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Investigating factors affecting bicycle sharing system acceptability in a developing country: The case of Mashhad, Iran

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ABSTRACT

The aim of this study is to investigate the factors affecting the acceptability of a bicycle sharing system (BSS) in Mashhad, which is the first BSS to be introduced in Iran. Given the low usage rated of the BSS, we distributed a survey in all stations. 134 users answered the questionnaire. We clustered the potentially relevant factors in five dimensions: *Socio-cultural*, *Economic*, *Infrastructure*, *System function and Environmental.* We eliminated the *Environmental* dimension because of invalid loading factors. Next, we evaluated the importance and significance of these factors and the four remaining dimensions for the acceptance of BSS in Mashhad. Furthermore, MANOVA was used to evaluate the relationship between the demographic characteristics and dimensions. The findings indicate that the system is mainly used by young people, students, people with a low-income and those without a vehicle. The results of the evaluations show that all four dimensions are effective, the impact of the *Economic* dimension being less important than the three other dimensions. The most important factors are the authorities' use of the system and driving behavior (Socio-cultural dimension), easy use and registration, and proper and timely maintenance (System function) and the availability of bike lanes and suitable bike equipment (Infrastructure). This study is the first attempt to investigate different factors and dimensions important for BSS acceptability in Iran. It can be said that the factors affecting the acceptability of BSS is different in different contexts. Nevertheless, we expect our results to be useful for the design and implementation of BSSs in other cities in Iran, and likely also in other developing countries.

1. Introduction

Over recent decades, in many cities worldwide urban population has increased due to the migration of people to cities (Han et al., 2009). It is expected that in 2050, more than 67% of the world's population will live in urban areas, and most of the increased urbanization is in developing countries (UN DESA, 2013). This phenomenon requires correct resource management and adequate service provision for urban residents (Browne et al., 2012). Especially in developing countries, poor resources and services have caused many urban problems, and cities have become very crowded and have suffered from various problems (Pajouhan and Ghadami, 2011; Sasanpour et al., 2014; Han et al., 2017). One of the problems is that the current social and economic developments are causing harm to the environment (Song, 2011). Emerging countries are trying to improve quality of life via economic growth and increasing travel options, but higher levels of car use result in an increase in energy use, polluting emissions and noise, a lower level of physical activity and reduced safety levels (Seidel et al., 2015). In many cities in the developing world today economic growth leads to an increase in the number of urban trips, often by car (Soltani and Shariati, 2013). Due to lifestyle changes and increases in commuting distances urban car use (expressed in kilometers) has increased, leading to negative effects such as increased land and energy use, increasing environmental impacts and congestion levels and more accidents (Shaheen et al., 2011). This also applies to Iran's major cities (Alaeddini and Fayezi, 2011). As a quantitative example of the problems: in developing countries approximately 500 million people die prematurely due to air pollution caused by transportation (Ostadi Jafari and Rasafi, 2013).

Achieving sustainable development is one of the most important goals in many countries (Hassan and Lee, 2015), and this certainly also applies to sustainable urban mobility (Berloco and Colonna, 2012; Ahmad and de Oliveira, 2016). In addition to public transportation urban cycling can play an important role in sustainable mobility, partly

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because it demands little energy and other resources (Shaheen et al., 2011). In addition bicycle use has a range of health, accessibility, environmental and socioeconomic advantages (Midgley, 2011; Taghvaei & Fathi, 2011; Berloco and Colonna, 2012; Soltani and Shariati, 2013; Gupta et al., 2014; Bernatchez et al., 2015; Tran et al., 2015; Karki and Tao, 2016; Manzi and Saibene, 2018; Morton, 2018). One policy implemented to stimulate cycling is providing rental bikes via Bike Sharing Systems (BSS). In Iran, the city of Mashhad introduced the first BSS, but the use rate is low (Jahanshahi et al., 2018; Jahanshahi et al., 2019): around 500–700 users (based on an estimation described in Section 3.2) out of approximately 1 million potential users (i.e. males above 15 years, they are allowed to use this system according to BSS regulations in Mashhad) in the city. Bike sharing schemes across the world are operated in different ways and under different circumstances, leading to differences in success and impacts, hampering easy implementation of successful schemes elsewhere (Mateo-Babiano, 2015). The success of BSSs in developing countries may depend on its acceptance, and factors affecting acceptance can also vary between cities and countries (Shaheen et al., 2011).

Studies exploring the use and acceptance of BSSs have mainly focused on developed countries, but as explained, results may not apply to developing societies due to their different cultural and social backgrounds (Mateo-Babiano et al., 2016). Therefore, the present study aims to measure the impact factors which were extracted from previous studies on the acceptance of BSSs in Mashhad, Iran. For this purpose, we reviewed papers on BSS implementation (key references being Shaheen et al., 2010; ITDP, 2013; Castillo-Manzano and Sánchez-Braza, 2013; Fishman et al., 2014; Fishman et al., 2015; Tran et al., 2015; Nikitas et al., 2016; Caulfield et al., 2017; Raux et al., 2017; Mattson and Godavarthy, 2017; Manzi and Saibene, 2018; Nikitas, 2018; Morton, 2018; Jahanshahi et al., 2019– see also Section 2), leading to 26 factors which were clustered into five dimensions: "*Socio-cultural*", "*Economic*", "*Environmental*", "*Infrastructure*" and "*system's function*" (see Table 1). Our aim was to explore the importance of each factor and dimension, and the related importance of some key socio-demographic variables, including income, age, education level and experience of using BSS. Our results would provide relevant information for the implementation of BSSs elsewhere in Iran and other developing countries.

More specifically, we aim to answer the question which factors and dimensions (clusters of factors) affect the acceptability of BSS in Mashhad, and to what extent? And secondly: what is the impact of socio-demographic variables on users' perceptions of the effectiveness of the dimensions?

2. Literature overview

This section gives a brief overview of the literature in the areas of BSS and the factors influencing BSS acceptance. In recent decades, cycling has become less attractive and cycling levels have declined due to various factors such as the increasing quality of alternatives (cars, buses, Light Rapid Transit), increasing commuting distances, economic growth and the rapid growth of motorization (Shaheen et al., 2011). However, in recent years promoting cycling has increasingly been seen as a solution for the urban problems set out above, and BSSs are one option to promote cycling. Shared bicycles are non-motorized transportation services that provide the possibility of travelling short distances without the need to own a bicycle. People can take a bike from one station to take a short trip and deliver the bike to the same station or another station (Shaheen et al., 2011; Fishman et al., 2013; Mateo-Babiano, 2015). BSS can reduce the barriers to cycling (Shaheen et al., 2010) and help to change the image of cycling, especially for people who think cycling is just for sport and is risky (Goodman et al., 2014). The first BSS was set up in 1965 in Amsterdam. However, due to theft and vandalism, the program failed (DeMaio, 2009). But over time BSSs have become better, and at the time of writing this paper (2018) worldwide 2598 shared bicycle schemes have been implemented or are being planned/under construction (Meddin & Demaio, 2018). Despite the rapid growth in global motorization, BSS usage rates have generally increased all around the world during the past 30 years (Shaheen et al., 2010).

