ORIGINAL ARTICLE

Identifying and Evaluation of Bike Paths problems using SWOT method (Case Study: the bike path between Taqi Abad Square and City Park Square crossroads in Mashhad)

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ABSTRACT
The problem of urban traffic is one of the biggest problems in large cities are confronted with it. Urbanization and the increase in traffic and densities in metropolitan especially urban centers, has created unfavorable conditions for urban areas. Since the bike is one of the cleanest, safest and least expensive methods of transportation in the world, solving problems and creating appropriate and standard bike lanes can encourage citizens to use this method of transportation and facilitate reaching sustainability. The aim of this study was the use of SWOT analysis in one of the main axis of Mashhad city to investigate and analyze the quality of bike path and identifying its problems and to encourage the use of this method of transport for daily trips and designing standards of bicycle paths. The results showed that by using effective measures could increase the efficacy of cycling and encouraging citizens to use bicycles, and to help expanding public transportation to in order to save fuel consumption and reduce air pollution by reducing trips inside the city.
Keywords: traffic, metropolitan, transportation system, bike, bike path, urban sustainability

INTRODUCTION

Development of public transport systems such as buses, taxis, subway and etc have major role in reducing pollution of motor vehicles but due to the limited capacity of the road and passersby, the traffic and noise and air pollution due to it still left. The use of bicycle as an optimal solution to solve some of the problems and difficulties in the field of urban transport can come true these demands by making continuous network design with beautiful paths, and safe and easy lanes. The use of bicycles in addition to being economical, pollution-free is effective in citizens' physical and mental health. Countries such as Japan and China have begun the use of bikes in years between 1970 and 1980. Moreover, today, bicycle has announced as the main transportation vehicle in their society, and this movement then spread to Europe and America. The developed countries of the world pay more attention to use the bike day-by-day, careful planning has been done in this regard, and enormous budget is intended to use it. Bicycle production from 1970 to 2002 nearly has been tripled. In 2002, about 104 million bicycles were produced. One of the main actions that municipal authorities follow in developed countries with regard to the principles of sustainable urban design and transport is creating favourable conditions for bicycle traffic Copenhagen is the capital Denmark. According to residents of this city, Copenhagen is one of the best cities in Europe for cycling. Since the first report of bicycle was prepared in 1995 to 2003, bicycle traffic increased by 41% while this figure was 18% for another motor vehicles [1]. In Netherlands, the city of Groningen, since 1997, city managers, follow the policy-making and planning for a complete city for traffic and transportation. The purpose of this policy is to reduce traffic congestion and control the development of urban dimensions. Given the wide acceptance of the bike is in the Netherlands, this city also operates vast activities in context of creating green paths for transportation. With a share of 43 percent of the use of bike, Groningen is the third of the world's pioneer's cities in the field of cycling while it has suitable conditions for economic activities as well [2]. In historical city of Yazd, Iran because of having dense constructions, not desirable network of roads for passing vehicles using all kinds of bicycle is very common. Users of bicycles are generally students, small businesses, workers of the government. The first

time that refers to the bicycle in the city of Kashan, is in Kashan comprehensive plan that has been developed and proposed during 1975 to 1977 that due to traffic congestion existed on Fin road due to the commuter cyclists. In this plan, creating a path for cyclists and considering criteria for taking the bike park at the level of elementary, middle and high school were proposed [3]. In Tehran, projects that have predicted the duty of transportation for to bike presented that due to not respecting and attention to the safety of cyclists, lack of marginal parking, and non-suitable path failed [4]. Studies of public bicycle scheme in Mashhad have begun since 2007 and in October 2010, through legislation of Islamic city council of municipalities were required to implement this plan. Since this plan has prepared more by traffic approach and travel demand discussion so has encountered by problems such as lack of beauty and comfort, lack of safety and public interest. Unfortunately, lack of attention to this issue by municipal authorities causes fading of this urban transportation. Therefore, the aim of this study was to development urban transportation systems regarding to various urban contexts and considering urban environments. In this regard, the design and development of a standard bike paths and providing functional and theoretical strategies and advices for bike traffic could encourage citizens to use this transportation method for their daily transit trips. The main question examined in this study was to investigating characteristics of successful bicycle network and study of problems and shortcomings of public bicycle network in Mashhad.

