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Transit-Oriented Development in Medium Cities, A User`s Viewpoint; A Case Study: Kermanshah

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ABSTRACT: Population growth within the cities has challenged the transportation network, making it crucial to pay special attention to the development of rail transportation. Additionally, in suburban areas and areas with poor transportation services, it is difficult to provide services such as the fire department, emergency services, security, and so on. The present research is an analysis on the economic, social, and transportation factors affecting transport development. A questionnaire was compiled. In the first part of this questionnaire, descriptive statistics were analyzed. The conducted surveys and analysis of the questionnaires, based on structural equations, show the need for an integrated developer transport that has the appropriate amenities and desirable services, including a clear understanding of the city under study. The results clearly indicate that all three transportation, social, and economic variables have a decisive role in public transport development. Despite good correlation among these factors, the parameters involved in the transportation variable have shown to have the greatest impact, with a 0.864 Pearson correlation factor; this factor in economics and social variables is almost 0.76. The results also showed the willingness of people to live and mix with applications near the railway station. Additionally, the user accepts the strategic investments to improve the transport situation and have a sustainable city.

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1- Introduction

Transport researchers have always been interested in moving goods and people in the shortest possible time, at the lowest cost, and with the highest safety. With increasing urban population growth and society's growing need for a dynamic and efficient transportation system, researchers have focused on combining transportation and land use. One of the most evolved views on urban development is transit-oriented development (TOD). Peter Calthorpe developed TOD in the late 1980s and presented it as a cornerstone of modern planning for the "New American Metropolis" in 1993. According to its definition, the purpose of this approach is generally to mix land uses and encourage people to live near transport services to reduce their dependence on cars [1].

Calthorpe views TOD as a simple and understandable solution for regional growth, as well as a way for transport companies to find alternative revenue sources. TOD is an evolving development model focused on areas in the vicinity of high-frequency transportation. Arrington and Cervero suggested TOD as a way to increase the number of public transport passengers [2]. In fact, TOD is a model for transportation and user integration in many rapidly developing cities, including those in Asia [3]. TOD is not only about promoting transportation but also encourages walking and biking within a secure network, which leads to safer roads, reduced pollution, and healthier cities [4]. Additionally, this method contributes to the welfare of citizens by potentially increasing fares and spending on the improvement of transportation facilities. One of the most important goals of this approach is to find a solution to improve land use and transport efficiency [5].

In many medium-sized cities, with populations between half a million and one million people and areas less than 100 square kilometers, there is no particular integrated transport system, especially in developing countries. An integrated transport system typically consists of buses, trains, trams, metro systems, bicycles, and pedestrian pathways, often supported by digital technologies like real-time information systems and integrated ticketing. Perhaps for various reasons, the need for these systems is not clear to these cities, and therefore, such systems have not been developed there. For example, in Kermanshah, bus scheduling and fleet allocation to various lines are not clear or regular.

In this research, the factors influencing the development of transport in the three areas of economic, social, and transport were examined from the user's perspective. The relationship between these three domains was examined, and the most important factor was identified. For this opinion, it is assumed that users do not know anything about TOD, and the questions asked are indirectly related to TOD. In this research, by using a Stated Preference (SP) study, an attempt has been made to get users' views on possible changes due to

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Transportation-Oriented Development.

2- Literature Review

TOD is a simple concept that combines dense development and pedestrian-friendly environments near public transport stations. It aims to promote public transportation, increase walking, biking, and other options, as well as reduce the use of personal cars. Economic effects, lack of knowledge, and lack of understanding about its features, benefits, and local effects all constitute design constraints [7, 8, 9]. Three main parameters (density, diversity, and design) affect the success of TOD [10]. Different combinations of land-use patterns around a development site can have important effects on future demand levels. One of the important considerations in transportation is its relation to land use, which is a major contributor to travel behaviors. Such a link is very important in planning and managing a transportation system and has been under consideration for many years [6]. The land-use mixes in TOD aim to reduce dependence on private vehicles. The construction of local sales can solve part of this need, although shopping patterns differ [11].

The type of land pattern and its related variables also affect TOD. Kuby et al. (2004) and Gustavo and colleagues (2014) considered the number of people employed and population as land-use variables. These two variables are equally related to walking distance, and all of them are significantly related to urban light rail systems [12, 13]. TOD aims to reduce traffic levels and transfer passengers from personal cars and roads to predicted lines and integrated public transport systems. Creating TODs near homes reduces traffic and, thereby, promotes the development process [14]. A study conducted for the city of Seoul, South Korea, included the following variables affecting metro demand: employment, business area, administrative area, net population density, number of transfers, bus lines, and a dummy variable. In the regression model, only the commercial area responded significantly to the demand for transport [15].