The first BSS in Asia was in Singapore in 1999 (Shaheen et al., 2010), and the first Iranian system was in Mashhad in 2012 (see Section 3.1). It is expected that the next generation of BSSs will benefit from electric bicycles (Fishman et al., 2014). However, due to budget issues in developing countries as well as high rates of vandalism and theft, the use of electric bikes in these countries seems improbable.

An important question is: which factors contribute to the acceptance of BSS in developing countries? To find out we searched for literature in the Web of Science and Google Scholar databases, using (combinations of) keywords: bike, bicycle, bike-sharing system, bicycle sharing system, cycling, shared bike, public bike, active transport, BSS, BSP, Iran and acceptance. The most relevant papers were published after 2010 owing to the fact that bicycle sharing programmes can be considered to be a relatively new topic of research. After selection based on abstracts there were 46 useful papers. In addition we explored the Iranian database, "SID" (Scientific Information Database, http://www.sid.ir) which contains Iranian journals and conference papers and added seven more useful Iranian sources to our selection. We clustered the different factors into five dimensions: "*Socio-cultural*", "*Economic*", "*Environmental*", "*Infrastructure*" and "*System's function*" (Table 1).

We next give a few examples of relevant papers. In Iran, Alaeddini and Fayezi (2011) evaluated the BSS in Tehran which implemented its pilot scheme in 2009. They included factors such as access, awareness, safety, traffic Infrastructure, satisfaction, sustainability and culture. They conclude that the system was successful in obtaining users, but suffered from a number of deficiencies such as inadequate information, lack of social awareness of cycling benefits, lack of road signs, and poor quality of the bikes and routes). Malek Husseini et al. (2012) focused on cycling in the 8th District of Tehran and reported that people were not used to cycling. Low social status, short bike paths, obstacles and urban traffic, long waiting time at docking stations, and inappropriate routes were all factors that impinged on the use of bicycles. Jahanshahi et al. (2018) investigated factors that influence BSS acceptance in Mashhad through a qualitative study including users, non-users and experts. The study revealed 7 dimensions and 26 factors extracted by using a thematic analysis method. Combining GIS and Multi-criteria analysis, Jahanshahi et al (2019) show that the design of the BSS in Mashhad was not based on their efficiency, but on making profit from the advertising billboards at docking stations. Consequently they tried to address the problems in locating BSS stations, and so to contribute to development of the existing programs and possible future programs in other cities (Jahanshahi et al., 2019).

In recent years various studies outside Iran have pointed to different factors that may influence citizens' use and acceptance of BSS. Assessing these factors can be done in many ways such as focusing on the travel behavior of people (Shaheen et al., 2011; Chen, 2016), investigating different factors enhancing their awareness of the benefits of bicycle sharing (Bernatchez et al., 2015), spatial analysis of citizens' access (Karki and Tao, 2016), and by reviewing motivators and barriers to the use of bicycles (Fishman et al., 2014), examining inequalities in the uptake and usage of BSS (Ogilvie and Goodman, 2012; Goodman and Cheshire, 2014; Goodman et al., 2014), assessing the factors influencing BSS acceptance and membership (Fishman et al., 2015), the impact of the natural and artificial environment (Mateo-Babiano et al., 2016), service quality and satisfaction among the users of a BSS (Castillo-Manzano and Sánchez-Braza, 2013; Zhang et al., 2015; Manzi and Saibene, 2018; Morton, 2018), acceptability and usage patterns of BSS in smaller cities (Nikitas et al., 2016; Caulfield et al., 2017; Nikitas, 2018), evaluating BSS users' characteristics (Raux et al., 2017; Hosford et al., 2018), investigating success factors (Médard de Chardon et al., 2017; Mattson & Godavarthy, 2017), etc.

In this study we build upon the results of the literature (see Table 1.

Table 1
Extracted dimensions and factors for acceptance of BSS.

Dimensions	Factors	Resources
Socio-cultural		
	SC1: Observing the mutual rights of drivers and cyclists	(Daley et al., 2007; Shaheen et al., 2011; Shokoohi and Nikitas, 2017)
	SC2: Awareness of benefits of cycling and BSS	(Fishman et al., 2014; Nikitas, 2018)
	SC3: Habit of using bicycle	(Midgley, 2011; Jahanshahi et al., 2018)
	SC4: Authorities use of BSS	(Fishman et al., 2014; Roland Berger Study, 2015; Jahanshahi et al., 2018)
	SC5: Getting participation of citizens in BSS programming	(Karki & Tao, 2016; Jahanshahi et al., 2018)
	SC6: Driving behavior (Perceived Safety of cyclists)	(Midgley, 2011; Shaheen et al., 2011; Goodman et al., 2014; Nikitas, 2018)
Economic		
	EC1: The registration fee of BSS	(Shaheen et al., 2010; Fishman et al., 2014)
	EC2: Cost of using BSS	(Fishman et al., 2015; Tran et al., 2015; Manzi and Saibene, 2018)
Environmental		
	EN1: Climate conditions for cycling	(Fishman et al., 2014; Mattson & Godavarthy, 2017; Médard de Chardon et al., 2017; Nikitas, 2018)
	EN2: Slope levels and altitude variations in the city	(Midgley, 2011; Tran et al., 2015)
	EN3: Environmental condition and beauty of bike lanes	(Taghvaei & Fathi, 2011)
Infrastructure		
	IN1: The bicycle design and color	(Midgley, 2011; Jahanshahi et al., 2018; Nikitas, 2018)
	IN2: Suitable equipment for bikes	(Midgley, 2011; Jahanshahi et al., 2018)
	IN3: Durability and quality of bike	(Roland Berger Study, 2015; Manzi and Saibene, 2018)
	IN4: Quality and quantity of bike lanes	(Fishman et al., 2015; Karki & Tao, 2016; Shokoohi and Nikitas, 2017;Nikitas, 2018)
	IN5: Integration of BSS with transport network	(Shaheen et al, 2011; Médard de Chardon et al.,2017)
	IN6: Proper distribution of BSS stations	(ITDP, 2013; NACTO, 2015; Manzi and Saibene, 2018)
	IN7: Number of BSS stations in the city	(ITDP, 2013; NACTO, 2015; Raux et al., 2017)
	IN8: Proper signs for the cyclists in the city	(Alaeddini & Fayezi, 2011)
System function		
	SF1: Informing people about the system	(Shaheen et al., 2011; Jahanshahi et al., 2018; Morton, 2018)
	SF2: Time interval of the operating system	(Fishman et al., 2014; Tran et al., 2015)
	SF3: Service quality of BSS to customers	(Zhang et al., 2015; Manzi and Saibene, 2018; Morton, 2018)
	SF4: Ease of registration	(Castillo-Manzano and Sánchez-Braza, 2013; Fishman et al., 2014)
	SF5: Easy use of the system	(Castillo-Manzano and Sánchez-Braza, 2013; Fishman et al., 2014; Morton, 2018)
	SF6: Proper and timely maintenance of bikes	(Midgley, 2011; Manzi and Saibene, 2018)
	SF7: Quick identification and resolution of problems in the system	(Midgley, 2011; Manzi and Saibene, 2018)

Resources), departing from the 26 factors and five dimensions they found (see Table 1). Whereas wearing a helmet while cycling is strongly recommendable for safety reasons (Høye, 2018), the obligation to wear a helmet is also a major barrier for the acceptance of a BSS (Fishman et al., 2014, 2015; Goodman et al., 2014). However, we did not consider this factor in the list as there is no helmet law for cyclists in Iran.