METHODS AND MATERIALS
This study was an applied study as its results would be of applied in urban planning and solving problems. The method of the investigation was cross-sectional that by using SWOT planning the results presented. Data collection was carried out using documents searching and field study which according to implemented plans and design criteria related to the investigation concluded and studied.
Study area
Distance between Taghi Abad Square and Park crossroads in urban dividing of Mashhad city has located in region one that has relatively heavy traffic due to multiple markets. Lots of commercial companies and one of the largest mobile markets of Mashhad has located in this region. These streets are considered as predominantly affluent neighbourhood of Mashhad that some of the largest hospitals of Mashhad (such as Qaem and Goharshad hospitals) have located in this area. In addition, the largest shops of selling carpets and food supply have located in these streets. This area has several old streets and famous places like three-way of guidance, Abouzar Ghaffari Boulevard, Reza Boulevard, Naser Khosrow and Molla sadra. At the south part of Malek Abad Street can mention to important historical garden of Malek Abad .

RESULTS
Qualitative analysis of biking paths
Qualitative analysis of studies on recognition of study area limitation, with emphasis on identification of good indicators of bike path and by separation of area have presented to four different functional orders. In the qualitative analysis, the scores for each row according to the privileges given to each indicator about bike path were desired.
Study of possibility of creating bicycle path based on the existing criteria according to six criteria including safety, continuity, to be easy, elegance, comfort and clarity of path in 4 axes of Taghi Abad- Ahmadabad square, Ahmadabad square-Felestin square, Felestin square-Khayyam three intersection and Khayyam three intersection-Park crossroads carried out. The results of possibility of creating bike path were as follows:
In the axis of Taghi Abad to Ahmad Abad square, of the six criteria studied, each of the 6 criteria were at good condition. On the other hand, 100% of the criteria were at suitable condition. Ahmad Abad axis to Felestin square of 6 criteria, 5 criteria of safety including ease of use, aesthetics, comfort, and clarity of the path that included 83% of the criteria were at good condition, and 17% were at to some extent appropriate condition. From Felestine square to three-intersection of Khayyam, of the 6 studied criteria, 3 criteria including path, the path coherence, clarity and beauty of path that included the 50% of the criteria were at appropriate condition. In case of three criteria of safety, convenience and comfort, it was in to the extent appropriate condition. In Khayyam three-intersection to Park crossroads of the six studied criteria, two criteria including path coherence and path clarity or 34% of the criteria were in appropriate condition. 4 criteria including safety, ease of use, aesthetics, comfort of path were to the extent appropriate. The results of SWOT analysis are shown in Tables 1-3.

Table 1. Qualitative analysis of biking paths (reference: authors)

Sum of privileges						Khayyam three-way intersection to Park crossroads			Felestin square to Khayyam three-way intersection			Ahmad Abad square to Felestin square			Taghi Abad to Ahmad Abad square			
Inappropriate		To the extent appropriate		Appropriate		Inappropriate	To the extent appropriate	Appropriate	Inappropriate	To the extent appropriate	Appropriate	Inappropriate	to some extent appropriate	Appropriate	Inappropriate	to some extent appropriate	Appropriate	pathCriteria
no.	%	no.	%	no.	%													
0	0	2	50	2	50		☆			☆			☆				☆	Path safety
0	**0**	**1**	**25**	**3**	**75**			☆			☆		☆				☆	**Path coherence**
0	0	2	50	2	50		☆			☆				☆			☆	Path easy to use
0	0	1	25	3	75		☆				☆			☆			☆	Path beauty
0	0	2	50	2	50		☆			☆				☆			☆	Path comfort
0	0	0	0	4	100			☆			☆			☆			☆	Path clarity
0	0	8	34%	16	66%	0	4	2	0	3	3	0	1	5	0	0	6	no.
	0%		34%			0	66	34	0	50	50	0	17	83	0	0	100	%