The expansion of single-family homes increases driving, but this increase is not related to proximity to or distance from stations. The development of residential density reduces driving and vehicle ownership. The use of personal automobiles, their ownership, the type of housing, and its geographic texture have a strong correlation with equal access to the railway station. The availability of parking lots is crucial when assessing the effects of traffic development on transportation. Development projects near transport facilities are often tailored to high congestion and residential ownership [16]. However, in recent years, the factors affecting the number of station passengers were summarized into three categories: economic factors, social factors, and station characteristics. Land use was selected as an environmental factor. Mixing was also studied, and an index was introduced for it [17]. Various factors that influence TOD success include the proper relationship between government and people, and the relationship between government institutions [18].

The role of TOD is a sustainable planning tool that can help compact metro cities. TOD has dramatically increased in India. Among other factors, the popularity of this method in developing countries, such as India, is the issue of subway construction in diverse and densely populated cities. However, considering the impact of TOD on a large number of existing infrastructures, such as roads, is very important. When a policy is considered for this, it is necessary to decide on the vertical development of the city. It is important to limit vertical development during TOD planning to consider the Level of Service (LOS) scheme for roads and subways, even with increasing congestion [19]. Increasing the quality of transportation services increases the attractions for new travelers but, most importantly, benefits the users themselves [20]. The social factor in relation to TOD should also be considered. People who live in luxury homes near stations and have luxury cars do not use transit. TOD provides a good opportunity to buy housing because public transportation becomes available in many ways, and people can more easily become homeowners by eliminating the burden of property ownership [21].

A study in China examined the impact of the built environment on the choice of mode of travel. The results of this study, with the participation of 3318 people, showed that the built environment has significant effects on the use of private cars near public transport stations and also indicate that increasing green cover and promoting various land-use development strategies in Transportation-Based Development Zones (TODs) may help reduce personal vehicle use and encourage low-carbon travel [22].

Final research models aimed at investigating the effect of environmental characteristics of railway stations on travel behavior show that car use is related to land-use diversity and street network design of the station area. The use of transit is highly dependent on the availability of transit and the diversity of land use. And walking is related to transit availability, land-use diversity, and street network design. The weakest effect among the environmental factors of the station area is density. Overall, the station area, with its dense, mixed, walkable, and transportation-friendly environment, motivates residents to walk more and travel less by car [23].

A study in Riyadh, Saudi Arabia, was carried out with the main aim of identifying the environmental, social, and economic benefits of implementing TOD. In this research a mixed-study method was used, and data were collected using a questionnaire survey and semi-structured interviews. These researchers find that TOD in Riyadh City would positively impact economic, environmental, and social aspects. TOD would reduce travel time, allow its people to have an active lifestyle, and reduce congestion [24].

TOD perspective has been studied in a comprehensive review of the equity impacts of urban rail transit (URT) station areas on the built environment, with a particular focus on social, travel, perception, health, and spatial dimensions, and their impacts on promoting or hindering equitable outcomes among diverse societal groups. The results show that URT station areas have positive impacts on economic growth and property values. However, they can also contribute to gentrification, exacerbating disparities between different

societal groups in station and non-station areas, along with an unequal distribution of resources and opportunities. Additionally, while these station areas encourage pedestrian activity and public transportation usage, they also carry the potential for environmental pollution, raising concerns about spatial accessibility and facility convenience, thereby impacting environmental equity [25].

A review article has notably led to the publication of over 300 articles explicitly concerned with TOD in Web of Science journals, as well as to many implementations of the concept, some already completed and others underway. This study aims to provide a comprehensive, systematic, and up-to-date review of TOD research achievements and challenges [26].

A study addresses the TOD investment issue in terms of the location, number, and size of the TOD zones along a rail line. An urban system equilibrium problem with TOD investment was formulated in this study. Two social welfare maximization models, which take into account different investment regimes for TOD projects, are then proposed for optimizing TOD investment schemes along a rail line and train service frequency on that line. The results appreciate that the TOD investment can cause population agglomeration at the TOD zones and a compact city; households and society can benefit from the TOD investment; and the private TOD investment regime outperforms the public regime in terms of total social welfare of urban system [27].

