

Original Research

## Introducing a Practical Model for Developing a Bicycle Sharing System in Shiraz

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### ABSTRACT

Due to insufficient attention paid to the bicycle sharing system infrastructure, a lack of culturalization on its proper usage as well as poor planning of construction, preservation, and development of this system, the present study was carried out to represent a functional model for developing a bicycle sharing system in Shiraz, a populated city located in the Southwest of Iran. The present study also is a fundamental research in terms of purpose and exploratory in terms of data collection and was carried out by applying the data-based theory method. Data collection tool was a semi-structured in-depth interview. Snowball technique as a purposeful sampling was used for a statistical population including experts and professionals. The data were analyzed by using open, axial and selective coding to extract the final pattern. The final model consists of a set of axial categories, causal conditions, and essential contexts, confounding variables, strategies and consequences of the bicycle sharing system in Shiraz. However, each of these conditions and factors has its variables and categories. In this study, the motivations behind sport activities, environmental efficiency, cutting urban traffic, flexibility, security and easy use of bicycle sharing system in Shiraz with highlighting barriers (infrastructures and equipment, educational culture, individual barriers, poor government strategy, social, economic and environmental barriers), and the necessary contexts (climatic conditions and appropriate landscape diversity, easy integration of bicycles and the internet, entertainment and leisure facilities, and gaining the support of many stakeholders) have been studied. Results show that the enhancement of health and happiness among citizens, promoting users' cooperation and satisfaction, overcoming the transportation and traffic problems, enhancing environmental qualities, creating employment, increasing the sustainable efficiency and attracting more investors from private sectors could be achieved by formulating sustainable urban mobility policies, promoting the lure of using the bicycle, developing the smart bicycle sharing system, technical infrastructures of designing of the bicycle sharing system, integrating and alignment of policies of public and private sectors, management of connecting with users, building a trading model and targeted advertising.

**Keywords:** Bicycle sharing system, Cycling, Health, Transportation, Environment.

### Introduction

Nowadays, most people living a sedentary lifestyle which raises concerns over their health as well as problems such as traffic congestion and environmental issues [1]. Marlier et al. have emphasized the importance of cooperation between different departments to prevent health problems and promote physical activities[2]. In this regard, cycling as a healthy and enjoyable activity can provide physical and mental benefits to the cyclists. Besides, cycling is one of the ways to achieve sustainable urban management and has become increasingly popular around the world in the past two decades as a recreational-sport activity [3]. Bauman et al. (2015) showed that cycling not only increases physical activities, but also promotes taking part in sport [4]. Cycling provides major health benefits to people. First, it significantly improves cardiopulmonary adaptation [5], cognitive function in adults [6] and metabolic [7], decreases the risk of cardiovascular diseases [8] and modulates the immune function of athletes[9]. Moreover, it could reduce inflammation and improve bone density [10].

To promote cycling, there is a need to cooperate with multiple sectors including sports, health, environmental, and traffic organizations. These organizations can foster good citizenship and offer

opportunities for participation in cycling. As a result, social and environmental factors influence the cycling behavior of users of bicycles [11]. On the one hand, Yeh et al. (2019) showed that infrastructure and improvement projects increase the number of trips and recreational benefits for cyclists [12]. From the perspective of Kaplan et al. (2019), promoting cycling and its infrastructure not only can lead to active commuting to school and work for children and adults respectively but also reduce cyclists' stress levels and form a habit of bicycling in them [13]. On the other hand, Fasczewski et al. (2019) have acknowledged that social and cultural support for cycling motivates citizens to participate in it. In Iran, bicycles have gradually been expelled from the context of community life because of political-economic culture since the 1970s which led to the idea that everybody may have a personal car [14].

Thus, the rapid growth of the automobile industry in Iran, a lack of safety for cyclists, and neglect the bike in various levels of planning in the country the importance of bicycles as a vehicle has put into the shadow and made it a recreation for kids [15].

Traditionally, Shiraz has a mild climate and the social context for cycling. However, special bike routes have existed in some parts of Shiraz for a few decades. But for some social and cultural reasons, a lack of necessary infrastructure, some distant trips, interference with traffic congestion and other vehicles which diminishing cycling safety, the importance of this vehicle has gradually been neglected [16]. In addition to a range of health and environmental and social benefits of cycling, the most important aspect of sharing cycling activities is their physical activity [17].