Table 2. SWOT analysis on biking paths(reference: authors)

Threats	opportunities	Weaknesses	Strengthens	
-possibility of occurring accident at the intersection between cyclists and cars -Lack of regulations for bicycles - Lack of culture for the use of bicycles -interaction of moving cyclists with bus stations and people at bus stops -According to the high respiration in cyclists, air pollution has destructive effects of on them	-to be close to shopping centres -presence of public transport stations -high percentage of the age group of 5 to 65 years old -proper lightening at night to increase security and to encourage people to use bicycles - creating facilities related to bicycles such as parking and cars services along the path - creating traffic signs and signals for the regulation of movement on the bike path - possibility of creating urban space along the path as a pause space and resting areas for cyclists - opportunity for communication with bike path of this axis with the urban potential and central axes	-lack of bike station -Not continuity of bike path -Lack of symptoms and signs related to biking - Lack of covered parking -presence of sewage valve in the line -Lack of differentiation of bike path from the other direction by colouring the path	-Presence of appropriate path for biking -Appropriate intersections -Presence of bicycle parking -Appropriate floor making -high safety of users due to the	Ahmad Abad street

-existing of subway station as a barrier along the way

-High number of signalized intersections throughout the oath that lead to slow movement
- Lack of enough parking and bike shop in the area
-lack of appropriate urban furniture along the path
-problems in cyclist access to the other side of the boulevard
-lack of pause space along the path
-high volume of traffic on the roadway at more hours of the day

separation of riding path of bicycle path

-appropriate boulevard width for adjacent of three kinds of traffic including riding, pedestrians and bicycles
-proper slope of the path
-presence of uses of population attractiveness
-dynamics and vitality of the street because of the current applications
-to being one-side of most of the subordinate streets and alleys connected to Ahmedabad Boulevard that passes of the bike through the intersection is done easier
-The importance of Ahmedabad Boulevard as one of the main arteries of Mashhad city

Table 3. SWOT analysis of Malek Abad (reference: authors)

Threats	Opportunities	Weaknesses	Strengthens
-lack of uses for absorbent of population -presence of multiple edges -Lack of proper lighting at night -interaction of car and bike, especially at Khayyam intersections and at the end of the Malek Abadi boulevard - More damaging of air pollution on cyclists	- Low effect of traffic flow of ride on biking move in more distance of path -opportunity to create an attractive and recreational bike path - opportunity to create urban space along the path as pause space -possibility of making parking and bike repair stations -adjacent to public transportation terminals -high security due to military centres -presence of Malek Abad garden on the south side of Boulevard, which also causes air stylized and beauty of landscape -opportunity to create visual diversity using vegetation and the pool -presence of multiple edges -Lack of proper lighting	-low quality of current bike path -improper floor making of path -presence of numerous obstacles in the path of the bicycle -Lack of bicycle parking -low width of bike path	-appropriate width of sidewalks and local access to Boulevard margin -presence of bike rental station -presence of appropriate vegetation high safety of users due to separation of riding and bicycle paths

at night
-interaction of car and bike, especially at intersections and at the end of the boulevard Khayyam- Malek Abad
- More damaging of air pollution on cyclists

-not use of the current path and changing it to a place for car park

-partial darkness of Boulevard at night due not being commercial of its edges
- High traffic and air pollution in most hours of the day
-interaction of moving vehicles and bicycles in some areas
-shortage of pause space along the path

-appropriate slope of path
-low number of signalized intersections
-importance of Boulevard as one of the city's arterial roads
- Relative coherence of path
- Little traffic in walk side
-presence of two major urban cores at the end of Boulevard (Ferdowsi University and Mellat Park)
-Lack of need to access to the southern side of the boulevard regarding their uses (Garden of Malek Abad)
- Relative clarity of path

Strategic analysis of bike paths at Malek Abad and Ahmad Abad streets

In all studies and investigations in the study area with an emphasis on favourable bike paths, area and 24, 23, 16 and 11 points of strengths, weaknesses, opportunities and threats and in binary comparing of internal and external factors a total number of 30 key strategies have been derived. The proposed strategy was based on four categories commensurate with the risk factors of invasive strategy (maximum-maximum), adaptive (minimum- maximum), contingency strategies (maximum - minimum) and defensive strategy (mini least) that were presented. Given the predominance of strengths, weaknesses, opportunities and threats, the best strategy analysis was invasive strategy with the approach of win-win strategy (Table 4).