3. Methods and data

3.1. BSS case study: Mashhad public bicycle sharing in Mashhad city, Iran

Mashhad is a metropolis located in northeastern Iran covering an area of 352.3 square kilometers and with a population of 3,134,408 (2017). It is the capital of Khorasan Razavi province and has a relatively dry climate (Department of Studies and Planning, 2017). Between 2008 and 2018 the population of Mashhad has grown from more than 2.4 million people to 3.3 million, the number of vehicle trips per day has increased from 4,035,560 to 6,576,268 and the increase in trip rates per day from 1.64 to 2 (Department of Studies and Planning, 2017, 2007). This has led to an increase in the average consumption of gasoline and natural gas over the last 5 years (Department of Studies and Planning, 2012, 2017) and has made the adoption of policies to use non-motorized modes of transport essential.

A BSS was implemented in Mashhad in 2012, the ultimate aim being a system of 150 stations and 3000 bicycles for males above 15 years old. In 2018 there were about 2300 bikes and 128 stations, providing 10 h of service per day. According to the contracts between the Mashhad Municipality and the related contractor, the system is active from 6:30am to 4:30 pm. Mashhad's BSS lacks RFID and GPS systems but it supports online registration.

The system's stations all have human operators, there is no automated kiosk. Bike delivery in the stations is done by giving the credentials and phone number to the operator who checks these data via automated systems in the stations. Smart cards were used at the beginning of the project at some stations to allow users to pick up and return bikes without an operator, but general implementation failed. Therefore, services are now only provided with an operator and the smart cards are only used as a means to provide information about account charges. The smart cards can also be used for buses and LRT system, both for using the system and finding information. There is no online and offline registration fee for membership in the system, but users pay 250,000 Tomans[1] (59.07 US $) as a deposit to guarantee the return of the bike. Using the bikes is free for the first 30 min, and costs 200 Tomans per hour for trips that last longer. All the bikes are of the same size but there are two types with minor differences in looks and materials. Fig. 1 shows the location of the stations. Based on our estimation (see next sections) the usage rate of the BSS in Mashhad is relatively low (approximately 500–700 users out of 1 million potential users) and consequently the goals of the scheme have not been met.

In fact, this BSS could be considered as an incomplete form of the third generation[2] of BSSs, but from the local (Mashhad) perspective this scheme can be considered as a new transportation technology. Fig. 2 shows one of the stations in the city.

[1] 1 $ = 4232 Tomans and 1 Euro = 4870 Tomans.

[2] BSSs can be categorized into four generations based on Shaheen et al. (2010): 1. White bikes (or free bike systems), 2. Coin-deposit systems, 3. Information technology-based systems, and 4. Demand-responsive, multimodal systems.

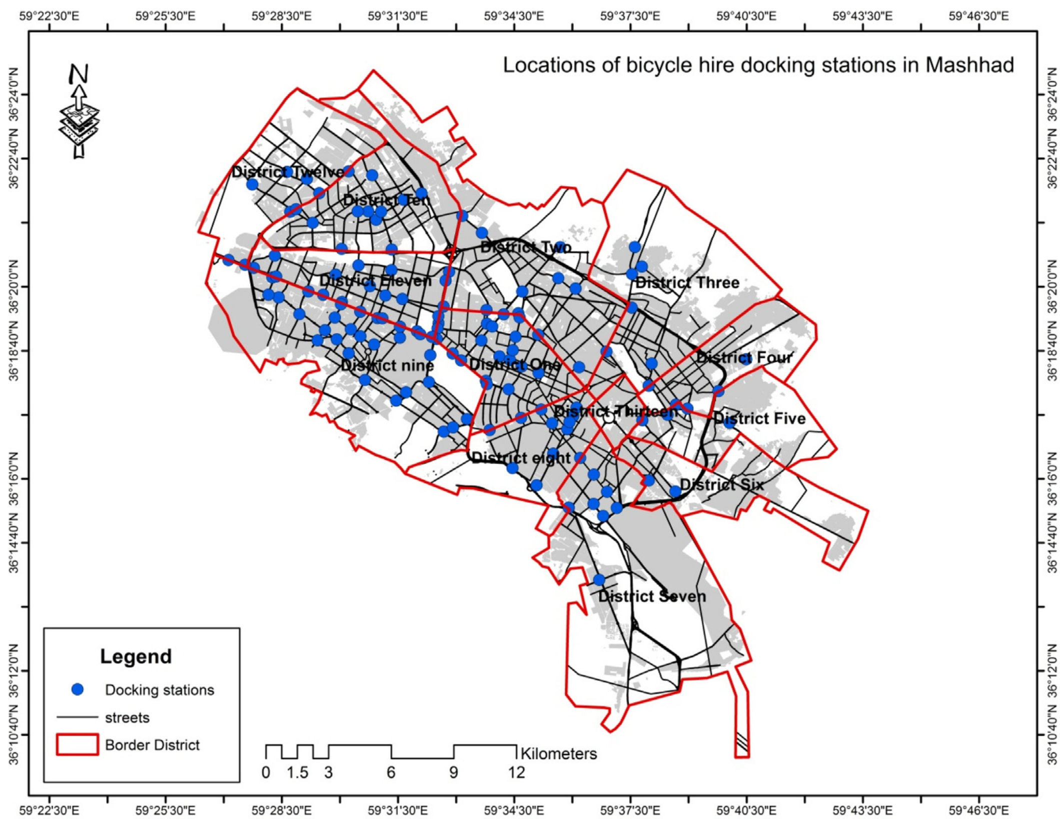

Fig. 1. Spatial distribution of BSS docking stations in Mashhad.

Fig. 2. Bicycle sharing station in Mashhad, Iran.

3.2. Data collection and sampling

Our original aim was to also include non-users in our research, because the motivations for not using the scheme are also of interest, but too many non-users were unfamiliar with the BSS and could not answer several questions. It is likely that weak marketing of the BSS led to low levels of awareness of the scheme. In line with, for example Madigan et al. (2017), we therefore eliminated non-users, and distributed questionnaires only amongst current users. Even though we could not include non-users, it is still of interest to study the behavior and motivations of users (Morton, 2018). Due to the lack of a proper information system, there was no precise information on the population of BSS users in Mashhad. Therefore we estimated the number of users based on a field study by two of the authors of this paper at the current 128 stations. Since we were unable to obtain any information about the usage rate, we asked all operators of stations to check the monthly usage rates for the previous 3–6 months. Based on the information on daily use of the BSS we estimated the number of users to be approximately 500–700. The average number of users per station is therefore very low. Comparing the estimated number of users with the 2300 bikes available, the use rate per bike per day is around 0.21–0.30, which is very low compared to the 3–6 trips per bike per day reported by most other international schemes (Fishman et al., 2015; Médard de Chardon et al., 2017). After assessing the questionnaire's validity via experts we chose to distribute 700 questionnaires among the 128 stations based on the average number of transactions reported by each station operator. The questionnaires were mainly distributed via the station's operators. In the data collection phase we went to the stations systematically and helped users and operators if needed, in case of questions about the questionnaire. Some of the users filled in the questionnaire at the stations, others provided the filled-in questionnaires the next time they used the system. We received 173 questionnaires of which 134 were useful resulting in a response rate of 19.1%. Note that we are not sure about the real sample size, due to the a priori distribution of questionnaires amongst stations – the real response rate could be higher. Incomplete questionnaires or those with very unlikely answers were not included. The questionnaires were distributed and filled in between Oct 2017 and March 2018.