Another study seeks to develop a bicycle-oriented TOD typology that combines indicators related to the cycling environment with traditional land use and transport indicators. Using Montreal, Canada as a case study, 14 indicators are generated to develop a TOD typology oriented on bikeability, and the 114 public station areas are grouped into seven distinct clusters. The results show that the addition of bikeability criteria to the TOD typology helps discriminate the different types of stations based on their current bikeability and bikeability potential. The proposed framework enables identifying and prioritizing targeted interventions to station development [28].

Attitudes Toward Walking to Transit Stations Among TOD Residents This study investigates the attitudes toward walking to transit stations among 249 residents living within 1 km of such stations (referred to as transit-oriented development, or TOD, residents), who are expected to use rail for daily travel. The research employed a two-stage analysis, utilizing factor analysis and a structural equation model, based on responses to 10 attitudinal questions [29].

Another study proposes a novel categorization of Seoul's subway station areas based on rail use characteristics, departing from traditional approaches that primarily focus on land use patterns or urban spatial structures. It argues that the actual use of the subway system by commuters significantly influences and shapes the surrounding land use. To achieve this, the study employs factor analysis to examine rail use patterns across different times of the day and days of the week. Subsequently, a multidimensional scaling method is utilized to establish the relationship between these rail use patterns and existing land use. The findings categorize Seoul's subway station areas into three primary types: residential, commercial and recreational, and office-centered. Notably, the study reveals that many station areas exhibit mixed characteristics of economic activities, a distinction from previous research. These mixed functions include combinations such as residential and commercial, residential and office, commercial and office, and even areas encompassing residential, commercial, and office functions. The research highlights a strong correlation between rail use and land use patterns [30].

3- Methodology

Several studies on TOD have been conducted in large cities and metropolitan areas. But the possibility of using this approach in medium-scale cities has been less noticeable. This study analyzes the factors affecting the failure or success of the TOD approach in medium-sized cities.

In many studies on TOD, many important factors have been considered from the perspective of experts. But in the meantime, the tendencies and perspectives of users of the system have been addressed less directly. Success in urban metropolitan areas largely depends on the needs of citizens and their views. In this study, factors affecting users are categorized into three categories: ***economics***, ***socials***, and ***transportation***. In this study, the role and weight of each of these three factors is examined in the success of the TOD design as well as the improvement of the transport structure.

Kermanshah is the ninth most populous city and a medium city of Iran and the capital of Kermanshah province. With a population of 946,651 people and an area of 93,389,956 square meters (almost 93 square kilometers), the ground distance of Kermanshah to Baghdad, 390 kilometers, to Tehran, 590 kilometers, to the Khosravi border (Iran and Iraq border), about 200 kilometers, and its airspace to Tehran is 413 kilometers. This city is of great importance because it is located at the crossroads of two-axis from north to south and east to west as well as with the neighboring country of Iraq and located on the way to the holy cities of Karbala and Baghdad. Figure 1 shows traffic areas in Kermanshah city.

Kermanshah city has no integrated transport system. Buses do not have a specific timetable, and the lag time and stops are too long. On the other hand, the poor quality of the carriage system is dissatisfying for users. In addition, the geometry and texture of Kermanshah city do not meet passenger demands in terms of the width of the main streets. In this study, the factors affecting TOD were classified, and the impact of each of the factors was examined to obtain user satisfaction with the public transportation system and understand the need to create an integrated transport system. Ultimately, the success or failure of TOD depends largely on government systems, land ownership, and demographics, as these factors greatly affect businesses and people near the transportation station. There are two main limitations in this questionnaire. First, the number of samples and second, the use of the stated preference method. In the stated preference method, this is because some respondents may not have an accurate idea of the subject, and as a result, there is a large standard error.

Table 1. Kermanshah city information (2016)

Number of transit routes	42
Total population	946,651
Total employment	286,651
Auto ownership(approximately)	230,000

Fig. 1. Traffic areas of Kermanshah.