On the other hand, the next few years will be crucial for the development of cycling transport, due to a huge investment in cycling infrastructure by transport planners [18] as well as sports managers' plans for greater citizens' engagement and participation. Therefore, in recent years the issue of bicycle-sharing systems has been discussed. The bicycle-sharing system allows people to rent bicycles at a station which is located in special spots around the city and ride them for a short trip and deliver them to another station [19].

The bicycle sharing system, as a system that requires participation in sports, health and transportation sectors, can provide an active trip for citizens. The bike-sharing system has made rapid progress over the years. Although the bike-sharing programs have always been controversial, they have positive effects on traffic flow, the environment, and public health. Moreover, the social effects, management and sustainable development of bicycle sharing have also been considered [20]. In addition, the fact is that bicycle usage patterns are affected not only by common contextual factors (e.g., time and weather) but also by opportunistic contextual factors (e.g., social and traffic issues) that pose a great challenge [1]. Bicycle sharing stations have also been set up in Shiraz in recent years to follow the lead of developed countries in this matter. Bike rental stations are an example system of user-bike interfaces [21].

Creating bike stations and designing bike lanes, the right space for citizens to ride the bicycle to get around the city will institutionalize using bicycles instead of cars for next generations to come. Bicycles are a very suitable choice for short urban trails. In Shiraz, the percentage of trips made by bicycle in the urban environment is 5.14%. Therefore, researching on cycling in urban planning in Shiraz is of great importance both in terms of sport and traffic issues [22]. The institutionalization of cycling among citizens is more likely to be facilitated with the development of the bicycle sharing system. As a result, it can bring numerous personal and social benefits. While the bicycle has found its special place in today's world due to a wide range of applications in different climate and geographical situations in Iran, especially in Shiraz, the importance of cycling and participation in sport have not been emphasized. However, the factors that contribute to the development of the bicycle sharing system have not been well discussed yet and the mechanisms that can provide a better quality of service are significantly less studied. In addition, the development of the bicycle sharing system requires understanding the users' and professionals' views on the cycling system sharing from different social, environmental, traffic and sports sectors. Therefore, the platforms and contexts facilitating this system should be provided and all possible barriers should also be identified so that planners and executives could fully manage their activities and citizens could optimally use

this system. Therefore, the present study aims to introduce a practical model for developing a bicycle sharing system in Shiraz.

### Materials and methods

The purpose of this study is to carry out qualitative research, in terms of data collection and using the grounded theory method. The statistical sample of the present study was (n = 25), including professors (n = 4), cycling staff (n = 3), managers of the General Directorate of Sport and Youth (n = 7), traffic police (n = 3), municipal sport officials and urban planners (4 people) and executives of the bicycle sharing system (4 people).

In this study, purposeful sampling was performed with a snowball method. The main method of data gathering in this study was the semi-structured in-depth interview technique which used existing research literature and the development of the bicycle sharing system to formulate questions. Samples of the interview questionnaire were:

What are the factors affecting a bicycle sharing system in Shiraz?

What are the conditions necessary for developing a bicycle sharing system in Shiraz?

What are the obstacles to developing a bicycle sharing system in Shiraz?

What are your suggestions for developing a bicycle sharing system in Shiraz?

How can the bicycle sharing system affect Shiraz (economic, social, cultural, etc.)?

According to Guba and Lincoln (1985), the scientific validity of qualitative studies consists of four criteria: credibility, transferability, dependability, and dependability. These are presented in the following table.

**Table 1.** Validation and Reliability of Qualitative Research Methods

<b>Credibility</b>	<b>Sampling until data reach a saturation point, long-term field involvement, multilateral data</b>
<b>Dependability</b>	Inspection, researcher documentation of data, methods and decisions, researcher multilateralism
<b>Confirmability</b>	Parallel examination of results and reflectivity
<b>Transferability</b>	A detailed description of the environment and the participants and a variety of views and experiences of the interviewees

Data were analyzed by coding. In the open coding phase, the codes referring to a common topic were grouped and referred to as the initial codes (extracted from the interviews). Concepts emerged and categories were extracted from the comparison and classification of concepts.