3.3. Variables and measures

Based on Table 1 we designed a self-administered questionnaire, asking people about the importance of factors using a 5 point Likert scale ranging from "not at all" to "very high". Socio-demographic variables we included are shown in Table 2. The survey had 34 questions (8 questions in the Socio-demographic part and 26 questions for the potential factors affecting BSS acceptance). We did not cluster the 26 questions according to potential factors in categories, to avoid possible bias due to the labels used.

Table 2
Demographic characteristics.

Characteristics	Number	%	Characteristics	Number	%
Age(in years)			*Car ownership*		
< 20	17	12.7	Yes	27	20.1
20–24	52	38.8	No	107	79.9
25–34	46	34.3			
35–44	10	7.5	*Sex*		
45+	9	6.7	Men	134	100
			Women	0	0
Highest finished degree			*Experience of using BSS*		
High School	42	31.3	< 6 months	73	54.5
Bachelor's degree	66	49.3	6–12 months	41	30.6
Master's degree & PhD	26	19.4	> 12 months	20	14.9
Occupation			*Major usage purpose*		
Public sector	25	18.7	Travel to a place	104	77.6
Private sector	7	5.2	Recreational/Fun	30	22.4
Student	93	69.4			
Others	6	4.5			
Jobless	3	2.2			
Monthly income(million Tomans)					
< minimum wage*	107	79.9			
1–2 times minimum wage	17	12.7			
> 2 times minimum wage	10	7.5			

* Mid 2018 the minimum wage was 1.1 million Tomans [1 Euro = 4780 Tomans].

3.4. Data analysis strategy

To check the reliability of the questionnaire we first explored the ranges of Cronbach's α coefficients (Table 2). Next, using AMOS 22 we executed a confirmatory factor analysis to validate convergence and divergence of all 26 of the model's items (Table 3). Using SPSS 22 software and a one-sample T-Test we analyzed the data to see if the selected dimensions affected the acceptability of the BSS. Furthermore, following Fishman et al. (2014), who studyied BSS membership in Australia, we used a repeated measure, the Friedman Test, to compare the dimensions' impact on acceptability. The Friedman Test was used to compare the effectiveness of factors in each dimension. Using MANOVA and Box's Test of Equality of Covariance Matrices, Levene's Test of Equality of Error Variances, Wilks' Lambda, univariate test and pairwise comparison we investigated the relationship between the effectiveness of the studied dimensions and the socio-demographic characteristics: age, income, education level and experience of cycling.

4. Results

Table 2 shows the distribution over socio-demographic variables. After showing descriptive analysis, at the measurement section the authors used SPSS 22 to assess the studied dimensions.

4.1. Demographic characteristics of sample

Table 2 reveals respondents' demographic characteristics.

Table 2 shows that most of the participants were less than 35 years old (85.8%). In addition, approximately two-thirds of the participants were students, with people working in the public sector being the second largest category as far as employment status is concerned (18.7%). Over three-quarters of the respondents used the BSS to travel to a destination, the rest for fun/recreational goals. This may be due to the time restrictions of the use of the system: it closes at 4:30 pm. 79.9% of respondents did not own a car. Almost half of the users had a bachelor's degree and almost 80% of the respondents earned less than the minimum wage, which is probably explained by the high share of students. Anyway, it is the people on a low income who use the BSS. More than half of the users had been using the system for less than 6 months, which may express a low level of loyalty to the BSS. Note that, as explained above, women are not allowed to use the BSS, nor males below 15, reducing the potential to around 1 million of the about 3 million people living in Mashhad.

4.2. Descriptive analysis

Table 3 shows the key statistics for the factors: median, mean,

Table 3
Descriptive statistics for indicators of dimensions.

Question	Median	Mean	Standard deviation	Not at all %	2	3	4	Very High %
SC1: Observing the mutual rights	4.00	3.96	1.007	0.7	9	20.9	32.1	37.3
SC2: Awareness of benefits of cycling	4.00	3.60	0.868	0.7	11.9	25.4	50.7	11.2
SC3: Habit of using bicycle	3.00	3.36	0.937	1.5	17.2	35.8	35.1	10.4
SC4: Authorities' use of BSS	4.00	4.04	1.103	4.5	8.2	6.7	39.6	41.0
SC5: Getting participation of citizens	4.00	3.92	1.076	1.5	12.7	14.9	34.3	36.6
SC6: Driving behavior	4.00	4.07	0.939	0.7	7.5	13.4	40.3	38.1
EC1: The registration fee of BSS	4.00	3.54	1.060	2.2	14.9	31.3	29.9	21.6
EC2: Cost of using BSS	4.00	3.67	0.964	0.0	12.7	29.9	35.1	22.4
EN1: Climate conditions for cycling	4.00	3.64	0.999	1.5	11.9	29.1	35.8	21.6
EN2: Slope levels/ altitude variations	4.00	4.18	0.812	0.0	2.2	18.7	38.1	41.0
EN3: beauty of bike lanes	4.00	3.69	0.937	0.7	11.2	26.1	42.5	19.4
IN1: The bicycle design and color	4.00	3.94	0.994	1.5	9.0	16.4	40.3	32.8
IN2: Suitable equipment for bikes	5.00	4.23	1.054	1.5	8.2	12.7	20.9	56.7
IN3: Durability and quality of bike	4.00	4.17	0.845	0.7	3.0	14.9	41.0	40.3
IN4: Quality/quantity of bike lanes	5.00	4.36	0.835	0.0	4.5	9.7	31.3	54.5
IN5: Integration of BSS-network	4.00	3.78	0.864	0.0	5.2	35.1	36.6	23.1
IN6: Proper distribution of stations	4.00	3.80	0.811	0.0	5.2	29.1	46.3	19.4
IN7: Number of BSS stations	4.00	3.86	0.860	0.0	6.7	24.6	44.8	23.9
IN8: Proper signs for the cyclists	4.00	4.18	0.874	1.5	2.2	14.9	39.6	41.8
SF1: Informing people	4.00	3.87	0.865	0.0	6.7	24.6	44.0	24.6
SF2: Time interval of the operating	4.00	4.01	0.884	0.7	4.5	20.1	41.8	32.8
SF3: Service quality of BSS	4.00	3.94	0.847	0.0	6.0	20.9	46.3	26.9
SF4: Easy registration	4.00	4.12	0.832	0.0	3.7	17.9	41.0	37.3
SF5: Easy use of the system	4.00	4.24	0.768	0.0	3.2	13.4	42.5	41.8
SF6: Proper/ timely maintenance	4.00	4.14	0.787	0.0	3.0	15.7	45.5	35.8
SF7: Quick identification/ resolutions	4.00	4.01	0.809	0.0	5.2	16.4	50.7	27.6

Table 4
Factor loadings and Cronbach's α coefficients of the dimensions.