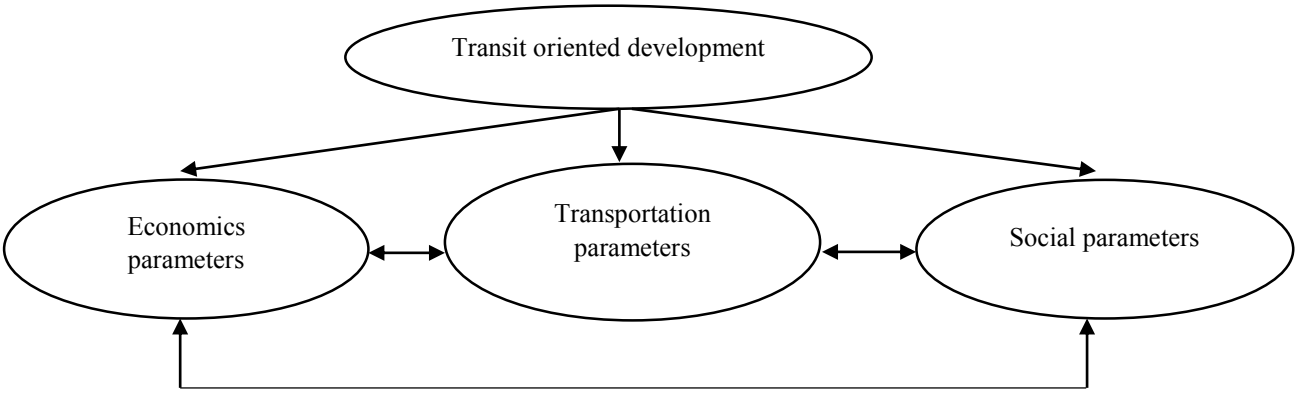

Fig. 2. Conceptual model of this study.

4- Results

The factor analysis model is used to collect and summarize information that accounts for meaning. The factor analysis is divided into exploratory and confirmatory categories. Using the Amos software, the confirmatory factor analysis method was used in this study to validate the structure of the questionnaire. Finally, once the factor analysis was studied, SPSS software version 16 was used to predict critical factors of the hierarchical regression model. Data collection was done using a simple random sampling method. Printed questionnaires were administered by interviewers throughout the city to pedestrians, bus users, and drivers of passenger vehicles. There are 175 acceptable questionnaires in this study from 250 collected data. Figure 2 shows the conceptual model of this study. Due to the existence of many restrictions in the economic and social field (asking many questions from the respondents was very difficult and even invalidated the entire questionnaire), an attempt was made to select impersonal questions and mainly with regard to the supply situation. The socio-economic parameters of the individuals were estimated indirectly. For example, instead of the income factor, the number of cars owned by the household was asked.

In this study, Pearson's coefficient was used to show the degree of correlation of factors related to the transportation system variable. The main research tool and data collection method was a questionnaire, which was researcher-made and consisted of four sections to examine the impact of each transportation and socio-economic variable on the development of the base rail. These four sections included the level of satisfaction with current transportation, and three separate sections included transportation, social, and economic variables. The first section included personal information (age, gender, occupation, education, etc.) and questions related to the subject under study, including (number of trips during the day, separation of vehicles used, how the city's public transportation services are provided during peak and off-peak hours, etc.). The second section included 10 questions, the third section included 6 questions, and the fourth section included 6 questions. The purpose of these questions was to find the impact of transportation, economic, and social factors on TOD and to find the transportation, economic, and social deficiencies required by TOD. Figure 2 shows the Conceptual model of this study.

The questionnaire questions are divided into three categories: transportation factors, economic factors, and social factors. Questions 1 to 5 cover transportation factors, questions 6 to 11 cover economic factors, and questions 12 to 16 cover social factors. The sum of these three factors, by interacting with each other, will affect the effectiveness and importance of TOD. This set is shown as a structural model in Figure 2.

The data collection method was a four-part questionnaire, which included the degree of satisfaction with current transportation and three separate segments of transport, social, and economic variables. The first section of the questionnaire asks for information on gender, education, number of trips per day, the segregation of used vehicles, and the operation of the city's public transport service at peak and off-peak hours. The results are in line with the descriptive analysis. Of the 175 distributed questionnaires, 50.9% were female respondents and 49.1% were male . Students made up the largest statistical community at 68%, which is acceptable due to the high volume of demand for urban travel during the academic year and the use of public transportation systems. Of the respondents, 51.5 percent use a taxi for their daily urban trips, and the percentage of bus and car users is roughly close (Fig. 3).

Due to its convenience and easy access, 82.3 per cent of people choose taxis as the common transportation system (Fig. 4). Based on Figures 3 and 4, it can be concluded that the most important factor in choosing between different vehicles is their accessibility.

