solutions for increasing the share of this transport method. The used methodology was to design a mixed questionnaire, a part of which included fuzzy pairwise comparison, while, in its first layer, the variables were classified using rotary analysis. In the other two sections of the questionnaire, the respondents were asked to express their opinions regarding the questions in the form of qualitative and words cloud. According to the inquiries made from the users in 20 selected terminals of Iran providing services to more than 85% of rural passengers, the indicators were weighted and divided into two groups based on the rotary analysis. The weighted results obtained from the users' opinions revealed that the safety, dynamics of incentive policies, and traffic system performance in the rural transport had the highest effects on the micro- and macro-level indicators. In the second section, based on the qualitative questions, a multivariate linear estimation model of the number of rural passengers was constructed. Moreover, in the third section, the users' suggested keywords focused on policy-making, travel time optimization, quality of services, and safety. Both the second and third sections had an acceptable agreement with the pairwise comparisons. Given the vast area of Iran and the distance between the population centers in the country, the obtained solutions to increase the share of public rural road transport included reducing the desirability of travel with private cars in short rural distances through interaction with industrial towns around metropolises, along with providing such areas with special services to attract passengers to rural transport with occupational goals.

1. Introduction

This study aims to seek solutions for mitigating the declining share of rural public transport in I.R. Iran since 2008 and to suggest measures to attract passengers to this mode of transport. According to the latest data published by the Iranian Roads and Transportation Organization for 2019, the average number of passengers was 18 per bus, 14 per minibus, and 4 per passenger car. Table 1 presents the number of intrastate and interstate passengers in terms of vehicle type from 2008 to 2019.

According to Table 1, the following remarks can be presented:

Road passengers are more likely to choose a minibus for intrastate trips, while interstate passengers are more likely to choose a bus. In recent years, the popularity of buses and minibuses has declined, while passenger cars have maintained their popularity.

From 2008 to 2019, using buses and minibuses for interstate and intrastate trips has decreased on a yearly basis. It seems that appropriate policies had been adopted for road trips by 2008; however, the market share of this mode has been later absorbed by other modes.

The number of road passengers is decreasing, and it can be seen that, in recent years, the attractiveness of road transport has decreased.

Finally, the question arises as how to increase the utility of road public transport systems. It is noteworthy that the decrease in the total number of public transport passengers

Table 1: Number of public Rural Road Passengers in Terms of Vehicle Type from 2008 to 2019 (Statistical yearbooks of road transport from 2008 to 2019) [1].

Year	Inter-state passenger (thousand)			Intra-state passenger (thousand)			Total (thousand)		
	Bus	Minibus	Passenger car	Bus	Minibus	Passenger car	Bus	Minibus	Passenger car
2008	74075	12004	7107	43901	67923	18945	117976	79927	26052
2009	80981	12757	7489	52324	73755	20305	133305	86512	27794
2010	84252	13670	8593	56290	76455	24382	140542	90125	32975
2011	84268	13366	9568	57675	75020	27057	141943	88386	36625
2012	79006	11211	8962	51593	68171	26026	130599	79382	34988
2013	76725	10640	8488	49026	65139	25770	125751	75779	34258
2014	77239	10136	9226	43600	59173	26176	120839	69309	35402
2015	75772	8588	9120	39209	52259	26330	114981	60847	35450
2016	67547	6790	8769	32599	47227	27207	100146	54017	35976
2017	64240	6334	8507	30137	45407	24323	94377	51741	32830
2018	62923	5816	7724	29100	39684	21742	92023	45500	29466
2019	57514	6642	7776	25137	35354	21552	82651	41996	29328

may occur for two reasons: first, a reduction in the number of intercity passengers due to reduced financial capacity and, consequently, a reduction in the general willingness to travel; secondly, a shift in the tendency of passengers from using public toward private modes of transport. The development of remedial strategies to increase the modal share of public transport requires identifying the main variables affecting the utility of the public transport system. This is to be carried out through extensive interviews, stakeholder surveys, information analysis, and the classification of variables using a rotary analysis and a fuzzy AHP approach. Passengers in all major rural bus terminals in the country (i.e., 20 terminals), accounting for 85% of total passengers, were randomly selected for the interviews.

The fuzzy pairwise comparison was applied due to its good adaptability with the data of the study and the way they were collected. The rotary analysis was also performed to complete the study using a method based on a programming language that readily makes complex calculations and can be suggested as an experience for future studies on rural road transport. It is worth noting that the users' opinions were collected, compared, and verified in three different sections, including rotary pairwise comparison, qualitative assessment, and word cloud.

The study was completed by fuzzy rotary classifying the opinions, words cloud analyzing the users' behavior, constructing a multivariate linear estimation model of the number of rural passengers and identifying an effective solution that can remarkably impact the share of rural public transport.

2. Literature Review

Analyzing the factors influencing the choice of transport and determining its utility leads to identifying the people who are attracted to each mode of transport and meeting the needs of each individual based on the utility of those transport modes. The choice of transport in intercity travels depends on many factors, and this diversity is due to the commercial differences between different modes of transportation, the heterogeneity of their passengers, and using them for modeling and evaluation.