Dimensions	Factors	Factor loadings	Cronbach's α	Mean	Standard deviation
Socio-cultural			0.650	3.91	0.647
	SC1	0.497			
	SC2	0.405			
	SC4	0.535			
	SC5	0.597			
	SC6	0.582			
Economic			0.788	3.60	0.919
	EC1	0.833			
	EC2	0.783			
Infrastructure			0.736	3.98	0.514
	IN1	0.472			
	IN2	0.623			
	IN3	0.609			
	IN4	0.601			
	IN5	0.399			
	IN6	0.453			
	IN7	0.417			
	IN8	0.411			
System function			0.683	4.00	0.485
	SF1	0.418			
	SF2	0.405			
	SF3	0.499			
	SF4	0.503			
	SF5	0.578			
	SF6	0.462			
	SF7	0.571			

standard deviation and percentages for each of the 5 categories on the Likert scale. Highest mean scores apply to factors in the *Infrastructure* and *Socio-cultural* dimension.

Note that we eliminated 4 factors (SC3, EN1, EN2, EN3) after executing the measurement step (see below).

4.3. Measurement step

4.3.1. Reliability

This section analyzes the effectiveness of the studied dimensions. Since the factors were extracted based on the literature and clustered into 5 dimensions, it was necessary to conduct a confirmatory factor analysis (CFA) to ensure the convergent and discriminant validity of the factors (Churchill, 1979; Byrne, 2012). Using CFA it is possible to confirm the relationships between a set of observed variables and a set of common factors (Muthen and Muthen, 2010) and CFA allows researchers to determine whether the hypothesized structure provides a good fit to the data (Diana, 2014). In this regard, first of all, we applied CFA on the factors shown in Table 4, and eliminated SC3, EN1, EN2 and EN3 because of invalid loading factors (0.077, 0.170, 0.212 and 0.276 respectively) which is below the threshold value of 0.4 (Field, 2013). Therefore we also eliminated the dimension "*Environmental*". Next we estimated Cronbach's α coefficients of dimensions. Results show that all dimensions have a value higher than the threshold value of 0.6, confirming the reliability of the model's dimensions and indicating acceptable internal consistency for every dimension (Hair et al., 2010).

We then investigated whether there is a relationship between the two selected dimensions. According to the correlation calculation, "*Socio-cultural*" has a positive correlation with both "*Infrastructure*" and "*System function*" (0.484 and 0.554 respectively; correlation is significant at the 0.01 level), whereas we found that "*Economic*" has no (significant) correlations with other scales. It seems all three dimensions except for "*Economic*" have positive relationships, with the strongest correlations between "*System function*" and "*Infrastructure*" (0.598; significant at the 0.01 level) which means as the impact of "*System function*" on acceptance of BSS increase, so does the impact of "*Infrastructure*".

Table 5
Dimensions significance, using one-sample T-Test.

Dimensions	Mean	T	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Socio-cultural	3.91	16.44	0.000	0.91	0.80	1.03
Economic	3.60	7.60	0.000	0.60	0.44	0.76
Infrastructure	3.98	22.19	0.000	0.98	0.89	1.07
System function	4.00	24.06	0.000	1.00	0.92	1.09

4.3.2. Analysis of dimensions and factors

4.3.2.1. Dimensions significance. We measured the effectiveness of dimensions by a one-sample T-Test based on the mean level (number 3 as the mean level of the Likert scale). Table 5 presents the results and suggests that all the dimensions are significant (at the 95% confidence level). The mean difference is highest for *System function* which illustrates a higher rate of significance. *Infrastructure*, *socio-cultural* and *Economic* have mean differences of 0.98, 0.91 and 0.6 respectively.

4.3.2.2. Dimensions effectiveness comparison. We next present a repeated measures analysis to compare the effectiveness of the dimensions: Wilks' Lambda $F = 8.924$ with significance of $0.006 < 0.001$. In addition Mauchly's Test of Sphericity and the Greenhouse-Geisser test both show significance levels of 0.00 indicating the reliability of the dimensions' differences. Next we applied pairwise comparisons and the Bonferroni test to estimate the dimensions' differences. Table 6 shows the results, revealing that the *Economic* dimension has a lower effect in comparison with other dimensions (also see Fig. 3). Fig. 3 shows the mean scores differences based on pairwise comparisons which shows that of the four dimensions the mean score for *Economic* dimension has the highest distance from the mean scores. "*Socio-cultural*", "Infrastructure" and "*System function*" have greater influences on BSS acceptability compared to "*Economic*" based on positive and significant mean differences (0.315, 0.382 and 0.404 in turn with $SIG < 0.05$) which reveals "*System function*" has the strongest impact on users' acceptance. So, the system function and performance of the private company managing the BSS in Mashhad was evaluated as a key factor influencing the BSS acceptance in Mashhad from the users' point of view.

4.3.2.3. Factors effectiveness comparison. Next we present the importance of each factor for user acceptance. This not only to be better able to understand user acceptance, but also because policy makers are able to take measures at the level of factors rather than at the level of dimensions. The Friedman Test was used to compare the effectiveness of the factors in each dimension. A non-parametric Friedman test of differences between *Socio-cultural*, *Economic*, *Infrastructure* and *System function* factors was conducted and rendered Chi-square values of 28.91, 2.18, 77.16 and 24.66 respectively, revealing that all dimensions were significant, and therefore we are able to do a comparison of the factors of all the dimensions ($P = 0.000 < 0.01$) except for the dimension *Economic* ($P = 0.140 > 0.01$).

As Fig. 4 shows, *Driving behavior in Mashhad* and *Authorities' use of BSS* have the highest mean rank respectively for the *Socio-cultural* dimension. In a qualitative study Jahanshahi et al. (2018) found these factors to be effective for the acceptance of BSS. In this dimension, *Awareness of benefits of cycling and BSS* are less important factors. For factors in the dimension *Infrastructure*, 'bike lanes' has the strongest impact. Indeed, as confirmed in earlier studies Mashhad does not have suitable and integrated bike lanes (Jahanshahi et al., 2018, 2019).

Table 6
Pairwise comparisons for dimensions.

Dimensions	Dimensions	Mean Difference	Std.error	Sig	95% Confidence Interval of the Difference	
					Lower	Upper
Socio-cultural	Economic	0.315[b]	0.098	0.010 [a]	0.052	0.578
	Infrastructure	−0.067	0.048	0.953	−0.195	0.060
	System function	−0.089	0.045	0.306	−0.210	0.032
Economic	Socio-cultural	−0.315[b]	0.098	0.010[a]	−0.578	−0.052
	Infrastructure	−0.382[b]	0.088	0.000[a]	−0.617	−0.148
	System function	−0.404[b]	0.086	0.000[a]	−0.634	−0.174
Infrastructure	Socio-cultural	0.067	0.048	0.953	−0.060	0.195
	Economic	0.382[b]	0.088	0.000[a]	0.148	0.617
	System function	−0.022	0.034	1.000	−0.114	0.070
System function	Socio-cultural	0.089	0.045	0.306	−0.032	0.210
	Economic	0.404[b]	0.086	0.000[a]	0.174	0.634
	Infrastructure	0.022	0.034	1.000	−0.070	0.114

a: Adjusted for multiple comparisons using Bonferroni.
b: The mean difference is significant at the 0.05 level.