Taxi services provide better services and are more convenient than bus services due mainly to the fact that buses lack cooling and heating systems, do not have specific schedules, have a low-quality fare system, and have excessive

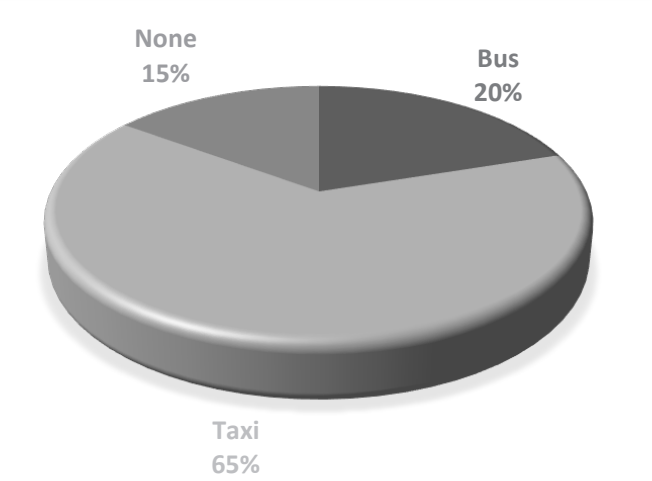

Fig. 3. Daily Trips.

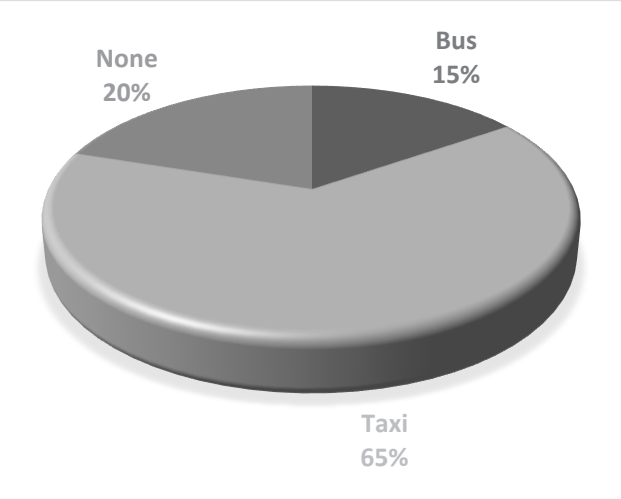

Fig. 5. Location of stations.

delays. It is important to note that in Kermanshah city, the use of taxis has more general popularity than other public transport systems. The reason for this is the social aspect of using a taxi. The low level of buses will not be welcomed by passengers with a different social status. Therefore, attention to the social aspects of the use of public transport systems, which has an important influence on the selection of users, has been investigated in this study. One of the most important issues to consider is the proper location of bus stations across the city. According to the results of the questionnaires, 64.6% of the people found bus station locations across the city appropriate (Fig. 5).

In the case of the transport variable, it is important to establish a station near the place of residence and work, create scheduled transport systems for managing time, and locate training centers near stations. For the socio-economic variable, it is necessary to establish stations near shopping malls, provide amenities for people that encourage them to walk to the nearest station, and provide them the opportunity to express their opinions about changing their commute around the stations, as well as understanding if people in the vicinity of public transportation facilities are satisfied. Modeling in this section is inferential.