In the axial coding stage, in order to relate the main categories to the sub-categories, a paradigm model was used to identify the causal conditions, axial phenomena, contextual factors, confounding variables, strategies, and outcomes. Then, through the selective coding and based on the pattern of the identified relationship between categories and sub-categories in open and axial coding, the categories were linked together and the relevant theoretical system was presented.

### Results

As Table 2 shows, the experts in the 25 interviews mentioned a wide range of factors to answer the questionnaire. Finally, a wide range of interview texts were extracted by removing similar concepts.

More precisely, at the first stage, many obtained themes were reduced to fewer codes by using the reciprocal process of data analysis. In order to avoid duplication of all the same basic codes that were conceptually very close, they came together to form the concepts that formed the categories. Finally, 33 categories were identified. In the second stage, axial coding components (such as causal conditions, axial phenomena, contextual factors, confounding variables, strategies, and outcomes) were identified by using the data collected (Table 2).

The most important step in the selective coding phase was to draw selected codes from coding components. The following table illustrates the selected coding pattern resulting from the axial coding outlined above.

**Table 2.** identified concepts and categories related to interview questions

Codes (identified concepts)	Subcategory	Selected Categories (Dimensions) main category
Establishment, Maintenance, and development of the bicycle sharing system	Development of the bicycle sharing system	main phenomenon
Physical health [23], Psychological health [23, 24], Pleasant social activity [24], Recreational use [25], An exercise important aerobics, Fitness, Weight loss	The motivation for physical activity is the use of bikes	Prerequisites for Bicycle sharing system Causal categories
Affordability [24], Economic benefits for families, Attracting consumers for leisure or shopping Purposes, Using bicycles for work purposes	Commercial use of bicycles	
An alternative system for disabled people, low time [23], Access to a cycling system [12, 26], Used by different classes and ages for short trips.	System flexibility	
No damage to the environment, No damage to infrastructure and transport routes, Decreased road maintenance costs, Reduced environmental waste, Socio-environmental dimension [23], Increased environmental awareness, No greenhouse gas emissions [23], Environmental health	Eco-friendly	
Time-wasting in public stations, Utility and necessity of transportation, Convenient organization, and cycling transportation facilities, Ease of movement in traditional areas of the city due to the narrow and narrow streets, High traffic, Convenient transportation	Urban Traffic Facilitator	
Privacy, Road Safety, Increasing Influence and Improving Non-Motor Transport Security [17], Guaranteed Cyclists' Rights [12], Cyclists' Psychological Safety, Cyclists' Safety	Convenient and safe usability	Bicycle sharing system platforms Contextual factors
Temperature, rainfall, special attractions for the routes, The need to respect the beauty of the route and its diversity, Urban furniture and green space, The potential of the physical environment, the smoothness of the floor and the short ride, The convenience of using the bike, The space available for the bike Riding, Different Landscapes, and Landscape variations [12]	Climatic conditions and diversity of urban landscape	
Paying attention to social media, Information technology, GPS tracking, Internet booking, Phone booking	Bike and internet integration	
Psychological Benefits, Health Benefits, Health-Focused Attitude towards Bicycles, Proximity to Public Transport Stations[25], Proximity to Crowded Centers, Proximity to Training Center [25]	Recreational and leisure bed	