When expressing their opinions, public transport users generally consider their immediate needs rather than the total utility of the transport system. Using the previous empirical criteria, Hoque et al. (2021) [2] indicated that traffic forecasters used their set of values in expressing their opinions. A goal of inquiries from users is to identify the issues of different parts of a transportation system. In this regard, Jafino (2021) [3] sought to identify parts of a network based on utilitarianism. In this framework, two main ideas were investigated: calculation of the transport demand with balanced weights and balance of users in the network. Jafino et al. (2020) [4] stated that the importance of using the opinions of transportation users to support decision-making is increasing, while the principle of balanced distribution resulting from ethical analyses is still applied minimally.

The way passengers value the waiting time and the access quality are among the crucial factors determining the desirability of a public transport system. Instead of conducting a face-to-face survey of passengers, Yap and Cats (2021) [5] investigated the behavior of passengers who denied boarding and their alternative decisions. The competitive evaluation of public transport operators from the users' perspective is of great importance to identify the supply improvement methods. Mo (2021) [6] assessed the competitive approach and a system's performance from four stakeholders' perspectives, including automatic vehicle operators, public transportation operators, passengers, and the transport authority. Introducing the required data and the processing stages, Hörl and Balac (2021) [7] studied a sample of repeatable travel demand for Paris and the suburbs to develop a general design. There are several contradictory approaches, such as the users' needs against the system's performance and goals (e.g., increasing the spatial coverage and increasing the frequency) for the redesign of public transport networks. Weckström (2021) [8] provided a multidimensional navigability approach from the users' perspective.

With the development of social media, we should investigate whether we can access reliable data through them to meet the information needs of public transport. According to studies, this approach has had good results in some routes, but on a large scale like within a country, comprehensive data cannot be accessed given the governmental restrictions. Sala et al. (2021) [9] questioned whether it was possible to extract reliable data on passenger travels from the content of social media (Twitter) to design bus routes in areas around cities. The information was tested for a great musical event in Barcelona, and an acceptable image of supply distribution was suggested. In a similar way, Yao (2021) [10] analyzed the information of twits regarding the sleep/wake status, local events, and planned traffic incidents of each day to describe the traffic of the morning in next day in 53 road segments of Pittsburgh.

Despite the unprecedented volume and variety of displacement data, origin-destination (OD) matrices are still the widest tools for organizing and expressing travel demand. Ballis and Dimitriou (2020) [11] stated that standard ODs could not fully demonstrate the factors affecting travel behavior, such as trip interdependency and trip chaining. They suggested considering home-based trip chains, and consequently, activity schedules in studying personal mobility. Khan et al. (2021) [12] reported increasing the attractiveness of public transport as a necessity for sustainable systems and mentioned a lack of empirical research to analyze how to do so. Santos and *Lima* (2021) [13] evaluated the public transport quality indicators and their performance concerning the users' opinions based on a multicriteria approach.

Fournier et al. (2021) [14] performed a survey of passengers regarding heterogeneous values, which resulted in a computational model for policy-making in determining the transportation price. Transportation based on managed demand can potentially raise the desirability of public travel. Kucharski and Cats (2020) [15] identified a combination of compatible trips, which remain attractive by replacing travel with private cars. They achieved a formulation that obtains optimum time value among prices, delays, and dissatisfactions. Developing and verifying a questionnaire, Deb et al. (2017) [16] analyzed the acceptance level of fully self-driving vehicles. The outcomes revealed that men and the youth residing in cities were more open to changes. Jokubauskaite et al. (2019) [17] investigated different trips and the weights allocated to them and found a framework to develop numerous trips.

Popović et al. (2018) [18] presented a satisfactory road transport system in the European Transport Committee based on the domestic market, fair competition, the realization of workers' rights, the implementation of decarbonization policies, using digital technologies in passenger transport in accordance with the principles of transport, sustainable transfers in cities, and fare and payment modes. Augustin et al. (2017) [19] investigated intercity buses in Germany and Italy based on a number of performance indicators, such as the travel company's development policies, the ticket prices, the frequency of service per day, the type of vehicles, and competitive indicators. Solak (2016) [20] evaluated the effects of the rules and policies of suburban road transport in Turkey as a platform for attracting more passengers, and they provided a structure to expand the contribution of public road transport. Afandizadeh and Safari (2020) [21] presented a set of models developed using clustering methods based on departure time.

The requirements for the intercity bus system are presented in the TCRP-79 (2019) [22] Report and used as a reference, the original version of which was published in 2002. This report addresses the issue of intercity buses in three sections. The first section deals with the requirements for developing intercity bus systems, related industries, and investment issues in this area. The second section presents a number of system improvement strategies in the form of planning, the establishment of affiliated branches, marketing, and the development of service facilities, smart equipment, and related items. The final section involves field studies carried out in different states to improve the system. The Interregional Travel Guide (2016) [23] discusses the topics related to passengers in suburban trips; however, these topics are not limited to the road system. This guide is important for providing a unified structure for developing benchmarks, gathering information, and providing an analytical tool.

Brzeziński et al. (2018) [24] analyzed the possibility of utilizing high-efficiency means of transportation in transportation companies as one of the most important ways to achieve a competitive advantage. This point is especially important in the passenger transport services market in large areas, because, in addition to the economic dimension, this also involves a social aspect. It should be noted that their study focused on groups of passenger transport vehicles. Wang et al. (2020) [25] argued that the rapid construction and development of existing high-speed rail (HSR) lines in China had increased the convenience of this mode of transportation and attracted passengers from other modes of transportation. Yan et al. (2021) [26] stated that the rapid growth in demand for intercity travel had put significant pressure on passenger transport networks in various countries. Wang et al. (2020) [27] evaluated the inevitable transfer in a multimode public transport network, and while confirming it, they explored the planning and management for an efficient transmission network and identified the needs that would lead to understanding the factors of these transfers. Paudel (2021) [28] considered the relationship between congestion and the quality of services in transportation systems as one of the concerns of citizens, planners, transportation managers, and passengers.

