Applying AHP and Clustering Approaches for Public Transportation Decisionmaking: A Case Study of Isfahan City

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Abstract

The main purpose of this paper is to define appropriate criteria for the systematic approach to evaluate and prioritize multiple candidate corridors for public transport investment simultaneously to serve travel demand, regarding supply of current public transportation system and road network conditions of Isfahan, Iran. To optimize resource allocation, policymakers need to identify proper corridors to implement a public transportation system. In fact, the main question is to adopt the best public transportation system for each main corridor of Isfahan. In this regard, 137 questionnaires were completed by experts, directors, and policymakers of Isfahan to identify goals and objectives in the field of urban transportation. In the next step, objectives were prioritized by a multi-criteria decisionmaking method. Afterward, for the main 35 corridors of the city, available information, including trip demands toward main destinations of studied corridors derived from Isfahan comprehensive transportation studies and number of passengers of bus lines, were collected. Finally, 3,906 taxi passengers were interviewed at the end points of each corridor. The role of each policy in improvement of the objectives was assessed by expert choices, and suitable public transportation policies in studied corridors were defined by clustering parameters and converting them into weighted criteria. Mass transportation and implementation of road space rationing policies had

the most influence on achieving prospected objectives in the city's urban transportation system. Findings of this paper present a general evaluation of each implemented policy for the studied corridors.

Keywords: Policy-making, public transportation, AHP, clustering

Introduction

Public transportation is a type of transportation in which the vehicle does not belong to the traveler (Simpson 1994). Any vehicle that is openly used to move people around is a part of a public transportation system. Regarding social equity, public transportation is more important for special groups of users such as older adults, youth, and low-income populations (UITP 2015). Generally, we can divide existing public transportation systems into two groups: regular and irregular. A regular public transportation system or transit system is defined as a system that has fixed origins and destinations and serves passengers on a schedule. This type of transportation includes large and small buses, double-decker buses, articulated buses, trolleybuses, some mini-buses, bus rapid transit (BRT) systems, tramway systems, light rail transit (LRT), monorail, subway, and commuter rail systems (Armstrong-Wright 1993). Unlike a regular transport system, an irregular public transportation system, known as light transportation or paratransit, usually carries passengers on unfixed routes without schedules. Paratransit, which includes private taxis, jitneys, mini-buses, vehicles for hire, ferry, and PRT, is popular in developing countries (Vuchic 2007). Variations of taxis are taxicab, taxi service, airport taxi, radio-dispatch taxi, jitney, rush-hour taxi, vans, and passenger transporters (UITP 2015).

Generally, policymaking is the process of providing a balanced response to different social group demands. Normally, various interested groups seek their own benefits, which could contradict other groups' interests (Schiefelbusch and Dienel 2009). Therefore, to be effective, decisionmaking in the Isfahan metropolis requires consensus among City managers. Zhou (2012) explained that public transportation policies can be categorized in two parts: those that respond to existing demand of public transportation and those that increase the public transportation share in serving total daily trips (Zhou 2012). The decisionmaking process for public transportation could also be self-detrimental. For instance, de Bruijn and Veeneman (2009) indicated that decisionmaking for light rail involves great technical and social complexity that leads to obstacles in the decisionmaking and demand strategic choices by the decisionmakers. Applying a multi-criteria decisionmaking (MCDM) method is a way to overcome this issue. A popular method of MCDM used by many researchers worldwide (Abbaspour et al. 2015; Jozi et al. 2011; Kheirkhah et al. 2010; Lai et al. 2015; Nosal and Solecka 2014) is the Analytic Hierarchy Process (AHP). AHP has been introduced as a fast, easy, and effective technique for the decisionmaking process that has a powerful ability to handle planning problems with a systematic approach.