The questionnaire was proven reliable by the Cronbach

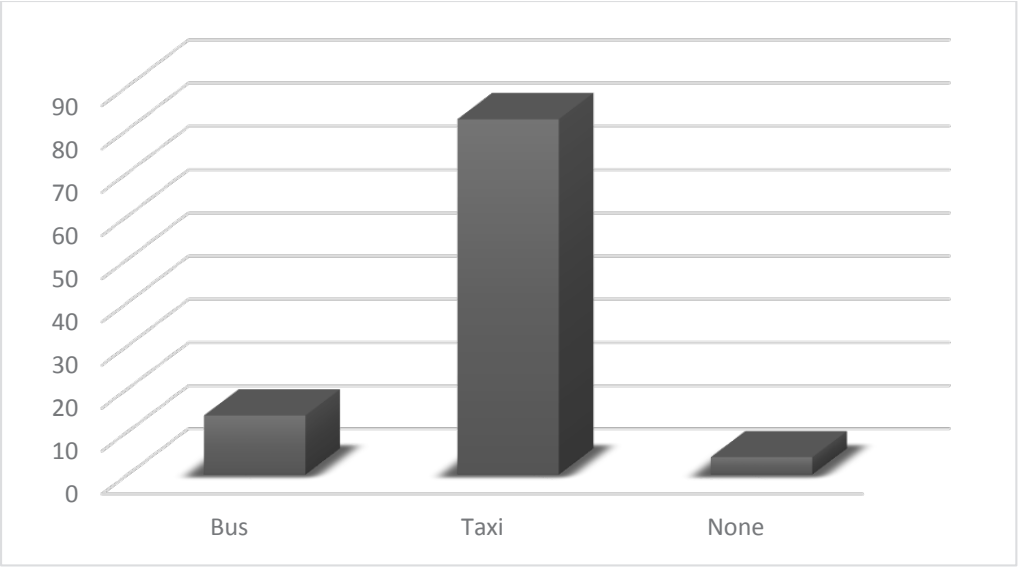

Fig. 4. Accessibility.

Table 2. Value of fitness indexes Confirmatory Factor Analysis Model of the satisfaction questionnaire of transport system function.

Observed values	Fit Indices
148.356	Chi-Square (X2)
101	Degrees of Freedom (DF)
0.002	Level of Significance (P)
1.469	Normal Chi-square (CMIN/DF)
0.903	Goodness of Fit Index (GFI)
0.871	Tucker-Lewis Index (TLI)
0.892	Comparative Fit Index (CFI)
0.052	Root Mean Square Error of Approximation (RMSEA)

alpha value of 0.733. Optimum reliability for the acceptable range is achieved at 0.7, and average reliability is achieved from 0.5 to 0.7. As there is no agreement amongst structural equation modeling experts on which fitness indicator provides a better estimate of the model, a combination of several indicators is reported. Therefore, among the indices of absolute fitness, the chi-square ratio indices to the degree of freedom (K-1), root mean square error estimation (RMSEA), and goodness-fit index (GFI) were all used in this study. Adaptive fit indices, Tucker-Lewis index (TLI) and CFI (CFI) were also used. The confirmatory factor analysis is presented using the Maximum Likelihood or Exposure Estimation (ML) method.

As shown in Table 1, the chi-square is 148.356, and the degrees of freedom are 101. The most important fit statistics are chi-square statistics, and this is the estimated difference between the matrix observed and estimated. However, because it is very sensitive to the sample size, its value is divided by the degrees of freedom. If the result is less than 2, it is appropriate. As shown in Table 1, this value is less than 2. The root mean square error of approximation (RMSEA) is 0.052, and because it is less than 0.08, it is acceptable and confirms the research model. Other indicators, CFI and GFI, are above 0.8, which confirms the suitability of the model. These statistics indicate the acceptability and reasonableness of the fitness indicators (fit) and, therefore, the fit and proper fit for the measurement model.

According to Fig. 5, the estimation values of the parameter (standardized load factor) for the transport sector indicate that Q2 and Q3 questions are the highest, Q10 and Q9 questions are related to economic variables, and Q13 and Q12 questions are related to social variables and are maximal. The results suggest that people are more likely to be close to their locations to railway stations (if built in the city) and welcome urban scheduled transportation systems. Other results from this analysis were the proximity of shopping malls to the stations and payment for accommodations near railway stations.

Another factor that has the most impact among existing variables is the willingness of people to walk to the stations if they are healthy. The parameter estimation values (standardized load factor) of questions Q6, Q7, Q14, and Q16 are less than 0.3 and will be deleted due to the weak relationship between these questions and the Latent variable (factors) from the questionnaire (Fig. 6). In this section, the dependent variable is the desirability of TOD, the latent variables include economic, social, and transportation effects, and the independent variables, which are introduced according to the items in the questionnaire, are each of the components of economic, social, and transportation characteristics. This research seeks to determine the mutual effects of the latent variables on each other and on the dependent variable. In other words, these four questions are not capable of predicting their own factors. These questions include a comparison of the cost of taxi and bus, the impact of the social status of choosing between personal car and public transportation, as well as the level of citizen cooperation with the authorities at the time of construction of new transportation infrastructure.

The weak questions were removed for the variable analysis, and the results obtained from the Pearson correlation coefficient are presented separately. In this research, the Pearson coefficient was used to show the correlation coefficient between factors associated with the transport system variable. The results show a high correlation between the extracted factors and the transport system variables. As shown in Table 3, the most correlation is the transport variable (0.869).