3. Methodology

In order for an inquiry, the first step is to determine the size of the needed sample for meaningful analyses. According to the annual statistics recorded by the Road Maintenance and Transportation Organization of Iran (2019) [29], more than 85% of intercity passengers travel through 20 main terminals. Equation (1) was used to determine the number of samples required in the mentioned terminals (Transit Capacity and Quality of Service Manual, 2013) [30].

$$N = \left| \frac{z_{1-\alpha/2}^2 p(p-1)}{d^2} \right|, \tag{1}$$

where Nis the adequate number of passengers, $z^2_{1-(\alpha/2)}$ is the normal distribution at the confidence level of α% ($z^2_{1-(\alpha/2)} = 1.96$ based on the confidence level of 95%), P is the distribution percentage ($p = 0.5$), and d is the acceptable error ($d = 0.5$).

In order to analyze the opinions of stakeholders of road transport, a questionnaire was designed, a part of which represented pairwise comparisons, while the variables required for rotary analysis were included in its hidden layer. The questionnaire was given to technical experts, office managers, representatives of the union, drivers, and passengers of carriers throughout the country, and they were asked to fill it in a given time.

In the first section of the questionnaire, aimed at the pairwise comparison, the respondents were asked to give scores to each of the determined indicators based on the developed questions. In the second section of the questionnaire, entitled quality assessment, the respondents were requested to express their qualitative opinions on road transport infrastructures and services to indicate their satisfaction with the system in the intended sample, according to the variables expressed and the separated provincial socioeconomic data of the National Statistics Center of Iran [31] and the Ministry of Roads and Urban Development of Iran [1, 29]; a suitable multivariate linear estimation model of the number of suburban passengers can be constructed. In the third section, the participants were asked to give their solutions to increase the share of public road transport in passenger transportation in the form of general and brief opinions. A statistical analysis program adaptable with the analytic features of Excel (XLSTAT) was employed to analyze the keywords, and the results were displayed using the word cloud method. This method was effective in identifying the frequency and similarity of opinions from the participants' responses.

Regarding the first section of the questionnaire, since the studied indicators were returned from micro-level to macro-level and vice versa, their direct pairwise comparison indicates a linear curve with frequent breaks while paving the path for a back-analysis. Therefore, in order to classify the indicators, the questions were asked from the participants in the form of pairwise comparison to identify the bilinear and hidden effective level and, accordingly, perform the ultimate classification through rotary analysis (using the R statistical programming language) and introduce the output of the classification as the input to the pairwise comparison weighting through fuzzy AHP. It is worth noting that rotary analysis is a statistical method that uses the studied data in the analysis of the same data and paves the path for the evaluation of other data from the same class concerning their nature. That is why it is called rotary analysis. In the first phase of classification, the concentration density of respondents on the performance levels of indicators is investigated. As can be seen in (2), by using the power cosine distribution function, the classification of the concentration of respondents on the performance levels of indicators can be shown in Figure 1.

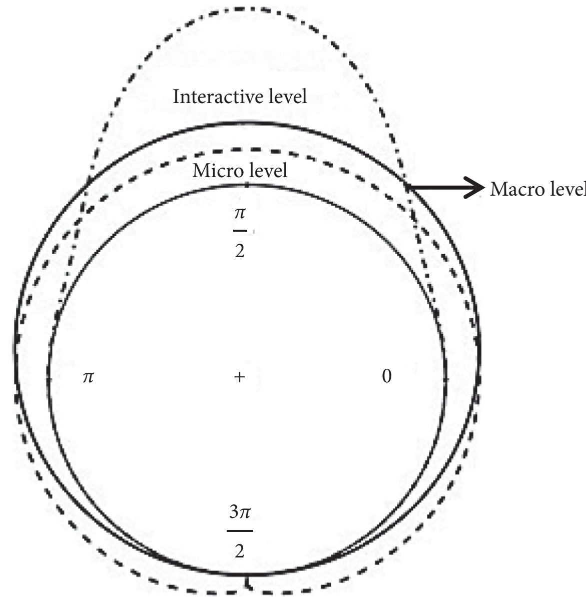

Figure 1: The classification of indicator levels using cosine power distribution.

$$f(\theta) = \frac{2^{-1+1/\zeta}\Gamma^2(1+1/\zeta)}{\pi\Gamma(1+2/\zeta)}(1+\cos(\theta-\mu))^{1/\zeta}. \quad (2)$$

After determining the density of concentration on levels, the indicators are classified to be weighted regardless of their performance levels. According to equation (3), using the von Mises density distribution function and based on the concentration density, the classification levels of indicators can also be determined and displayed. Circular statistics in R (2014) [32]:

$$f(\theta) = \frac{1}{2\pi I_0(\kappa)}e^{\kappa\cos(\theta-\mu)}, I_p(\kappa) = \frac{1}{2\pi}\int_0^{2\pi}\cos p\theta e^{\kappa\cos(\theta)}d\theta. \quad (3)$$

In the next step, by performing the fuzzy hierarchical analysis, the weights of indicators in each class can be determined. Given the advantages of the fuzzy (AHP) hierarchical analysis in reflecting the experts' opinions, this method was employed to weight and analyze the participants' answers in the form of linguistic preferences from equal importance to completely more important and within three fuzzy spectra of the lower, middle, and upper limits. The participants had to score their opinions from 1 to 9, and from 1/2 to 1/9 (reverse structure) in the form of pairwise comparison.