Low cost shared system compared to the motor transport system, Attraction of Private Investment [24], Various Investors, NGO Support, Municipal Support, Sports and Youth Offices Support, Citizens Support, Urban Management Support	Supporting multiple stakeholders	<b>Barriers to Bicycle sharing system</b>	<b>interfering factors</b>
The bike's apparent lack of attractiveness (color and design) [27], the lack of different bike sizes at stations, Bike stiffness and quality, Poor track lighting at night [28], A lack of easy access to cycling routes [29], A lack of use of the latest technologies [30], lack or lack of routes Bike specials, A lack of parking space for bikes [31], Inadequate cycling facilities, Damaged bicycles [32], Inappropriateness et Traffic, limited service hours, holiday bike service centers, A low number of cycling stations	Infrastructure and Equipment		
A lack of community education [33], Bad driving habits, changing people's lives and cars, A lack of cultural infrastructure [31, 32], Early childhood education [34], Low cycling culture, A lack of research and innovation[35], Weakness or A lack of media advertising [29], the disproportionality of women cycling with public culture and community customs, A lack of participation and usage by senior people [36]	Educational Culture		
A lack of time and worry, Laziness [37], Improper user hours, Habit and poor mental attitude towards bicycles [38], A lack of cycling skills, A lack of awareness of the physical health functions of cycling [39], Physical disability for cycling, Fatigue of users	Individual obstacles		
Inappropriate planning[36], Weaknesses in policies and incentives [33], cyclist insecurity [40], Poor spatial distribution of cycling stations, Difficult access to bike stations, A lack of government funding, Laws, Regulations, Obstructive guidelines	Weak government strategy		
Incompatibility with Social Prestige [36], Attitude, Social norms and regulations [36], Influence and Social Impact [34, 41], Pressure and social labels [39], Social disapproval, A lack of access to women, A lack of participation of all stakeholders in system development [42]	Social barriers		
A lack of funding for a bicycle, Expensive bike and maintenance costs [35], A lack of financial credibility to provide a proper site [31], A lack of financial credibility to build cycling routes, A lack of conditions for attracting investors, Inadequate government funding and facilities, Exchange rate instability for bike purchases and technology development, Cost inefficiencies [43], A lack of proper operation	Economic barriers		
The attractiveness of cycling routes [28], Air [32], Topographical barriers in the city, Urban traffic density [31]	Environmental barriers		
Identify the strength and weakness of the bicycle sharing system, Take advantage of opportunities such as holding sporting events, Determining the number of trips to be taken by bicycle, Checking short-range trips in the area, Assessing the need for using bicycles for health, Setting station target levels [44], Bike demand forecasting [45, 46]	Formulating sustainable urban mobility policies	<b>Bicycle sharing system mechanisms</b>	<b>Strategic categories</b>
Attracting bike use (calorie consumption, or carbon footprint), Attractive designs to reduce consumer costs, Considering population variability, Varying bike supply at different times and locations, Designing attractive cycling routes [47], Deployment of sports equipment on routes, Development, and renovation of bicycles, Adequate lighting of bike paths, Cleanliness of bike paths [12], Beauty of paths	Extend the appeal of using a bike		

<p>Emphasis on innovation and technology [48], A better understanding of smart cities planning and management [30], Route information system deployment, Purchase and use of new equipment and technologies, Information systems bicycle sharing system, integration of Bicycle sharing system and public transport [45], quality of interaction between system physical design and service delivery [24], increased awareness of the system, distribution of instructions and booklets System Usage Guide [45], Demand and Supply Proportional</p>	Smart Bicycle sharing system	
<p>Standardization of facilities, creation of special bicycle paths [17], expanding population-based bicycle-sharing network [49], high width bicycle special paths, separation of shared paths, sufficient competence and skill of providers system, maintenance plans, bike redistribution mechanisms, proportional distance of origin and destination, creation of signposts on bike paths, existence of dedicated bike lanes, design of bike paths in accordance with the wind direction and sunlight, continuity and continuity of travel path bicycle, optimum location, parking), maintenance services dynamic density of stations [50], optimized routing [44], suitable slope bike routes</p>	Technical infrastructure of the system	
<p>Financial support and subsidies, public-private partnerships in the construction, operation, maintenance and financing [1], formulation of facilitation rules, provision of joint ventures with reputable foreign companies, incentive-support policies, expanding the support of nonprofits (environmentalists, community sports and cycling), investment, management and finance [24]</p>	Integration and alignment of public and private sector policies	
<p>Studying successful systems and their performance, using consultants and experts, expanding research, training system providers, identifying target audiences, identifying all system stakeholders, applied research and developing innovative solutions [45], information sharing, knowledge, and expertise, training programs</p>	Research and Development	
<p>Proper organization of users, building long-term relationships with users, enhancing user recognition, respecting other citizens' rights, easy access to the system and user registration, social impact [30], increasing citizen motivation, considering users' needs and tastes. , empowering citizen satisfaction, improving citizen perception [30], increasing citizen cycling motivation</p>	Manage communication with users	
<p>Creating and maintaining a system image, pricing, ability to change prices for customer loyalty, paying attention to tourism emphasizing the system, paying attention to user costs, building trust among stakeholders, operating business models for bicycle sharing system, ensuring consumer attention, social branding, having various aspects of value for stakeholders [24]</p>	Developing a business model	
<p>Newspaper and magazine advertisements, posters, television and radio ads, catalogs and brochures, creative promotional campaigns, attending regional and international exhibitions, system introduction seminars, an advertising-training programs, installation and system development by advertising company in exchange for the right to advertise, develop a culture of cycling through the media</p>	Targeted advertising	
<p>Entertainment &amp; Recreation, Increasing Citizenship, Positive Health &amp; Wellness Effects [51], Improving Cardiovascular Health [52], Improving Cardiopulmonary Function, Muscle Relaxation, Fat Reduction, Reducing Injury and Accident</p>	Increasing vitality and citizenship health	Outcomes bike sharing systems introduction