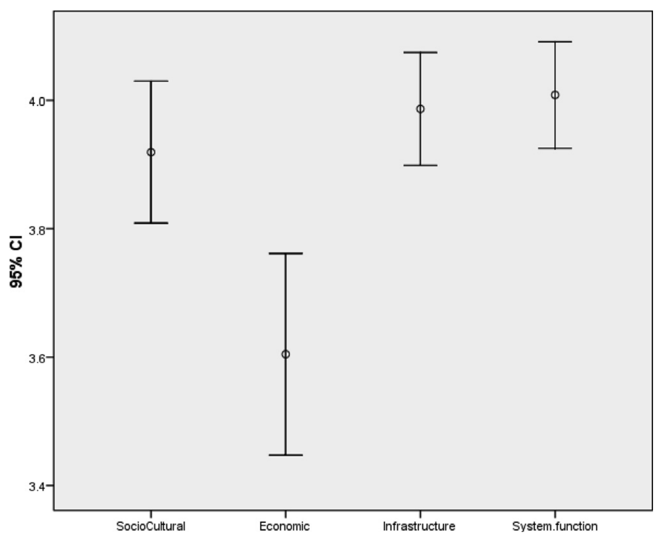

Fig. 3. Different mean score of dimensions.

Finally, in the dimension *System function* the results indicate *Easy use of the system* to be the strongest factor. This confirms the earlier findings of Fishman et al. (2014, 2015) who found that easy usage and convenience were key factors to motivating people to use BSS. In this dimension, *informing people about the system* is the least important factor.

4.3.2.4. Relationship between dimensions and demographic aspect. The literature shows that socio-demographic characteristics can affect BSS acceptability (Transport for London, 2010; Shaheen et al., 2011; Fishman et al., 2014; Bernatchez et al., 2015; Tran et al., 2015; Spotswood et al., 2015; Jahanshahi et al., 2017). Therefore we explored the relation between some socio-demographic variables (educational levels, income, age and experiences of using BSS) and the dimensions, using MANOVA analysis. For this purpose, first of all, we used Box's test to evaluate the equality of covariance matrices and Levene's test to evaluate the equality of error variances, followed by Wilks' Lambda test to explore if there is any significant difference between the dimensions when the values of socio-demographic variables change. Next, a univariate test illustrates which dimensions change due to changing the value of socio-demographic variables. Finally a pairwise comparison reveals how demographic categories affect the impact of selected dimensions on the acceptance of BSS. Note that the first impression may be that the results of this section could differ from the descriptive results presented above, because we now only focus on the differences in the perception of the users about the effectiveness of selected dimensions considering their age levels, income levels, educational levels and experiences.

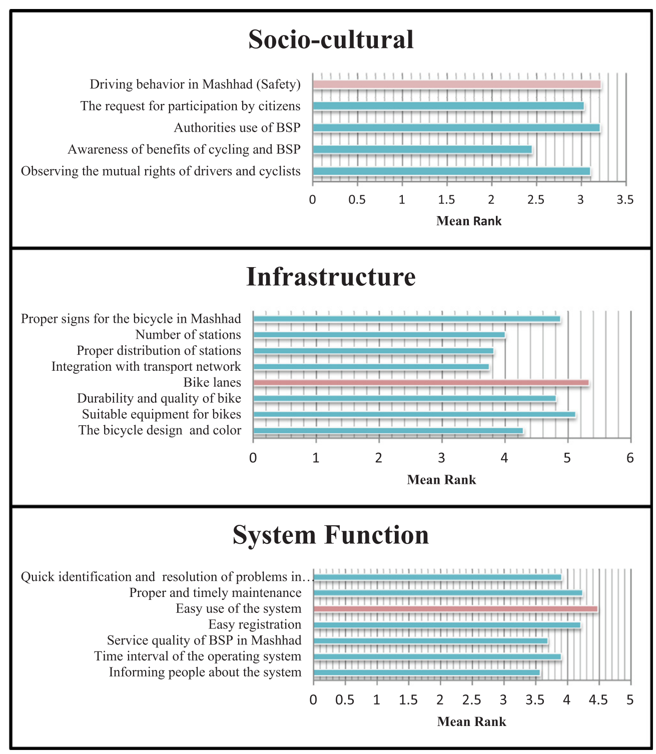

Fig. 4. Factors comparison for each dimension based on mean rank of Friedman test. Red factors have the highest impact on acceptance of BSS in each dimension. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

4.3.2.4.1. Educational levels. The educational level (and related: knowledge) of the citizens can affect their use preferences (e.g. Bernatchez et al., 2015). According to studies in the context of the success of BSSs, the number of university students has a major role in the success of these programmes (Tran et al., 2015). This confirms findings of other recent studies in the area of BSS which show the education level of BSS users to be relatively high (Ricci, 2015; Raux et al., 2017; Manzi and Saibene, 2018). Therefore we explored the impact of education level on the dimensions.

For *Education*, results of the Box and Levene tests indicate that it is

Table 7
Univariate tests for Educational Levels.

Dimensions	Mean Square	Sig	F	Partial Eta Squared
Socio-cultural	1.203	0.055	0.91	0.043
Economic	0.424	0.609	0.60	0.008
Infrastructure	2.039	0.000	0.98	0.116
System function	1.066	0.010	1.00	0.068

reliable to use MANOVA (SIG < 0.05 for both). After which, Wilks' Lambda test was used to determine whether the MANOVA is statistically significant or not. Results illustrated that there was a statistically significant difference in all the dimensions based on educational levels, $F = 2.75$, $p < 0.05$; Wilk's $\Lambda = 0.848$, partial $\eta2 = 0.079$.

To determine the impact of education level on the dimension's impact on BSS acceptance, Univariate tests were used. Table 7 shows that educational level has a statistically significant effect on both the dimensions *Infrastructure* ($F = 8.58$; $p < 0.05$; partial $\eta2 = 0.116$) and *System function* ($F = 4.79$; $p < 0.05$; partial $\eta2 = 0.068$), whereas there are no significant effects for the *Socio-cultural* and *Economic* dimension (P is more than 0.05 for both of them). In order to investigate and compare the effect of different educational levels on *Infrastructure*, we used pairwise comparison, showing that mean scores were statistically significantly different between "High school" and "Bachelor's degree" ($p < 0.05$), and "Master's degree & PhD" and "Bachelor's degree" ($p < 0.05$), but not between "High school" and "Master's degree & PhD" ($p = 0.114$). (Sig < 0.05 for each two educational levels in Table 8 means that these different levels of education had different opinions about the dimension which selected for them in the table). Results reveal that the Infrastructure characteristics of BSS are less important for acceptance of users with a bachelor degree (mean differences are negative: -0.248 and -0.442 compared with H and M in Table 8). Respondents with a Bachelor degree score significantly different from those with a Master and PhD degree ($p < 0.05$) on the dimension *System function* (see Table 8). As can be seen, users with a Bachelor degree are less sensitive about the performance of the BSS company compared to users with a higher level of education (Mean difference of -0.323). To sum up, respondents with a Bachelor's degree had a different perception of the effectiveness of the dimensions *Infrastructure* and *System function* compared to people with lower and higher levels of education.