Regarding the numerical representation of fuzzy expressions, it is suggested that a fuzzy number may be expressed as a triangle or a trapezoid. In the triangular case, the corresponding number is displayed as $M = (a, b, c)$, where a, b, and c represent the lowest possible value, the most probable value, and the maximum possible value for the desired number, respectively, and the desired number can be between a and c. The fuzzy hierarchical analysis was conducted in the study according to the method suggested by Wang (2008) [33] as follows:

The first step: plotting the hierarchy curve.

In any multicriteria analysis, plotting the hierarchy curve (decision tree) is one of the first and of course important steps. Because it is the goal after plotting this curve, the structure of the hierarchy of indicators and subindicators and the options are clearly defined. In principle, even before designing a fuzzy AHP questionnaire, the decision hierarchy plan must first be determined.

The second step: defining the fuzzy numbers to make pairwise comparisons.

In this stage, it is necessary to define the fuzzy numbers that are needed to make pairwise comparisons, so that experts can provide their answers accordingly. These numbers are already listed in Table 2.

The third step: creating the pairwise comparison matrix using fuzzy numbers.

At this step, the questionnaires have been provided to the experts, and they have answered them. Therefore, in this step, the matrix of pairwise comparisons containing fuzzy numbers is prepared.

The fourth step: calculating matrix S for each row of the pairwise comparison matrix.

The S are triangular fuzzy numbers calculated from the following equation:

$$\widetilde{S}_i = \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j} \times \left(\sum_{i=1}^{n} \sum_{j=1}^{m} \widetilde{M}_{g_i}^{j} \right)^{-1}, \tag{4}$$

in which M denotes the triangular fuzzy numbers inside the pairwise comparison matrix. In fact, when calculating the matrix S, components of fuzzy numbers are added peer to peer and multiplied by the total inverse fuzzy sum. This step is similar to calculating the normalized weights in the ordinary AHP but with fuzzy numbers.

The fifth step: calculating the relative magnitude of Sis.

In this step, Sis are compared with respect to their magnitude based on the equation (5) and Figure 2:

$$V\left(M_2 \geq M_1\right) = hgt\left(M_1 \cap M_2\right) = \mu_{M_2}(d) = \begin{cases} 1, & \text{if } m_2 \geq m_1, \\ 0, & \text{if } l_1 \geq u_2, \\ \dfrac{l_1 - u_2}{\left(m_2 - u_2\right) - \left(m_1 - l_1\right)}, & \text{otherwise,} \end{cases} \tag{5}$$

From the equation above,

$$M_2 = \left(l_2, m_2, u_2\right), M_1 = \left(l_1, m_1, u_1\right). \tag{6}$$

The sixth step: calculating the weights of criteria and options in pairwise comparison matrices.

In this step, the unnormalized weight vector is obtained by finding the lowest value of the calculated Vs in the previous step.

The seventh step: calculating the ultimate weight vector.

In the last step, the weight vector obtained in the previous step is normalized to achieve the ultimate weight vector as the goal of fuzzy computations.

4. Data Description

The studied data were defined in three sections. In the first section, with the goal of pairwise comparison of indicators, the respondents were asked to give scores to each of the determined indicators based on the designed questions.

(i) Dynamics of incentive policies: This variable indicates whether the policies considered at the macro-level to develop a public road transport system are up-to-date or not.

(ii) Traffic performance of the system: This variable denotes the performance of the road transport system, including its infrastructures and executive tools. Therefore, it involves the performance and function of some cases, such as the qualitative level of roads, terminals, buses, minibuses, and road taxis.

(iii) System coverage: This variable represents the coverage level of the public road transport fleet by the whole origin-destination pairs of the country.

(iv) System integrity: It denotes the function and interaction of different modes of public road transport and the performance of the related executive organizations with each other.

(v) Safety: It indicates the safety level of the public road transport system.

(vi) Environment: This variable represents the indicators associated with the environment, especially air pollution, regarding the road transport system.

(vii) Trip time: It indicates the condition and quality of choosing the public road transport mode concerning trip time.

(viii) Resting services: It indicates the quality of resting services regarding the public road transport infrastructures, such as terminals and roadhouses.

(ix) Smart systems: This variable indicates the effect of using smart systems in attracting passengers and the way they are employed in the current condition of the public road transport system.

Table 2: Fuzzy spectrum corresponding to linguistic preferences.