Mass transportation includes transporting a large number of people among predetermined places. Subway, LRT, tramway system, monorail, regional train, and BRT are variations of mass transportation systems. Rail systems—in particular, heavy rail systems—are more popular in developed countries these days. In developing countries, either there is no urban rail system or the network coverage is poor. In these countries, suburban, heavy, and light trains have been operated in small parts of cities for which most expenses could not be covered by cities. One of the most important sorts of public transportation in developing countries is bus because of economic issues. In developed countries, buses operate beside rail transportation systems and usually operate at a fraction of their capacity. In developing countries, there is either no rail transportation system or limited rail lines. On the other side, in developing countries, the car ownership rate is low, and the only available regular transportation system is bus; consequently, buses usually operate above their capacity in rush hours (Armstrong-Wright 1993).

Implementing a BRT network is part of an emerging public transportation policy around the world, which is different in details depending on each city's characteristics such as pathways, population, resources, and texture of the city, although it has similarity in many aspects. A BRT system is formed of different parts including exclusive lanes, stations with intelligent doors and appropriate facilities, terminals, low-floor vehicles for easy and quick boarding and alighting, beautiful interior and exterior design, passenger comfort facilities, advanced fare collection system, extended time service with low headways, and embedded adaptive bus preemption signal control system. This system is simple and has lower expenses in comparison with rail systems. Additionally, in recent years, BRT systems have gained the ability to transport up to 20,000–30,000 passengers per hour per direction. To date, there are several successful dedicated bus lines, such as Porto Algeria with 26,100 passengers per hour per direction and Sao Paulo with 18,600 (OECD 1995). According to EIU (2010), one of the best-operated BRT systems is in Curitiba Brazil. The role of BRT is different in developed and developing countries. In developing countries, BRT moves a huge number of passengers at its capacity; in developed countries, BRT is a system with high-level of technology and high-level of services that competes with private automobiles (TCRP 2007).

One of the important subjects in public transportation policy is choosing an appropriate system, considering the economic conditions and city status or proper place. Therefore, by focusing on different references during a comparison of alternatives, we briefly explain the effective factors in choosing a public transportation system:

- *Financial-economic factors* – costs of implementation, operation, equipment, and unit expense per trip unit; improving productivity via development of feeder lines; total subsidies paid on public transportation; total fare collected; and flexibility in operation.
- *Social factors* – supporting development of a city via applying a modern transportation system, serving urban transportation demand through a good quality public transportation, increasing urban mobility, improving safety, and reducing accidents, enhancing passenger comfort, establishing high capacity

urban feeder lines, offering cheaper services, increasing passenger satisfaction and reliability of the system, reducing waiting time, providing affordable means of transportation between every origin and destination for all levels of income.

- *Environmental elements* – air and noise pollution, energy consumption, water and soil pollution, land occupation, and visual effects (Vuchic 2007; Carmen et al. 2002).

A systematic approach in this paper is applied to define appropriate criteria for evaluating and prioritizing public transportation strategies to serve travel demand and regarding the supply of current public transportation system and road network conditions of Isfahan. The aim of this paper is to define a set of criteria to choose an appropriate public transportation system as the established goal. Criteria are objective measures of the goal to measure how well each alternative achieves the goal. According to Baker et al. (2002), criteria should be able to discriminate among the alternatives and to support the comparison of the performance of the alternatives. Hence, the procedure of defining criteria is based on the current public transportation supply and demand and road network status. For optimal allocation of available city resources, it is necessary to obtain local priorities and preferences through a public transportation decisionmaking process. The main question in this paper is that what kind of policy is appropriate for public transportation in each city corridor in a unified framework? Undoubtedly, implementation of policies involving mass transportation, road space rationing, bus service enhancement, improvement of roundabout geometric design in urban squares and building park-and-ride facilities, improvement of taxi systems, establishment of exclusive taxi lines with taxi stops, shared taxis, van paratransit systems, and urban minibuses can play an important role in the facilitation of urban mobility. However, it should be mentioned that each city has its own limitations. Accordingly, there should be particular consideration about Isfahan's road network characteristics. This paper intends to present a contribution toward development of unified framework for city public transportation decisionmaking with a capability for the systematic practice of similar policies in other cities. In this paper, the necessity of a general procedural implication of public transportation decisionmaking is illustrated by a practical case study. Accordingly, this paper provides a method in the selection of BRT corridors for Isfahan in 2013. Brief steps of this paper are as follows:

1. Asking Isfahan policymakers, managers, practitioners, and experts were asked their opinions about the most important objectives (criteria) in the field of urban transportation. Priorities of objectives were determined using AHP.
2. Considering main transportation corridors of the city, available data were collected, including trip attraction to principal destinations, obtained from comprehensive transportation and traffic studies of Isfahan by Isfahan University of Technology (IUT 2008), performance data, and a survey from some bus users.
3. Interviews were conducted with taxi passengers at the end destinations of desired corridors.

4. A data bank was compiled in Microsoft Access from the interview results for primary evaluation and further analysis of data as an innovation in public transportation sector of city.
5. Each alternative role was determined as a definite policy in improvement of objectives by surveying from experts.
6. Appropriate criteria were determined based on clustering available parameters in supply and demand data of transportation systems to clarify suitable alternatives of public transportation systems in studied corridors.
7. Proper alternatives were offered as feasible policies of public transportation for the studied corridors.

Quick Review of Isfahan

In Isfahan, with a 260-square-kilometer area and a population of about 2,000,000, more than 4 million trips are performed every day. Isfahan is a city with many tourist attractions that are mostly centered in downtown, and more than 30% of daily trips are attracted to downtown. There are shortages in city transportation such as inefficient orientation of sustainable urban transportation, fundamental weakness and shortage of the road network because of the impossibility of network expansion, widening of roads, and large expenses of releasing real estate for road construction. Moreover, the historical and valuable texture of the city leads experts to find solutions based on optimal application of public transportation to solve the city's traffic difficulties. For optimal allocation of available city resources, it is necessary that officials apply appropriate policies to public transportation. For this purpose, 35 main corridors of Isfahan in which public transportation policymaking is a feasible solution were considered for this study. Taxi and bus services are the only available public transportation systems in Isfahan, for which demand data have been updated in comprehensive transportation and traffic studies of the city. The current public bus system of the city has lacked effectiveness for quite a long time. Long travel time, long headways, and congested buses gradually have led to the formation of taxi lines, which constitute a paratransit network. In essence, taxis have predetermined origins, destinations, and paths. Passengers are boarded at an origin station or on their path (who share the same route) up to the taxi's capacity (four passengers in a sedan) and are dropped off on their way or eventually at a destination point. This form of taxi service, similar to jitney, is very common in many developing countries; however, it is obsolete or different from services in many developed countries. In addition, supply information of public transportation in these corridors exists in comprehensive transportation and traffic studies (EIU 2010). Features of transportation supply and operation of public transportation, including number of passengers, trip time, travel speed, and waiting time for each section and station, are collected by Isfahan's public transportation corporation.

Surveys of City Managers and Experts

To determine the objectives of city transportation, managers, directors, and experts in the field of transportation and urban traffic completed 137 questionnaires. These forms included 12 objectives describing fair distribution of transportation services among various income levels, environmental pollution alleviation, building expenses of rapid public transportation systems, alleviating traffic congestion in city streets and highways, traffic safety improvement especially pedestrian safety, and reliability improvement in transportation systems regarding schedule adherence. In addition, trip comfortability, accessibility to transportation systems, attractiveness of the transportation system, facilitation of a sense of living in a modern city, mode choice diversity in city trips, efficient response to transportation demand, reducing energy consumption in city transportation sector, reducing travel time, and trip cost in the city were other objectives. Respondents were mid-level managers and experts from public organizations who are relevant to city traffic management, such as multiple divisions of Isfahan Municipality, the Provincial Bureau of Road and Transportation, the Bureau of Transportation Terminals, the Police Department, the Department of Housing and Urbanization, and all major universities in the city. All responses were treated equally regardless of the position of respondents.