Table 4. SWOT table on strategies (reference: authors)

Weaknesses	Strengthens
-lack of bike station	-Presence of appropriate path for biking
-Not continuity of bike path	-Appropriate intersections
-Lack of symptoms and signs related to biking	-Presence of bicycle parking
- Lack of covered parking	-Appropriate floor making
-presence of sewage valve in the line	-high safety of users due to the separation of riding path of bicycle path
-Lack of differentiation of bike path from the other direction by colouring the path	-appropriate boulevard width for adjacent of three kinds of traffic including riding, pedestrians and bicycles
-existing of subway station as a barrier along the way	-proper slope of the path
-High number of signalized intersections throughout the oath that lead to slow movement	-presence of uses of population attractiveness
- Lack of enough parking and bike shop in the area	-dynamics and vitality of the street because of the current applications
-lack of appropriate urban furniture along the path	-to being one-side of most of the subordinate streets and alleys connected to Ahmedabad Boulevard that passes of the bike through the intersection is done easier
-problems in cyclist access to the other side of the boulevard	-The importance of Ahmedabad Boulevard as one of the main arteries of Mashhad city
-lack of pause space along the path	
-high volume of traffic on the roadway at more hours of the day	

1. Providing services to cyclists (such as a car park and garage) with respect to the importance of bike paths of main communication axes 2. Emphasis on the use of bicycle regarding the high volume of traffic at field study in order to reduce socio-economic costs 3-organizing public transport stations to avoid interference with motor bike paths 4-organizing bike network linkage with an emphasis on the design and modification of intersections 5. Attention to organize bike paths and simultaneously to both dimensions of traffic and aesthetic	1. Strengthening of bike paths to facilitate access to shopping centres 2. The hierarchical organization of bike paths in moving traffic with an emphasis on main communication axes 3. Coordination of the capacity of bike routes in the axes with related service capabilities to them 4. Strengthening local bike paths (with an emphasis on community centres and the neighbourhood units) 5. The unity of the local bike paths with main trails axes 6. Promote the safety of cyclists on main arterial bike roads 7. Introducing measures to encourage more people to use bicycles 8. Encouraging different age groups to the use of bicycles with the proposed arrangements for the women to use this system 9. The measures provided to use the bike day and night 10. The operation of the motor areas of the bike path those are associated with the use of absorbent population to increase interaction, dynamism and vitality 11. diversification to space at station nodes of bike path to encourage greater use of bicycles	**Opportunities** -to be close to shopping centres -presence of public transport stations -high percentage of the age group of 5 to 65 years old -proper lightening at night to increase security and to encourage people to use bicycles - creating facilities related to bicycles such as parking and cars services along the path - creating traffic signs and signals for the regulation of movement on the bike path - possibility of creating urban space along the path as a pause space and resting areas for cyclists - opportunity for communication with bike path of this axis with the urban potential and central axes
1. Prevention of accidents at intersections along the bike paths according to their number 2. Providing access of public transport stations to bicycle parking 3-equipped bike paths with a variety of regulatory and supervisory models 4-extension of culture of using bicycle through creating a secure network of passing for bicycle 5. The provision of green space paths due to air pollution in order to protect the health of cyclists 6. Environmental monitoring and control of bike paths in order to maintain and repair them if necessary 7. Securing the bicycle-passing network in order to reduce interference of cyclist moving 8. Diversification of bike paths to increase tending to use of bicycles 9 riders accessibility in the width of main artery	1. Increase of management monitoring of local road for proper implementation of provisions relating to bike 2. The provision of social and cultural context in order to encourage people to use bicycles 3. Suitable network interconnections of biking with other systems of public transport 4-reinforce of cover of bike paths with emphasis on attractive uses cover of population and educational applications to reduce the tend to use private cars 5. Publicity and awareness of the benefits of the bicycle network for motor vehicle drivers culture	**Threats** -possibility of occurring accident at the intersection between cyclists and cars -Lack of regulations for bicycles - Lack of culture for the use of bicycles -interaction of moving cyclists with bus stations and people at bus stops -According to the high respiration in cyclists, air pollution has destructive effects of on them