Linguistic preferences	Importance	Low limit (L)	Midline (M)	High limit (U)
Equal preference	1	1	1	1
Preference lower than medium	2	1	2	3
Medium preference	3	2	3	4
Medium preference to high	4	3	4	5
High preference	5	4	5	6
High preference to very high	6	5	6	7
Very high preference	7	6	7	8
Very high preference to completely high	8	7	8	9
Completely high preference	9	8	9	10

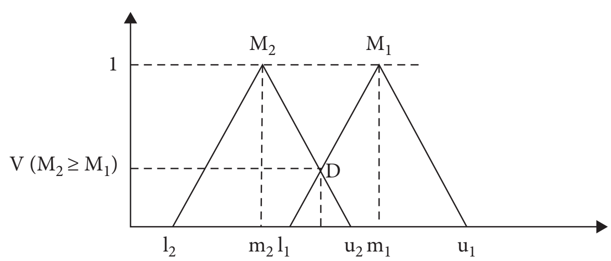

Figure 2: Pairwise comparison of triangular fuzzy numbers.

In the second section of the questionnaire, the qualitative opinions of the participants on the road transport infrastructures and services were received to identify the level of satisfaction with the system.

In the third section of the questionnaire, the respondents' opinions were obtained in the form of solutions to increase the share of public road transport in transferring the passengers.

Given the existing limitations, the inquiries were made from the passengers in four successive days from 2019 to 02-12 to 2019-02-15. The surveys in the West, East, South, and Beyhaghi Terminals of Tehran (the commercial and administrative center of Iran) were made face-to-face. Meanwhile, the coordinated representatives performed the surveys in the other 20 terminals selected (Tabriz Central Bus Terminal, Kaveh Bus Terminal in Isfahan, Shahid Kalantari Bus Terminal in Karaj, Bushehr Bus Terminal, Imam Reza Bus Terminal in Mashhad, Siahat Bus Terminal in Ahvaz, Enqelab Bus Terminal in Zahedan, Shahid Karandish Bus Terminal in Shiraz, Azadegan Bus Terminal in Qazvin, Qom Bus Terminal, Shahid Kaviani Bus Terminal in Kermanshah, Eastern Borujerd Bus Terminal, Sari State Bus Terminal, Persian Gulf Bus Terminal in Bandarabbas, Hamedan Bus Terminal, and Yazd Bus Terminal) during the same period. A total of 330 samples, including 114 passengers, 63 drivers, 32 members of passenger unions, and 21 traffic experts, were selected and surveyed. Of the participants, 45% had B.Sc. Degrees, and 29% had M.Sc. or higher degrees. The experts, separated by expertise and management levels, were selected, such that all levels (from associate to Ph.D. degrees) were covered. The passengers were chosen randomly, and the drivers were selected according to their vehicles and working hours.

5. Results and Discussion

This study aims to replace the traditional methods of attracting passengers to the public road transport system with scientific techniques and identify effective solutions to increase the share of this transportation mode with the aid of the users' opinions. It should be noted that the efficiency of social networking services, especially on regional and local scales, has been recognized based on the studies by Sala et al. (2021) [9] and Yao (2021) [10]. However, given the filtering of such tools as Twitter and Telegram in Iran, and the national scale of this study, using questionnaires seems to be still more efficient unless the conditions change. The study by Ballis and Dimitriou (2020) [11] had a similar suggestion.

5.1. Evaluation of the Information regarding the First Section of the Questionnaire: Pairwise Comparison of the Indicators.

Table 3 lists the classification results of the indicators used in this study for policy-making in road transport to increase its share in micro- and macro-levels using the indicators effective in the desirability of public road transport system and the power cosine distribution function.

The classification of the concentration of respondents on the performance levels of indicators revealed that they had equal comparisons in the micro- and macro-levels. However, regarding the indicators with conflicting levels, they expressed different opinions, proving the performance power of these indicators (e.g., safety, environment, and system coverage). It also revealed that the respondents had properly separated the micro- and macro-levels and had not positioned them in one analytical field.

After determining the concentration density on levels, the indicators should be classified to be weighted regardless of their performance levels. According to equation (3), by using the von Mises density distribution function and based on the concentration density, the levels of indicators were divided into two groups, one with five indicators and the other with four indicators, as shown in Table 4. As can be seen in Figure 3, four indicators are grouped and shown by dashes, and four other indicators are in another group shown by dots. Another indicator (shown by a solid line), positioned between the two groups, is classified in the group shown by dots given its shorter polar distance with them.

Table 3: Indicators affecting the utility of the public rural road transport system.

Effective indicators	Micro-level	Macro-level
The dynamics of incentive policies		✓
System traffic performance	✓	
System coverage	✓	✓
System integrity	✓	
Safety	✓	✓
The environment	✓	✓
Time of trip	✓	
Resting services	✓	
Smart systems	✓	

Table 4: Classification of indicators based on rotational analysis.

First category	Second category
The dynamics of incentive policies	System traffic performance
System coverage	Safety
System integrity	Time of trip
The environment	Smart systems
Resting services	—

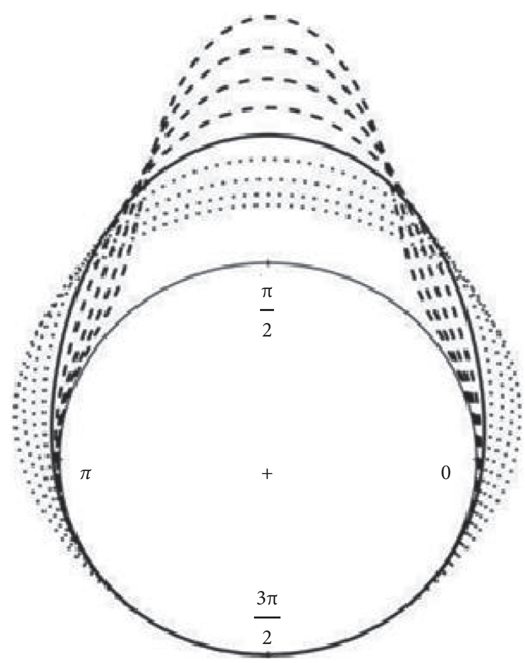

Figure 3: Functional classification of indicators for weighting.