In this study, after separating the problem into its components, the AHP method was used mainly to allocate weights or rate the selected objectives for transportation policy appraisal. The AHP method is a multi-criteria decisionmaking technique proposed by Saaty (1990). To make comparisons between defined criteria, a scale of numbers is needed that indicates the relative importance of a dominant element over other elements with respect to the criterion or property to which they are compared (Saaty 2008). Saaty and Hu (1998) pointed out that the relative importance is stated based on a 9-point scale or weight of criteria that is determined with the robust method of estimation in AHP (Saaty and Hu 1998). Results are presented in Table 1 in normalized priorities for the defined objectives (criteria), showing the relative importance of objectives. As indicated, traffic congestion reduction, trip cost reduction, increase in safety, and pollution reduction are the most important objectives in the selection of appropriate transportation system respectively.

TABLE 1.
Final Priorities of Objectives
Based on Survey of Managers
and Experts

No.	Objective	Score	No.	Objective	Score
1	Traffic Congestion Reduction	0.179	7	Travel Time Reduction	0.085
2	Trip Cost Reduction	0.114	8	Trip Comfortability	0.084
3	Traffic Safety Improvement	0.108	9	Energy Saving	0.054
4	Pollution Reduction	0.108	10	Efficient Response	0.046
5	System Attractiveness	0.086	11	Fair Distribution	0.026
6	Increase of Reliability	0.085	12	Costs of Implementation	0.023

Prioritization of Transportation Policies with Respect to Objectives Ranking

Effective policies for improving urban public transportation in terms of mass transportation alternatives or solutions are categorized as implementing BRT or tram, traffic demand management, enhancing bus service, precise improvement of bus lines' start/end stations in urban squares such as organizing the traffic situation, and building park-and-ride facilities near origins and destinations of bus lines. Improvement of common available taxi systems in a city such as taxi service, taxicab, shared taxi, and paratransit system are other policies in public transportation. To determine the influence of each policy with respect to city transportation objectives, it was requested from responders to carry out a pairwise comparison to construct matrices expressing the relative preferences of a set of alternatives with respect to 12 objectives to classify alternatives based on their relative merits. Next, the AHP methodology was applied to identify the true order of priorities such as in similar studies (Leskinen et al. 2005). Finally, each corresponding number of the seven policies preferences for improving transportation system was multiplied by the priority relating to each objective of Table 1. All numbers were then summed, and global priorities of alternatives were calculated. Table 2 presents the global transportation alternative priorities with respect to all transportation objectives.

TABLE 2.
Global Priority of Alternatives

Global Priority	Proposed Alternatives
Mass transit (BRT, ¹ tram, monorail)	0.258
Traffic demand management (road space rationing, exclusive bus lanes ²)	0.213
Improvement of bus system (improvement of bus line, exclusive bus and taxi lines ³)	0.160
Implementation of complementary facilities (building park and rides-terminals, improvement of urban squares traffic condition)	0.137
Improvement of shared taxi system (provide exclusive lines)	0.112
Paratransit system (van or urban minibus)	0.070
Taxi service and taxi for hire (private taxis ⁴)	0.050

¹ BRT is a bus system with dedicated lanes, low-floor buses, and fare collection at station gates.

² In some sections, bus has dedicated lane; fare collection and fleet are same as conventional bus lines.

³ Exclusive bus lines, also called express bus, skip some stations and stop only at major stations on their route.

⁴ Exclusive taxis also move passengers between origin and destination points without stopping on their way to board passengers.

Table 2 results indicates that mass transit and traffic demand management, which score 0.258 and 0.213, respectively, seem to have significant role in terms of their ability to meet the public transportation sector needs of Isfahan. Paratransit, taxi service, and taxi for hire would do rather badly at satisfying the city's requirements in this case study.