4.3.2.4.2. Income. Previous studies show that income can affect the use of BSSs (Karki and Tao, 2016). For example, studies in London and Australia have shown that users of the BS programme had higher incomes compared to other citizens (Transport for London, 2010; Fishman et al., 2014, 2015). Also a recent study in France shows that BSS users have relatively high social positions (Raux et al., 2017). Ricci (2015) found the same result in a review of BSSs. But the impact of income could be different in other contexts. For example, in developing countries or in smaller cities people with low incomes might use the programme more than others because of its affordability and because they probably don't own a car. The results reveal that it is reliable to use MANOVA (SIG > 0.05 for both tests of Box and Levene). But Wilks' Lambda test shows there was not a statistically significant relationship between income level and scores on the dimensions ($F = 0.728$, $p = 0.667 > 0.05$; Wilk's $\Lambda = 0.956$, partial $\eta2 = 0.022$). Univariate tests also confirm this. The significance for all four dimensions is higher than 0.05 (0.628, 0.977, 0.120 and 0.621 for *Socio-cultural*, *Economic*, *Infrastructure* and *System function* respectively). Although most BSS users in Mashhad have a low income, the results reveal that income level is not significantly related to the impact of dimensions on the acceptance of BSS. Note that the BSS is available in all parts of Mashhad, both in parts where low incomes dominate, as well as in parts with mainly people with high incomes, so the geographical distribution of the BSS does not influence the relationship between income and BSS use.

4.3.2.4.3. Age. The Box test results reveal that the requirements are met to investigate the impact of different age levels on the studied dimensions by MANOVA ($p < 0.05$), although Levene's test only showed this to apply for the dimensions *Infrastructure* and *System function.* Therefore we also executed Wilks' Lambda test and the results revealed the correlations to not be significant ($F = 1.563$, $p = 0.076 > 0.05$; Value = 0.825, partial $\eta2 = 0.047$). Therefore we conclude that there are no significant relations between age and the scores on the dimensions. This contradicts a recent study showing that older people are more willing to accept and support BSS (Nikitas, 2018).

4.3.2.4.4. Experience of using BSS. Results show SIG < 0.05 for both the Box and Levene's tests, but Wilks' Lambda test reveals that there was not a statistically significant difference between levels of experience of using BSS and the scores on the dimensions ($F = 0.962$, $p = 0.0664 > 0.05$; Value = 0.942, partial $\eta2 = 0.029$). This contradicts the findings of Spotswood et al. (2015) who found experience of biking to be positively correlated with BSS acceptance levels.

5. Discussion and conclusions

This study investigated the factors influencing acceptance in the users of the first BSS in Iran, implemented in Mashhad in 2012. The

Table 8
Pairwise comparisons for educational level.

Dimensions	Educational Level	Educational Level	Mean Difference	Std.error	Sig	95% Confidence Interval of the Difference	
						Lower	Upper
Infrastructure	H	B	0.248[b]	0.096	0.011[a]	0.058	0.439
		M	−0.194	0.122	0.114	−0.434	0.047
	B	H	−0.248[b]	0.096	0.011[a]	−0.439	−0.058
		M	−0.442[b]	0.113	0.000[a]	−0.665	−0.218
	M	H	0.194	0.122	0.114	−0.047	0.434
		B	0.442[b]	0.113	0.000[a]	0.218	0.665
System function	H	B	0.173	0.093	0.066	−0.011	0.357
		M	−0.150	0.118	0.206	−0.383	0.083
	B	H	−0.173	0.093	0.066	−0.357	0.011
		M	−0.323[b]	0.109	0.004[a]	−0.539	−0.106
	M	H	0.150	0.118	0.206	−0.083	0.383
		B	0.323[b]	0.109	0.004[a]	0.106	0.539

a: Adjusted for multiple comparisons.
b: The mean difference is significant at the 0.05 level.
H: High School; B: Bachelor Degree; M: Master Degree & PhD.

results show that the majority of users are under 35 years (85.8%). This is in line with the findings of some earlier studies in developed cities (Shaheen et al., 2011; Morency et al., 2011; Buck et al., 2013; Fishman et al., 2014; Bernatchez et al., 2015; Ricci, 2015; Raux et al., 2017). We also found that the system is mainly used by people with a low to medium income, and by students. The effect of income contradicts studies in developed countries (e.g. Transport for London, 2010; Ogilvie and Goodman, 2012; Fishman et al., 2014, 2015; Ricci, 2015; Raux et al., 2017; Hosford et al., 2018) which is probably explained by the affordability of the system compared to, for example, owning and using a car. Higher daily transportation costs of using a car were reported as a motivation to use BSS in Jiangsu, China (Li et al., 2018). The fact that students are an important client category is in line with the findings of some previous studies (Tran et al., 2015; Castillo-Manzano and Sánchez-Braza, 2013; Mattson and Godavarthy, 2017). For example, one-third of BSS users in Paris are students and most of them also work at least part-time (Raux et al., 2017). The present study illustrates that almost 80% of the users don't own a car, whereas most of the users in France had access to a car. In Beijing, Hangzhou and Shanghai BSS users had higher levels of car ownership compared to non-users (Fishman et al., 2013). Owning a car may discourage people in some cities to use a BSS. This probably applies to some people in Mashhad, but also in the more developed city of Seville in Spain (Castillo-Manzano and Sánchez-Braza, 2013). On the other hand access to cars does not have a clear impact on BSS use in other cities, for example, Paris or in some Chinese cities (Raux et al., 2017). Also it is interesting to note that since bike sharing stations in Mashhad are present in all districts (both affluent and deprived areas) the high level of use amongst people with lower incomes cannot be explained by the geographical distribution of the system (as found in the study of Goodman and Cheshire, 2014). As also explained by Bernatchez et al. (2015), knowledge and education have a significant role in increasing the awareness of BSS in Montreal, Canada. The high percentage of utilitarian trips (as opposed to recreational trips) is probably due to the early closing time of the system of 4:30 pm.

Results further reveal that all four dimensions, *Socio-cultural*, *Economic*, *Infrastructure* and *System function* have a significant effect on users' acceptance of the system, the impact of the *Economic* dimension being lower than the other three dimension. The results also showed that authorities' use of the system encourages others to use the system, probably because it improves the social status of using a BSS (see also Roland Berger Study, 2015). Some studies show that seeing a cyclist with sporty clothing can discourage other people to accept cycling for commuting (Green et al., 2012; Goodman et al., 2014). Authorities cycling in formal wear might to some extent compensate this effect.

We also found that the bad driving behavior of other road users has a negative impact on the use of the system, confirming earlier findings of Jahanshahi et al. (2018). Also the fact that citizens can participate in the planning of BSS is an important factor for its acceptance. It is crucial to understand the fact that the success of each program in a society depends on social participation through democratic processes, and it is important to note that planning must also be done by people, not just for people. Not involving people can damage the interest in, and success and acceptance of urban programs (Rahnama, 2008; Karki and Tao, 2016).