In the next step, regarding the defined classification, the weights of indicators in each class were determined by performing the fuzzy hierarchical analysis. Table 5 provides the ultimate results of the stakeholders' opinions.

According to the statistics published in the World Bank Report on Iran (2016) [34] and National Statistics Center (2019) [31], the main competitor of public road trips is trips by private cars, and rail and air transport methods have no great potential due to their improper infrastructures in Iran. This issue, along with the high importance of safety in trips reported by the users given the high rate of road accidents in Iran, indicates the necessity to improve the safety of public trips. Moreover, according to the Office of Transportation Planning and Economics (2017) [35], public trips are safer than private ones. The delays, dissatisfactions, and optimum time value formulation introduced by Kucharski and Cats (2020) [15] are different from the obtained results. The reason is that the users in Iran pay attention to the high rate of road accidents and underestimate the importance of the environment, smart systems, and trip time, which can be expected from the users in a developing country like Iran. It seems that the concern of Iranian users over safety influences important indicators like trip time mentioned in other studies.

Table 5: Results of weighting the indicators.

The first category	Weight 0.43	The second category	Weight 0.57
Indicator	Weight	Indicator	Weight
The dynamics of incentive policies	0.27	Safety	0.39
Resting services	0.21	System traffic performance	0.26
System coverage	0.19	Time of travel	0.19
System integrity	0.18	Smart systems	0.16
The environment	0.15	—	—

5.2. Evaluation of the Information regarding the Second Section of the Questionnaire. In the second section, six questions were asked to evaluate the quality of the current road transport infrastructures and services. The following provides each question, along with the answers given to it:

(i) The first question: What is your evaluation of the status of the country's roads regarding infrastructures?

Of the participants, 51% described the status of the country's roads as weak in terms of infrastructures. Moreover, 43% gave a good score, and 6% gave an excellent score to the road infrastructures of the country. Given the undeveloped infrastructures of Iran according to the Plan and Budget Organization (2015) [36], the similarity of the users' opinions with the multidimensional attitude of Weckström (2021) [8] and Jafino et al. (2020) [4] indicates the low expectations of the Iranian users.

(ii) The second question: What is your evaluation of the status of the country's roads regarding safety?

Of the respondents, 69% stated that the country's roads had weak safety. Moreover, 26% gave a good score, and 5% gave an excellent score to the safety of the country's roads. Hörl and Balac (2021) [7] mentioned the role of safety in repeatable trips, which can help identify a solution in the current study.

(iii) The third question: What is your evaluation of the services provided by the carriers?

Fifty-one percent of the participants described the services provided by carriers as good. In addition, 40% gave a weak score, and 9% gave an excellent score to the state of their services. The responses to this question have a good agreement with the condition of the carriers that provide services to the users.

(iv) The fourth question: What is your evaluation of the status of passenger terminals regarding their provided services and construction quality?

Of the whole participants, 61% stated that the passenger terminals had good performance regarding their provided services and construction quality. Furthermore, 37% gave a weak score, and 2% gave an excellent score to the state of the services provided by them. The relative satisfaction of the users can indicate the potential to attract more passengers to the public transport system. Mo (2021) [6] mentioned this competitive attitude.

(v) The fifth question: What is your evaluation of the access to passenger terminals?

Sixty-nine percent of the respondents described the condition of access to passenger terminals as good. Meanwhile, 28% gave a weak score, and 3% gave an excellent score to this variable. According to Fournier et al. (2021) [14], it can be realized that the users are relatively satisfied with the access costs.

(vi) The sixth question: In your idea, to what extent do carriers have delays?

Of the respondents, 52% stated that the carriers have a good performance regarding the probable delays. However, 47% gave a weak score, and only 1% gave an excellent score to this variable of the carriers. Although the valuation of the passengers to the delay time has no conflict with the results of Yap and Cats (2021) [5], the Iranian users do not give the delay in trips the importance that they should, due to the lack of fast access systems like subways to most terminals of the country. This issue is more analyzed in the fourth part of this section.

Based on the questions asked and statistics information, a multivariate linear estimation model of the number of rural passengers can be constructed. This model helps measure the impact of changes in different sectors on passenger volume in order to apply appropriate strategies accordingly.

Regarding the bus passenger estimation model, according to the variables expressed and the separated provincial socio-economic data of the National Statistics

Table 6: Results of constructing the bus passenger estimator model in rural trips.