A hierarchical regression method has been used to identify the most important and effective factors in this research. A total of three factors were considered to determine the most important predictor of the effect of each of the variables. (Table 4). A step-by-step comparison of the results in the

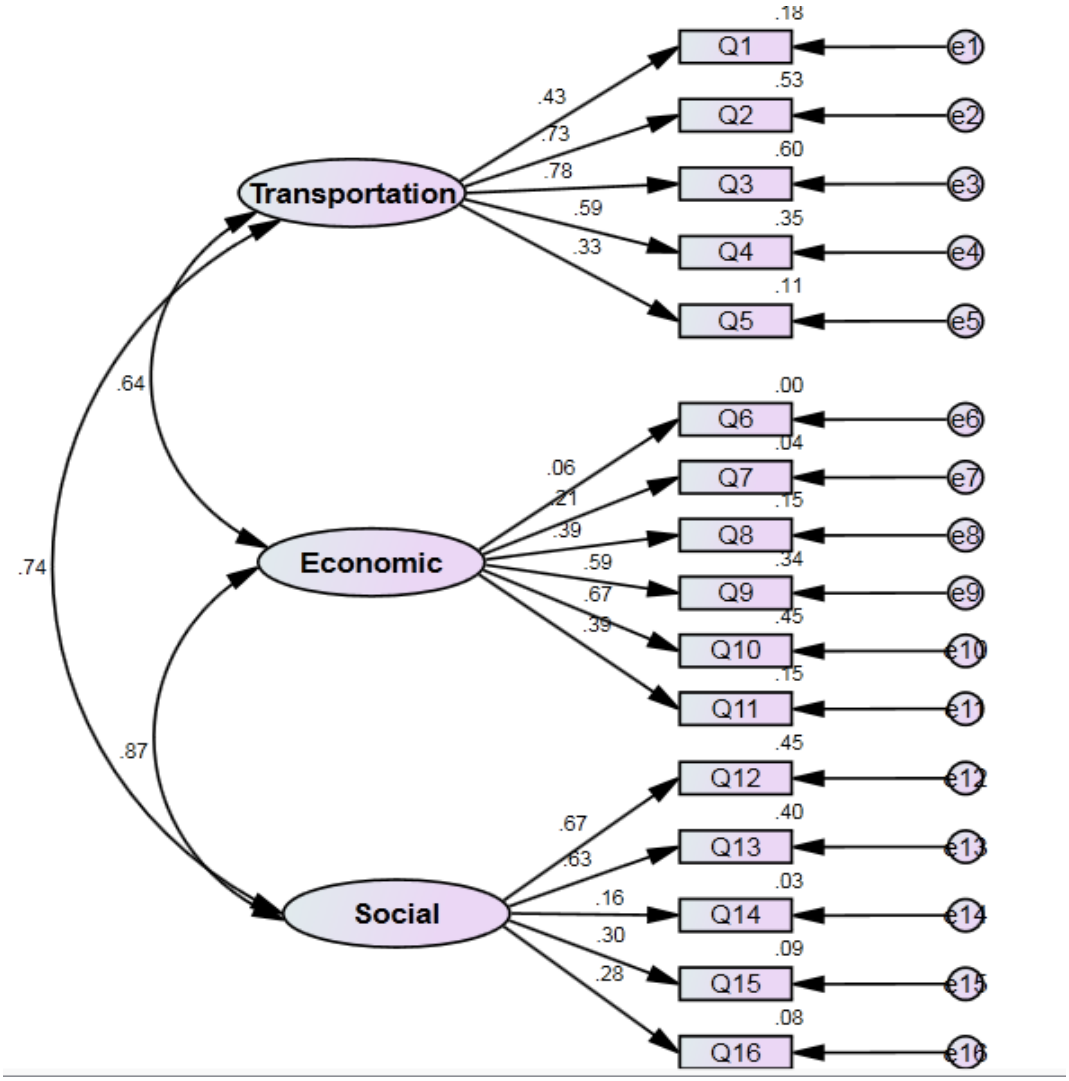

Fig. 6. A three-factor model satisfying the performance of the transport system and its subscales.

Table 3. Pearson's Correlation coefficient.

p-value	Pearson's Correlation coefficient	Variables
0.001	0.869	Transportation
0.001	0.763	Economic
0.001	0.762	social

Table 4. Model Summary.