In the category *Infrastructure* we found acceptance to depend on the (perceived) quality of the bike lanes, the availability of suitable bike equipment and proper urban traffic. Mashhad does not have a proper and integrated system of bike lanes (Jahanshahi et al., 2019) and the bicycles in the BSS are of poor quality. They do not have suitable and high quality accessories and equipment, no baskets, no horn, no light, no gears, no adjustable seat. These results are partly in line with the literature. Castillo-Manzano and Sánchez-Braza (2013) found that easy registration and easy use of BSS in Seville, Spain plays a vital role in users' satisfaction. Additionally, in a recent study, Manzi and Saibene (2018) found that "bike comfort and functioning" is a key factor for the use of BSS. This factor relates to questions IN2 and IN3, and we also found these factors to be of importance. Generally, improving cycling infrastructure is urgently recommended for developing countries (Ahmad and de Oliveira, 2016). Alaeddini and Fayezi (2011) also found traffic signs to be an important factor for BSS use. The importance of the quality of the bike routes is confirmed by several studies, such as the study of Taghvaei & Fathi (2011) who emphasized the need for safety, continuity and soundness of routes. A suitable and large bicycle lane network can be one of the main contributors to the success of a BSS (Castillo-Manzano and Sánchez-Braza, 2013). Findings of Shokoohi and Nikitas (2017) in Kuala Lumpur show that in a city with poor bike lanes, the poor quality of cycling infrastructure and low levels of safety are major barriers to BSS use. This also applies to Mashhad. Also in small sized cities in India, safety concerns are a key barrier to bicycle use in general (Majumdar and Mitra, 2015). Perceived risks are related to infrastructure characteristics such as the quantity and quality of bike lanes, to traffic signs and to the use of some equipment such as horn, helmet and lights. Goodman et al. (2014), Nikitas et al. (2016) and Nikitas (2018) mention the perceived risks related to infrastructure as one of the most common barriers to cycling and BSS use in the cities. Infrastructure and safety especially play an important role in cities and countries with low levels of cycling and high levels of car use in addition to a low quality cycling infrastructure (Nikitas, 2018). This confirms our results.

With respect to the *System function* dimension we found Easy use and easy registration to be important, confirming the findings of Fishman et al. (2014, 2015). Chen (2016) even considers these factors to be some of the most effective factors in creating loyalty to the use of shared bikes. Jahanshahi et al. (2018) found that a remarkable percentage of non-users mentioned hard registration as an important barrier to participating in the BSS system in Mashhad. We found proper and timely maintenance of bicycles to be the next important factor, confirming the results of Midgley, (2011) and it was one of the main concerns of BSS users in Milan, Italy (Manzi and Saibene, 2018). Additionally, according to the literature, the convenience of car driving is a considerable barrier to the use of BSS (Shaheen et al., 2012; Carse et al., 2013; Fishman et al., 2014).

As part of the *Infrastructure* dimension we found spatial factors, mainly proper distribution of stations and system integration with public transport network and the number of stations in the area, to be important. The proximity of stations to work and a proper distribution of stations were also found to be important by Fishman et al. (2014). Also in another study by Zhang et al. (2015), a proper spatial distribution of stations was an important factor in improving user satisfaction of a BSS in Hangzhou, China.

Socio-demographic characteristics were hardly correlated with the factors and dimensions, the main exception being education level: users with a bachelor's degree are less sensitive to the dimensions *Infrastructure* and *System function*. We did not find a study which claims that people with a specific educational level have a different perception of the effectiveness of some factors on the acceptance of BSS. The lower level of sensitivity of users with a bachelor's degree could stem from the fact that around 79% of users with a bachelor degree are students. Tran et al. (2015) found that students are an important category of consumers of BSSs. The lower level of sensitivity we found could be explained by the fact that most people with a bachelors degree were students.

As argued above we think it is important to consider the specific geographical, physical and cultural diversities in developing countries, making it risky to blindly follow the findings of western countries. We next link this statement to our findings. An important finding is that due to the low costs of BSSs in Iran, this system could be considered as a viable option by the citizens. However, in order to make the system attractive the shortcomings of design, planning and operation need to be overcome. Based on earlier studies it seems that the company running the BSS in Mashhad has not been successful in operations, supervision and management of the BSS, and that the cycling infrastructure in Mashhad is of poor quality (Jahanshahi et al., 2018, 2019). Therefore cooperation between the public and private sector could result in better infrastructure and BSSs. In addition, additional financial resources could improve the quality of the BSS and consequently acceptance and use, either directly, for example by increasing the quality of bikes, or indirectly via, for example, advertising, education, and improving bike infrastructure in general, or even designing the transport system for active modes, as opposed to motorized transport. A recent study also found that more cycling-related investments in smaller cities with low bicycle usage levels can facilitate cycling, and reduce some concerns and barriers, and result in more acceptance (Nikitas, 2018). Also some recent studies illustrating the success of BSSs in cities and countries like Kuala Lumpur (Malaysia) and India could depend on cycle infrastructure investments (Shokoohi and Nikitas, 2017; Patel and Patel, 2019). To summarize, the quality and quantity of bike infrastructure is a key factor for the success of any policy aimed at stimulating cycling, including the implementation of a BSS. Manzi and Saibene (2018) argue that a monopoly for a (BSS) service provider can easily lead to a lack of understanding of the low level of satisfaction of the clients. Providing a second BSS in Mashhad by a private company could therefore have positive effects.

Now, according to the findings, a few suggestions are made to solve the existing problems and improve the performance of Mashhad BSS and other similar systems:

- Defining mutual rights and laws of bikers and drivers of motor vehicles in order to improve their reciprocal rights.
- Raising awareness among citizens and users and increasing knowledge regarding the need and the way to use BSS.
- Ambition and dedication of national and regional government officials to use bicycle in transportation in order to encourage more people to use sustainable modes of transportation.
- Raising the level of participation of citizens in the city in designing and planning BSSs (and other urban projects).
- Increasing the quality (design, equipment) of bikes in a BSS, increasing the availability of bikes, and checking the bikes' health.
- Increasing the time intervals of the BSSs, encouraging both utilitarian and recreational use.
- Creating proper and safe urban cycling routes.
- Improving the redistribution of bikes over stations.
- Providing an information app to see the real time number of bikes available at each station; to be able to collect data to improve the design of BSS, and to support adequate redistribution of bikes across stations.
- Designing and installing suitable traffic signs on roads and streets so that other motor vehicles pay more attention to the rights of cyclists.
- Installation of traffic lights for bicycles.
- Banning vehicles from entering certain urban areas and adopting proper related fiscal and controlling policies.

5.1. Limitations

This study focuses on a BSS with low usage rates in a developing country. The sample size is relatively small, as a result of the low usage rate of usage and the small number of users in Mashhad, Iran. Consequently the results cannot be easily generalized; they might apply to small scale bike-sharing systems in similar contexts. Also the fact that we could not include non-users limits the value of our study.

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