Interviews with Taxi Passengers

Because there is a shortage of information about taxis, which accommodate more than half of the city's public transportation trips, field studies were conducted via interviews with passengers and taxi drivers in nine main city squares that are major origins and destinations of city trips. The intended locations were selected beyond the central zones of the city to cover large peaks of trip attraction in the central zones based on transportation comprehensive studies. Furthermore, at selected points, an unsynchronized combination of different public transportation systems exists. Surveying points were selected to illustrate a general overview of taxi routes and trip objectives, which are done inside the city by taxi. Whereas the majority of intra-city trips by taxi end in one of the squares or intersections in the second traffic ring of Isfahan, surveying points and surveyor locations for interviews with dropped-off passengers were located in major squares and intersections (1–Azadi Sq, 2–Noorbaran int, 3–Bozorgmehr Sq, 4–Ghods Sq, 5–Ahmadabad Sq, 6–Shohada Sq, 7–Jomhoury Sq, 8–Jahad int, 9–Haftome Moharram int), as presented in Figure 1.

FIGURE 1.
Map of selected survey locations

Questionnaires were designed in three sections—1) passenger information; 2) trip purpose, including primary origin and final destination and portion of route traveled by taxi, waiting time, and taxi fare; and 3) maximum fare for taxi for hire and substituted vehicle for taxi in situations in which there was no taxi or passengers desired not to use taxi. Surveying for this research was conducted on three weekdays in May 2013, with 3,906 passengers interviewed in the nine main squares and intersections of the city.

Primary results of this interview emphasized the existence of problems in the urban taxi system, especially in early morning and at noon. The main causes of dissatisfaction

among passengers were the inability to control and supervise the taxi system, lack of proper scheduling, unbalanced distribution, and non-optimal allocation of the city taxi fleet. For instance, taxi service for schools in the morning and at noon and the unbalanced distribution of taxi fleet leads to inefficient service during these hours. In the evening, there is a deficiency in performance of the urban taxi system due to the decreased number of active taxis. Additionally, findings indicate that a majority of exclusive taxi lines in the city satisfy passenger demands at origins, but passengers may be confronted with many inconveniences in the middle and at the destinations of trips.

Integrated Data Bank

The substantial gathered data from the interviews on urban roads of the city public transportation corridors were entered into a research data bank after necessary corrections. These data consist of personal information of responders, trip objective, address of origin and destination of trips, and length traveled from origin to destination by taxi (whole trip, more than half of trip, less than half of trip, less than one-third of trip). In addition, waiting time to get a taxi, taxi fare, number of family members traveling by taxi, maximum proposed fare for booking a taxi for hire, and hired vehicle when no available taxi were included. Data from a comprehensive transportation study of the city were updated and consist of total demand for trips ending at a main destination of the studied roads and demand for public transportation trips by bus and taxi. Bus service information such as passengers traveling, passengers per kilometer, efficiency, daily waiting time, peak-hour waiting time, average running speed, average trip speed, running speed before square, trip speed before square, running speed after square, trip speed after square, and the number of picked-up and dropped-off passengers in the studied squares was added to the integrated data bank. Finally, the integrated data bank was entered into Microsoft Access.

Clustering Effective Factors in Choosing Each Policy

Clustering is the common term for a variety of numerical methods used to create objective and firm classifications (Everitt et al. 2001). Jain et al. (1999) defines clustering as patterns or observations that are grouped based solely on the data. The primary objective is to find groups of similar entities in a sample of data (Aldenderfer and Blashfield 1984). Clustering groups different observations whose patterns of scores on variables are similar. Consequently, clustering is a promising tool for data analysis whose aim is the separation of members to homogenous groups. Moreover, clustering can be applied in situations in which primary recognition of relationships between observations does not exist and, therefore, is counted as data mining.

Similarity and dissimilarity of members based on desired factors are described according to the quantity concept of distance between members and is the main key to identifying clusters. There are different methods of clustering, depending on various factors such as kind of distance definition, consideration of distances between cluster centers, farthest and nearest members, members' average, and comparison of

members with each other to determine the degree of similarity, which then is divided into two general groups of hierarchical and K-means clustering. One of the most applicable methods of clustering is K-means clustering, which is used for numerical variables. In this method, the number of clusters is selected initially and members are arranged in clusters in a way such that their distance from the centroid of the cluster would be minimum. Accordingly, by changing the number of clusters and proficient interpretation of each clustering, the best results would be obtained (Johnson and Wichern 2007).