Increased user satisfaction, increased participation and use of the bicycle [52], increased motivation and effort of users, increased social interaction, increased learning and publicity of the cycling system, improved quality of life for citizens	Improve user engagement and satisfaction
Reducing transport and traffic problems [52], increasing the speed of bicycle traffic compared to other vehicles in busy areas, contributing to sustainable transport	Improved transportation and traffic problems
Reduce fossil fuel consumption, reduce energy and fuel consumption, reduce noise pollution, reduce visual pollution, reduce air pollution, improve fuel management, Reduce energy loss and time;	Improving environmental quality
Reduce urban transportation costs, create sustainable employment, Tourism development, reduce waste and system Costs, Proper use of resources, Reduce labor loss Rates, Smart city development	Creating employment and increasing sustainable productivity
Increasing system providers' revenue levels, Increasing investor interest, Greater investment opportunities, Better system financing	Increased attraction of private sector investors

The pivotal category is a phenomenon that forms the basis of the process. This category is titled for the obtained framework or pattern. The central phenomenon of this research is the development of the bicycle sharing system which includes the establishment, maintenance, and development. The identified concepts are divided into six categories in terms of causal terms. In summary, causal outcomes include the use of motivational and sport-based bicycles, the commercial use of bicycles, system flexibility, environmental friendliness, urban traffic facilitators, and security and usability. Once having added up the concepts and eliminated similar concepts, four categories of climatic conditions and diversity of urban landscape, bicycle and internet integration, leisure contexts and multiple stakeholder support were identified. The coding results for the confounding factors included seven categories of infrastructure and equipment, cultural, educational, individual barriers, poor government strategy, social, economic, and environmental barriers. The coding results for the strategies needed to develop the bicycle sharing system included 9 categories (formulating sustainable urban mobility policies, expanding the appeal of bicycle use, intelligent bicycle sharing system design, technical sharing infrastructure of bicycle sharing system, integrating and aligning public and private sector policies, research and development, user relationship management, advertising business model development). Coding results for the development implications of the bicycle sharing system include 6 categories consisting of enhancing vitality and citizenship health, promoting participation and satisfaction of users, improving transportation and traffic problems, promoting environmental quality, creating employment and increasing productivity, and increasing investor attraction.

The pattern of the bicycle sharing system based on the six paradigms resulted from the open, axial and selective coding is as follows:

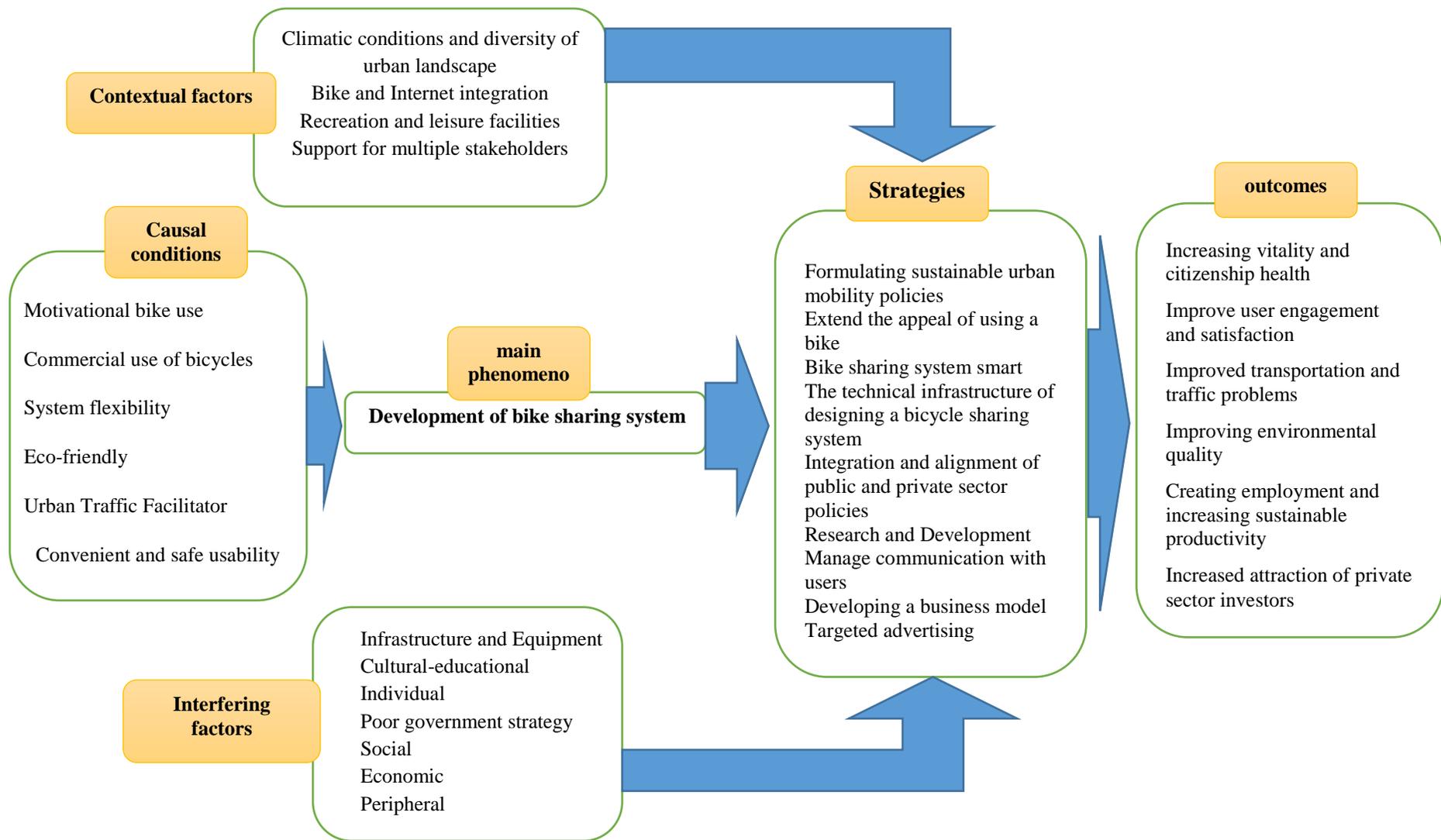


Figure 1: pattern paradigm research based on coding

## Discussion and conclusion

The purpose of this study was to provide a practical model for developing a bicycle sharing system in Shiraz. The concepts and categories were formed by using experts' opinions. Then, their views were analyzed by using the grounded theory method. The results of pattern from the research data consists of 5 categories namely prerequisites, main phenomena, mechanisms, system development barriers, strategies and outcomes. Prerequisites included motivations for taking part in sports activities, improving environmental efficiency, facilitating urban traffic, flexibility, security and ease of use of the bicycle sharing system in Shiraz. The barriers to develop this system included the unsuitable infrastructures and equipment, educational, social, economic, environmental and individual barriers, and poor government strategy as well. Mechanisms to achieve this end summarized in the appropriate climatic conditions, easy integration of bicycles into the Internet, leisure facilities and the stakeholders' support. The strategies were to formulate sustainable urban mobility policies, use the street's appeal for bicycle transport, provide the intelligent system, promote public-private cooperation and develop a business model. Developing a bicycle sharing system resulted in enhancing citizenship vitality, users' participation and satisfaction, transportation, environmental quality, creating more job opportunities, and attracting private sector investments. The Shiraz bicycle sharing system model as an applied model can be used to improve the mental and physical health of citizens which sports officials and managers would be more aware of citizen participation in sports. Based on the results, it is recommended that:

1. the attractiveness of cycling routes be enhanced by using trees, adequate light, a lovely urban landscape with adequate space, natural perspective, and especially considering women's and children's safety, and appropriate signage that does not limit the view will also helpful.
2. The routes be predictable, the messages of the signs be clear and unified but shouldn't be numerous so that all cyclists, including both resident and strangers, can find their way easily.
3. Routing should be in such a way that cyclists always move on flat and continuous route and do not collide with motor vehicles. In this regard, the route should not be bended and its slope and bumpiness as well as high traffic fluctuations should be minimized. In addition, the route should be kept away from the effects of the weather (rain and sun) as much as possible.
4. The time and distance between the source and the destination be short. Avoid one-way streets and other obstacles that cause time waste.
5. Creating special infrastructure for women (such as dedicated bike parks and training centers)
6. Develop cultural activities and motivational factors among talented people capable of using bicycles, including students, government or private sector employees, and so forth.

Last but not least, in the present study, data have been analyzed by the qualitative method, however it has also uncovered many areas that need additional study in other big cities of Iran and use other statistical methods to identify unknown angles of development of the bicycle sharing system.

**Conflict of interest:** None

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## چکیده فارسی

### ارائه الگوی کاربردی توسعه سیستم اشتراک دوچرخه در شهر شیراز

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به دلیل نبود توجه کافی به زیرساخت‌های سیستم اشتراک دوچرخه و همچنین عدم فرهنگ‌سازی برای استفاده صحیح از آن و همچنین برنامه‌ریزی ضعیف در راستای استقرار، نگهداری و توسعه این سیستم، تحقیق حاضر با هدف ارائه الگوی کاربردی توسعه سیستم اشتراک دوچرخه در شهر شیراز انجام گرفته است. پژوهش حاضر براساس هدف از نوع تحقیقات بنیادی است و برحسب گردآوری اطلاعات اکتشافی و با استفاده از روش نظریه داده بنیاد انجام شده است. ابزار گردآوری داده‌ها مصاحبه عمیق نیمه ساختار یافته بود. جامعه آماری شامل خبرگان و متخصصان بوده و از روش نمونه‌گیری هدفمند با تکنیک گلوله برفی استفاده شده است. داده‌های جمع‌آوری شده با استفاده از کدگذاری باز، محوری و انتخابی، تجزیه و تحلیل شدند و الگوی نهایی استخراج گردید. مدل نهایی از مجموع مقوله محوری، شرایط علی، بسترها و زمینه‌های لازم، متغیرهای مداخله‌گر، راهبردها و پیامدهای سیستم اشتراک دوچرخه در شهر شیراز تشکیل شده است. هر کدام از این شرایط و عوامل تشکیل‌دهنده الگو دارای متغیرها و مقوله‌هایی هستند، که توجه به تحقق آنها موجب توسعه سیستم اشتراک دوچرخه در شهر شیراز می‌گردد. نتایج بیانگر آن است که به دلیل انگیزه فعالیت ورزشی، بهره‌وری زیست‌محیطی، تسهیل ترافیک شهری، انعطاف‌پذیری، امنیت و راحتی، از سیستم اشتراک دوچرخه در شیراز استفاده می‌شود و توسعه سیستم اشتراک دوچرخه، پیامدهایی همچون افزایش نشاط و سلامت شهروندی، ارتقای مشارکت و رضایت کاربران، بهبود مشکلات حمل و نقل و ترافیک، ارتقای کیفیت زیست‌محیطی، ایجاد اشتغال و افزایش بهره‌وری پایداری و افزایش جذب سرمایه‌گذاران بخش خصوصی را به دنبال دارد.

**واژه‌های کلیدی:** سیستم اشتراک دوچرخه، دوچرخه سواری، سلامتی، حمل و نقل، محیط زیست.