DISCUSSION

Based on the obtained results some main criteria are listed for successful biking path. A bicycle network is successful when the following criteria in addition to the following criteria are welcomed to public and in addition to reducing traffic and environmental issues, cause health for citizens. - The safety of road: safety is one of the basic criteria for bicycling. One of the main causes of conflict for cyclists is incompatibility of cycling with other modes of transport. Therefore, the interference and collision of biking paths and other motor vehicles should be prevented as much as possible and in areas where bicycle traffic volume is high,the motor vehicle speed must be kept low as possible.

- Network coherence: In network, designing must be tried to create continuous paths, of direct lines. This network should be developed outside of urban core. In other words, a dense network of bike paths to residential, business, shopping and leisure time should connect the whole of the city.

- Easy route: cycling network should be easy. In easy network, cycling is easy for most people. Longitudinal steep slopes, high and long standing at the intersection and the amount of deviation from the shortest path, make the path hard.

- The beauty of the path: regarding the bicycle traffic speed and its relative low speed, paying attention to around environment is more in comparison to motorized vehicles traffic. Thus, it is necessity of observing the beauty and diversity of the path that is very important. In addition, paths should be equipped with urban furniture, green spaces and places to park the bike and signs.

- Easy route: if the ease of route does not interfere with respect to short and coherence network, it must be considered in determining the shape of network. [5].

- Clearly of path: bike paths to inform cyclists of facilities of around path should have complete clarity and readability and should be tried to connect the path in a continuous, direct and shortest route shape and distance between source and destination. Diversion routes that make the travel distances long should be avoided [6].

In the current study, Mashhad bike network had lots of problems and shortcomings that generally cited as follows:

- Lack of bike stations all over the city
- Lack of continuity of bike paths
- Lack of signs and guidance boards for biking
- Lack of facilities such as parking and bicycle repair shop
- Lack of space to pause along the paths
- existing of several obstacles along the path and etc.

CONCLUSIONS AND RECOMMENDATIONS

Today, metropolises encounter with many problems such as traffic and pollution from motor vehicles. The use of bicycles in addition to physical and mental health of individuals can reduce traffic and pollution of the motor vehicle. In Mashhad that is the second largest metropolis in Iran the lack of efficient and convenient bicycle strongly felt. In this study, by using SWOT analysis, one of the main and busy axes of Mashhad has been analyzed and by strategic analysis of axis, a set of practical recommendations for improving the bike path and encouraging more people to use bicycles as a means of transportation, offered as follows:

1. Strengthening bike paths to facilitate access to shopping centre
2. The hierarchical organization of bike paths in order to move the traffic by emphasis on main communication axes
3. Coordination of capacity of bike routes in the axes with their related service capabilities
4. Strengthening local bike paths (with an emphasis on community centres and the adjacent units)
5. preserving unity of the local bike paths with main axes biking paths
6. Promoting the safety of cyclists on main arterial bike roads
7. introducing measures to encourage more people to use bicycles
8. encourage of different age groups to use of bicycles with the proposed arrangements for the ladies to use this system
9. The measures provided for use the bicycle day and night
10. to get beneficiary of existing motor spaces along the bike path that is associated with the use of absorbent population to increase interaction, dynamism and vitality
11. space diversification in station nodes of bike path to more encourage to use of bicycles

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