In this study, to choose an appropriate transportation system for studied corridors, effective factors in the selection of each policy were determined. By applying the clustering method, effective variables in choosing policies as feasible alternatives were divided into meaningful groups. The K-means clustering method was applied by using IBM SPSS statistics software. Accordingly, corridors were categorized into meaningful groups based on variables. Table 3 represents clustering based on variables and influence of each cluster in choosing public transportation policies concluded through the judgment of professionals and experts.

Identifying Appropriate Corridors for Policy Implementation

Applying results from Table 3 and scoring the studied corridors in case of existing an appropriate objective for each public transportation policy, total scores of policies were obtained for each corridor. Corridors with higher priority for each policy were identified as shown in Table 4. To go further into detail and as an example, note that a corridor such as Jomhouri Sq-Jahad Int-Hakim Nezami St-Azadi Sq, which has high travel demand, long-ride bus users yet low travel speed, and considerable taxi fare, has the highest priority to implement a mass transit system. Regarding the economic conditions and budget of Isfahan, policymakers tend to select BRT rather than rail systems due to its lower costs of implementation.

TABLE 3. Cluster Influence of Each Variable on Policy Selection

Source of Information	Variable	Influence of Cluster's Type in Choosing Policy							
		Number of Clusters	Mass Transit	Service Quality Improvement of Bus System	Service Quality Improvement of Taxi System	Improvement of Corridors' Origin	Implementation of Road Space Rationing	Taxi for Hire	Paratransit
Bus Corporation Studies	Passengers traveling	4*	very high	high			high		high
	Passengers per kilometer	4	very high	high					
	Efficiency	3**		low					
	Daily waiting time	3		high					
	Peak waiting time	3		high					
	Daily trip speed	3	low	low			low		high
	Running speed before square	3				low			
	Difference in two speeds	3				high			
	Running speed after square	3				low			
	Dropped-off passengers	3				high			
	Route length	3	high	high	low				
	Picked-up passengers	3				high			
Comprehensive Transportation Studies	Total trips demand	4	very high				high		
	Bus demand	4	very high			high			
	Taxi demand	3			high				
	Taxi demand versus bus demand	3	low	High	low				
	Public transportation demand share of total demand	3	High			high	low		
Interviews with Taxi Passengers	Waiting time	3			high			high	high
	Taxi fare	3	high	high					high
	Desired Taxi fare	3	low	low				high	low
	Total trip by taxi	3	high						
	Less than half of trip by taxi	3						high	
	Alternative mode for bus	3	high	low					
	Alternative mode for minibus	3			high				high
	Alternative mode for vehicle for hire	3						high	
	Alternative mode for taxi service	3						high	