Variables name	Coefficient	t-test	Variables	Coefficient	t-test
1Age	3.13e−2	2.64	11Number of transportation companies	2.34e−5	2.76
2Employment rate	0.231	−2.32	12Number of buses	1.73e−2	3.45
3Family size	0.103	2.23	13Bus age	4.33e−3	−3.23
4Gender composition	2.234	−2.63	14Number of resting complexes	5.97e−5	2.43
5Per capita car ownership	4.25e−2	−3.65	15Freeway and highway length	4.61e−2	3.44
6Level of education	2.67e−5	−2.28	16The length of the arterial pathways	2.27e−4	2.23
7Economic strength of the household	2.43e−2	−3.29	17Waiting time (delay)	4.83e−2	−3.88
8Travel expenses	2.11e−3	−4.12	18Access	5.69e−3	4.45
9The purpose of the trip	6.25e−2	3.75	19Fixed model	0.37	2.23
10Number of accidents (killed)	1.78e−4	−2.89			

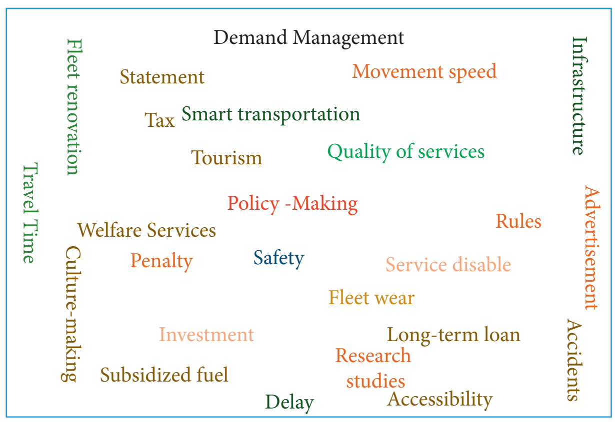

Figure 4: Word cloud map for the answers of the respondents to the questionnaire.

Center of Iran [31] and the Ministry of Roads and Urban Development of Iran [1] [29], the estimated volume of rural bus passengers is as follows:

$$\begin{aligned} U_{Bus} = {} & \overline{\beta_1} \times v1 - \overline{\beta_2} \times v2 + \overline{\beta_3} \times v3 - \overline{\beta_4} \times v4 - \overline{\beta_5} \times v5 - \overline{\beta_6} \times v6 - \overline{\beta_7} \times v7 - \overline{\beta_8} \times v8 \\ & + \overline{\beta_9} \times v9 - \overline{\beta_{10}} \times v10 + \overline{\beta_{11}} \times v11 - \overline{\beta_{12}} \times v12 + \overline{\beta_{13}} \times v13 + \overline{\beta_{14}} \times v14 + \overline{\beta_{15}} \times v15 \\ & + \overline{\beta_{16}} \times v16 - \overline{\beta_{17}} \times v17 + \overline{\beta_{18}} \times v18 + \overline{\beta_{19}} \times v19 + C_i + \varepsilon_i. \end{aligned} \tag{7}$$

This model is made using data from 2008 to 2019. The results of the model construction and names are presented in Table 6.

5.3. Evaluation of the Stakeholders' Responses in the Words Cloud Section. In the third section of the questionnaire, the users were requested to express their opinions about the short-term and long-term solutions and programs to increase the share of public road transport in the transportation of passengers in the form of separate items. Figure 4 demonstrates the obtained word cloud, which indicates the concentration of the suggestions.

The suggested solutions focus on policy-making, trip time optimization, safety level improvement, and quality of services. The other keywords extracted from the suggestions can also be seen in the figure. The opinions are depicted either horizontally or vertically, given the small space of the figure. The larger thickness of the text for an indicator represents its more repetitions.

As can be seen, the results of this section agree with those of the two previous sections. The users preferred their personal benefits to the system, as stated by Hoque et al. (2021) [2], and the utilitarianism principle of Jafino (2021) [3] is also observed. In this section, the users paid slightly lower attention to safety and gave more importance to management issues, such as trip time and quality of services. The difference between the results of this section indicates the importance of the surveying method and the fact that the type of questions can lead to the answers. This can be one of the reasons to consider the data of social networks as a supporting factor.

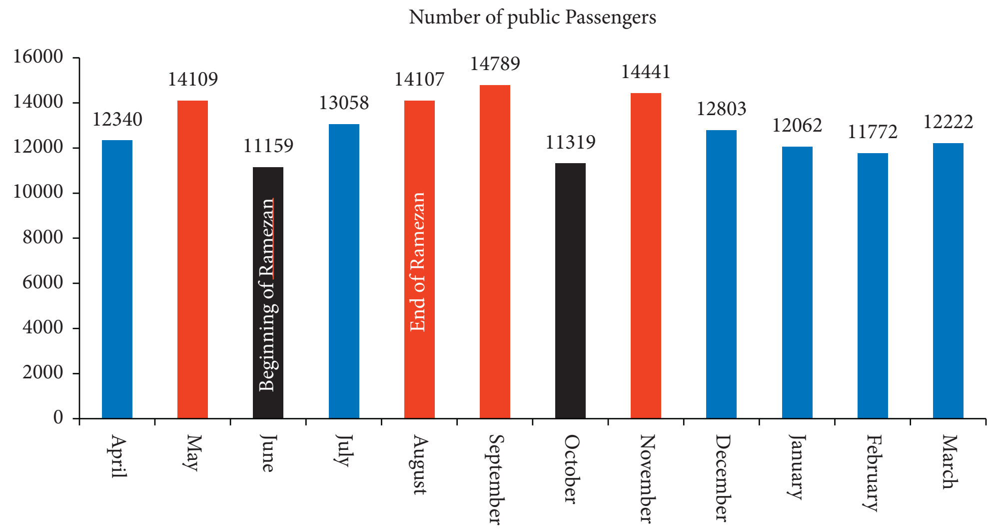

Figure 5: The bar graph of the number of public passengers (thousand) in different months of 2019.