Watson Camera Statistic	Estimate of Error	Coefficient of Determination	Predictive factors
	3.801	0.755	Transportation
1.828	2.001	0.932	Economic
	0.000	1.000	social

table shows that the coefficient of determination in each stage has increased significantly compared to the previous stage, and the estimation error in the final stage has decreased significantly compared to the first stage. An examination of the variables shows that all three variables under study play a decisive role in explaining the dependent variable (TOD). Since the Durbin-Watson statistic is close to 2, it can be assured that the assumption of independence of the residuals has also been met in the regression analysis.

Comparison of step-by-step results of the table shows that the coefficient determination in each step has a significant increase compared to the previous stage, and the estimated error in the final stage has decreased significantly compared to the first stage. Thorough analysis of the variables shows that all three of the studied variables play a determining role in the relationship between the dependent variable (TOD). Because the Durbin Watson Amplitude is close to 2, it can be assured that the presumption of the independence of the remainder has been observed in regression analysis.

5- Discussion

In the present urban structure, the most important factor with the first priority is the ***transport factor***. This means that due to the geometry and structure of the city, as well as the problems with access to urban services, users are more likely to be more suitable for the transport system, even if they are more expensive. In other words, citizens tend to have an integrated transport system. However, a significant part of urban budgets will be spent. Based on these results, users are demanding changes in their structure and location to utilize urban amenities, especially transportation. These two can be for system providers (urban management), in the sense of changing the structure of urban development and development within the scope of transport facilities. In other words, TOD is considered the best option for solving urban structure and transportation problems.

On the other hand, considering the ***social factors*** and people's desire to use green transportation, urban managers can take more serious measures in the direction of developing sustainable and environmentally friendlily and have the support of citizens in this regard.

At least the economic factors are very important for citizens. Based on this research, ***the out-of-pocket cost*** is less valuable than the ***marginal costs*** for users.

6- Conclusion

In this study, the confirmatory factor analysis was used to examine the effect of three transport, economic, and social variables in TOD. People's satisfaction with the performance of the current public transportation system, with a statistical society of 175 people who completed the questionnaire, was considered in the descriptive analysis. There are two main limitations in this questionnaire. First, the number of samples and second, the use of the stated preference method. In the stated preference method, this is because some respondents may not have an accurate idea of the subject, and as a result, there is a large standard error. The following results were obtained from the analyses made with the Amos software and hierarchical regression:

1. According to the results, most intra-city trips are made by taxi. Bus use is less popular among citizens mainly because of high delays, lack of proper bus schedules at stations, poor service quality, and lack of desirable services during peak and off-peak hours.

2. 51.4% of people approved the need for rail transport to organize public transport, and 28% found it somewhat necessary; although that probably the lack of familiarity with rail transport systems has completely reduced percentages.

3. According to the results of the factor analysis, the majority of people tended to the railway stations near their place of residence, and most of these people were willing to pay more to change their location to the nearest stations to receive the available services and facilities.

4. Time management proved to be an important variable due to the high tendency of people to travel on railway systems on a specific timetable.

5. The proximity of shopping malls to the stations and the acceptance of this issue by the citizens reflect the willingness of people to join communities near transport systems, which, while reducing intra-city travel and travel time, also creates new job opportunities.

6. Appropriate facilities in rail transport systems encourage people to walk and bike up to the nearest stations. This issue not only reduces fuel consumption and pollution caused by it, but also promotes bicycle culture and the beautification of cities.

7. According to the correlation results, the transport variable had the greatest impact (0.869) among the transport, social, and economic variables. In other words, when it comes

to transportation needs, factors such as reduced travel time have more impact on economic and social issues. However, due to the step-by-step regression results, all of these factors affect TOD.

Based on this research, and considering the limitations of the research (especially the small number of respondents), the following recommendations can be made for transportation policymakers:

1. Expand access to the bus system by developing public transportation.

2. Any mass transit development plan should be accompanied by the implementation of feeder systems.

3. Regular scheduling is a factor in attracting users.

4. Permits for shopping centers and increased residential density should be issued near public transportation stations.

In order to achieve better success with transportation systems, it is suggested that researchers in the future investigate all factors influencing the social position of people in the selection of public transportation and the existing welfare factors around the stations, and compare the impact of fares on choosing the type of system with specified facilities. Also, based on the studies conducted, it is recommended that studies be conducted on this issue, looking at the interaction between providers and users with different strategies. There was no urban railway transit system in the city under study. It is recommended that a similar study be conducted in a city with this system and the results be compared with this city.

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