*Four clusters: very high, high, average, and low

**Three clusters: high, average, and low

TABLE 4.
Priority of Corridors for Policy
Implementation

Score	Endpoint	Corridor	Policy
Mass Transit	Jomhuri Sq-Jahad Int-Hakim Nezami St-Azadi Sq	Jomhuri Sq	10
	Azadi Sq-Bozorgmehr Sq-Ahmadabad Sq-Qods Sq	Azadi Sq	6
	Ahmadabd Sq-Takhti Int-Haftom Moharram Int	Ahmadabad Sq	6
	Shohada Sq-Malekshahr	Shohada Sq	6
	Azadi Sq-Qaemiyah	Azadi Sq	5
	Qods Sq-Zeinabieh	Qods Sq	5
	Ahmadabad Sq-Khorasgan	Ahmadabad Sq	5
Service Quality Improvement of Bus System	Shohada Sq-Malekshahr	Shohada Sq	10
	Jomhuri Sq-Robab Blvd	Jomhuri Sq	7
	Ahmadabad Sq-Khorasgan	Ahmadabad Sq	6
	Modarres St – Qods Sq	Qods Sq	6
	Shohada Sq-Qarazi Hospital	Shohada Sq	5
	Qods Sq-Haftoon	Qods Sq	5
	Azadi Sq-Margh	Azadi Sq	6
	Azadi Sq-Sepahanshahr	Azadi Sq	6
	Azadi Sq-Enghelab Sq	Azadi Sq	6
Road Space Rationing	Jomhuri Sq-Jahad Int-Hakim Nezami St-Azadi Sq	Jomhuri Sq	4
	Jomhuri Sq-Shohada Sq-Qods Sq-Ahmadabad Sq	Jomhuri Sq	4
	Bozorgmehr Sq-Enghelab Sq	Bozorgmehr Sq	3
	Ahmadabad Sq-Emam Hossein Sq	Ahmadabad Sq	3
	Ahmadabad Sq-Takhti Int-Vafae Int	Ahmadabad Sq	3
	Shohada Sq-Jomhuri Sq	Shohada Sq	3
Paratransit	Jomhuri Sq-Esteghlal Sq	Jomhuri Sq	9
	Ahmadabad Sq-Khorasgan	Ahmadabad Sq	8
	Azadi Sq-Baskool	Azadi Sq	8
	Azadi Sq-Hotelpol	Azadi Sq	7
	Jomhuri Sq-Simin Int	Jomhuri Sq	7
	Azadi Sq-Enghelab Sq	Azadi Sq	7
	Jomhuri Sq-Rehnan	Jomhuri Sq	7
	Shohada Sq-Qarazi hospital	Shohada Sq	6
	Azadi Sq-Margh	Azadi Sq	6
	Azadi Sq-Sofeh Terminal	Azadi Sq	6
	Jomhuri Sq-Robab St	Jomhuri Sq	7
	Azadi Sq-Bozorgmehr Sq-Ahmadabad Sq-Qods Sq	Azadi Sq	7
	Qods Sq-Haftoon	Qods Sq	6
	Ahmadabad Sq-Khorasgan	Ahmadabad Sq	6
	Azadi Sq-Baskool	Azadi Sq	6
	Khaju-Qods Sq	Qods Sq	6
	Khane Esfahan-Jomhuri Sq	Jomhuri Sq	5
	Shohada Sq-Malekshahr	Shohada Sq	5

TABLE 4. (cont'd.)
Priority of Corridors for Policy Implementation

Score	Endpoint	Corridor	Policy
Paratransit (cont'd.)	Allameamini St-Baghgoldaste St	Noorbaran Int	5
	Azadi Sq-Margh	Azadi Sq	5
	Jomhuri Sq-Esteghlal Sq	Jomhuri Sq	5
	Azadi Sq-Sepahanshar	Azadi Sq	5
	Jomhuri Sq-Modarres St	Jomhuri Sq	5
	Jomhuri Sq-Zeinabieh	Jomhuri Sq	5
	Jahad Int-Zeinabie	Jahad Int	5
Service Quality Improvement of Taxi System	Jomhuri Sq-Ashoora	Jomhuri Sq	6
	Bozorgmehr Sq-Ayenehkhaneh Blvd	Bozorgmehr Sq	6
	Jomhuri Sq-Modarres St	Jomhuri Sq	5
	Azadi Sq-Amirieh	Azadi Sq	4
	Jomhuri Sq-Amirkabir Blvd	Jomhuri Sq	3
	Ahmadabad Sq-Sarhang Bridge	Ahmadabad Sq	3
	Azadi Sq-Sepahanshahr	Azadi Sq	3
	Noorbaran-Shahrestan Bridge	Noorbaran Int	4
	Haftom Moharram Int-Ashoora	Haftom Moharram Int	4
	Ahmadabad Sq-Atashgah St	Ahmadabad Sq	4
	Haftom Moharram Int-Montazeri St	Haftom Moharram Int	4
Taxi for Hire	Jomhuri Sq-Khaneesfahan	Jomhuri Sq	6
	Shahrestan Bridge-Bozorgmehr Sq	Bozorgmehr Sq	6
	Azadi Sq-HotelPol	Azadi Sq	5
	Azadi Sq-Rahahan	Azadi Sq	5
	Bozorgmehr Sq-Khorasgan University	Bozorgmehr Sq	5
	Jomhuri Sq-Zayandehrood Terminal	Jomhuri Sq	4
	Haftom Moharram-Zayandehrood Terminal	Haftom Moharram Int	4
	Azadi Sq-Sepahanshahr	Azadi Sq	4