5.4. Integrated Analysis of the Stakeholders' Answers. In order to draw a conclusion from the users' responses, the travel status of the passengers in the rural public transport system during different months of a year is investigated. Figure 5 demonstrates the travels of passengers in 2019. May, August, September, and November have the highest number of public travels.

The least travels have occurred in June due to the beginning of Ramadan and October due to the reopening of the schools and universities. The relative agreement between Figures 5 and 6 indicates that the most travels occur in summer and the months with more holidays, but the goals of trips in these months should also be studied.

According to Figure 5, in each month, on average, 12831 thousand passengers are transferred by the public transport system of the country. Meanwhile, according to the annual report of the Road Maintenance and Transportation Organization (2019), a large portion of travels, especially on holidays, take place with private cars (4% with buses and minibuses, and 2% with automobiles). Based on the origin-destination report of the country (2016), most of the travels by bus have occupational (42%) and educational (19%) objectives. Accordingly, of the total monthly travels, 5389 thousand have occupational objectives. A glance at the answers given to the question concerning the delay in travels and performance of terminals reveals that while a large portion of travels happen with occupational objectives, the users have no considerable sensitivity to delays and performance of passenger terminals.

Moreover, according to the data of the geographic information system of industrial towns and areas of Iran (2018) [31], the average distance between industrial towns and cities is 30 km, as shown in Figure 7. On the other hand, almost 41700 industrial and manufacturing units are active in the industrial towns of the country, in which 729 thousand people work. With an average of 25 working days per month, there is a potential for 36450 thousand travels, 15% of which have been attracted to public transport. The low share of public business travels from the total potential working travels in the country can be attributed to the indifference of existing users to the

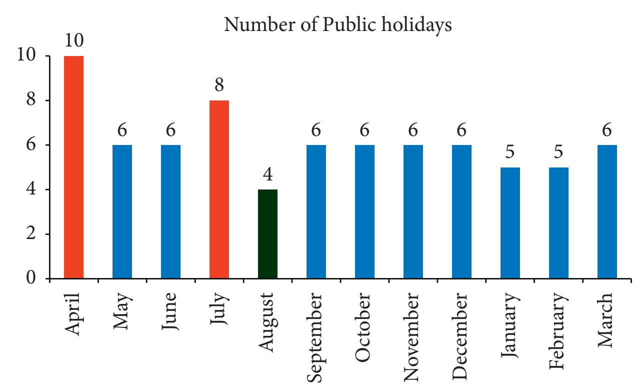

Figure 6: Number of public holidays in each month of 2019.

Figure 7: Location of industrial towns.

coverage and integrity of the system and the quality of the rural road infrastructures.

6. Conclusions

The dynamics of incentive policies in the first class and safety in the second class have greater weights, as an indicator of the macro-level and an indicator of the interactive level, respectively, which are along each other according to the rotary analysis. Thus, the weighting results indicate that the dynamics of incentive policies and policy-making with a focus on safety can highly influence the micro- and macro-level indicators to increase the share of public road transport.

In the first class, following the dynamics of incentive policies, the coverage and integrity of the system have, respectively, greater weights. Regarding the comparison with the opinions of the users in the second section and the 50% satisfaction with the infrastructures, in this class, the users prioritize development and incentive policies to complete the existing network rather than constructing new roads. Almost 70% of the respondents have described safety as weak, indicating the correct weight of this indicator in the second class of the first section of the questionnaire. The satisfaction with passenger terminals (61%) and with access to them (69%), along with the relative satisfaction with the infrastructures, can indicate the potential to attract more passengers in the existing conditions. The only risk leading to the undesirability of this method is the strong belief of the users in the lack of safety in the system. This shows the importance of focusing on making society aware of the higher safety of public travels compared to private ones, as well as trips with short distances to attract passengers in the short term.

In the word cloud section, safety was mentioned after trip time and services, but there is an acceptable agreement with the weights obtained in the first section overall. The access and incentive policies were again emphasized, while the users still did not pay attention to smart transportation. Regarding the delay in trips and satisfaction with carriers, some differences can be observed between the classifications and opinions of users, which is due to the large portion of business travels and can be more analyzed in future studies. The passengers with occupational objectives, who travel for work, have a small share among the total intercity passengers, including public and private transport. Meanwhile, this small share makes up 40% of the public travels of the country. This is the reason for the lower attention of Iranian users to delays and the role of passenger terminals in increasing the desirability of rural public road travels.

By increasing the costs of business travels with private cars in short rural distances through interactions with industrial towns and providing these areas with special services, the finances of public transport can be improved, and the potential to make the number of rural public travels six times larger can be realized. Establishing carriers in industrial towns and encouraging their workers to use public transport, creating smart mechanisms to provide special facilities in this field (e.g., timing and ticket applications), offering special discounts, providing VIP services for managers of workshops and factories to promote using this system, coordination with managers of towns in macro-levels to impose restrictions on the passage of private cars, i.e., increasing the performance costs of this system, are all appropriate solutions that further activate the public rural transport system in this field and effectively increase public travels.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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