The AHP results imply that policies including mass transit and implementation of traffic restriction measures have the highest influence on achieving the objectives for city transportation. According to Table 4, the main corridors of mass transit of the city connecting the zones with significant trip generation and attraction in Isfahan are presented in Figure 2. Because the proposed mass transit corridors are partially or totally located downtown, implementing them would necessitate traffic limitations for private vehicles. In addition, traffic restrictions for private vehicles in the central area of the city could lead to a revival of tourism and historical streets, thanks to giving priority to pedestrians. Constructing park-and-ride facilities and terminals or improving the traffic condition of squares at the start/end points of bus lines, even at a small scale, has high priority to boost the condition of significant corridors. Furthermore, deploying shared taxi and improving its system could help to transport a large number of passengers between major origins and destinations who are waiting at stations to catch a shared taxi in the city streets. It is observed that passengers are willing to pay

more money to avoid a long waiting time. Taxi for hire is more likely to be used in Azadi Sq, Rahahan, Sepahanshahr, Bozorgmehr Sq, Shahrestan Bridge, and Khorasgan university stations, because passengers residing in these locations have a high income level and expectation. Small stands for passengers and taxis could be installed on the city streets; taxi service should not necessarily have a fixed station if communication with a navigation system from a permanent place via a wireless system, telephone, or cellphone is possible.

FIGURE 2.
Proposed corridors for mass
transit system in Isfahan

In spite of deficits and problems, a bus system is still the best public transportation system for passengers, so a bus system improvement policy for the studied corridors should have the highest priority; however, other paratransit systems such as vans and minibuses should not be ignored. Considering taxi system limitations such as short life cycle and low passenger capacity, a paratransit system could be new and efficient in Isfahan. This system would increase the beauty of the city, decrease environmental pollution, and occupy three times less space than roads in comparison with taxis, considering the number of passengers transported. Establishing stations for picking up and dropping off passengers without any interference in a square's traffic is an important issue in planning paratransit system in Isfahan.

Conclusions and Further Study Suggestions

Different policies of public transportation as feasible alternatives play an important role in achieving objectives of sustainable development as the goal in each city. Policies such as developing mass transit and implementing traffic demand strategies such as road space rationing have the most influence on attaining the city's transportation objectives. Because of expenses and resource limitations, some corridors and special areas of the city were identified to be the most appropriate for assigning the policies. In this paper, the priorities of public transportation corridors were determined for policy implementation via available data from the city transportation system, interviews with passengers, and polling of experts, practitioners, planners, and city managers. The findings indicate that the general evaluation of corridors that are suitable for performing each policy as a practical alternative. In essence, each corridor may be suitable for implementing some policies, which should be analyzed technically and economically in detail at the level of installation and performance. Finally, the authors recently proposed the studied corridors to the City Council to get approval for implementation of a BRT system based on our findings. Support for a BRT system was approved unanimously by the City Council in July 2015. It is also worth noting that the overall assessment of the approved BRT corridors should be considered precisely as an implication of policy in future.

Although the proposed approach is flexible, additional policies that are suitable for different public transportation corridors can be included to the model and can be evaluated for specific corridors. The approach of this article can be used in other cities, and the importance of the objectives and policies for selection of an appropriate transportation system for each city can be compared and evaluated. In addition, in further studies, more technical and economic aspects of one or more policies should be considered in more detail.

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