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Walking and Other Environmental Friendly Forms of Urban Transportation

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Abstract

Walking offers several social, economic, and environmental advantages as a mode of non-motorized transportation. Furthermore, several areas of sustainable development are being highlighted nowadays, and the promotion of sustainable transportation modes is being explored in accordance with this approach. As a result, the goal of this study is to investigate the situation of the interaction between walking and sustainable urban transportation. For this article, the most important resources related to walking traits were surveyed using a documentary method, and after explaining the concept of sustainable transportation and its indicators, and drawing on the perspectives of transportation experts in Tehran, Iran's capital and largest city, different modes of urban transportation were compared in proportion to each criterion and to each other, and were analyzed using AHP m. According to the findings of this study, walking is the most environmentally friendly way of inner-city transportation.

Keywords: *Walking, Non-motorized transportation, Sustainable transportation, AHP*

INTRODUCTION

TODAY, transportation has evolved into one of the most significant concerns of global urbanization. The major determinant of dynamism in urban life and a sustaining ingredient for all social, economic, and cultural activities in cities is

movement; "Transportation is really both the builder and the breaker of cities."

Walking as a means of non-motorized transportation is the oldest and most natural individual transportation technique that has been with man since the beginning of city construction and has been regarded as the first and simplest sort of displacement since the beginning of city creation. Weakling's characteristics such as cheap cost, mobility, non-destruction of the environment, and the potential of social connection, among others, have made this mode of urban transit one of the most essential human activities.

On the other hand, since the importance of sustainable development has grown in recent decades, the promotion of environmentally friendly urban displacement strategies has become more important than ever. As a result, urban experts have identified sustainable urban transportation as a critical prerequisite for present ecosystems. Furthermore, sustainable mobility is one of the pillars of sustainable city planning and design, with significant implications at multiple dimensions of neighborhood, district, and urban, as well as many economic, social, and environmental concerns.

This research attempts to examine the value of walking in cities as well as measures of sustainable transportation. It also intends to investigate the function of pedestrian mobility in urban sustainable transportation.

TRANSPORTATION IN THE CITIES AND ITS VARIOUS MODES

Transportation has been more important in the formation of cities as one of the primary elements of development. Because of the breadth and depth of issues encompassing the notion of transportation, it is referred to as an industry or a discipline of engineering sciences. The following are some of the most prominent relative definitions:

- Transport or transportation is the movement of people, cattle, animals and goods from one location to another. The field can be divided into infrastructure, vehicles, and operations. Transport is important since it enables trade between peoples, which in turn establishes civilizations.

- Transportation engineering means application of scientific principles and technology in planning, useful plan of performance and management of all types of transportation facilities for supplying the safe, rapid, easy, simple,

economic and coordinate (with the environment) transfer of people and goods.

As it is obvious the common concept in all transportation definitions is centralized on the people and goods movement. On the other hand, transportation modes have been divided into many different categories. For instance, transportation may be divided according to the cargo, passenger, geographical situation of trip (inner city and inter cities) or their targets. Although inner-city transportation maintained a steady and nearly uniform trend before to the industrial revolution, a tremendous mutation happened in this context with the development of the steam engine. The presence of motorized vehicles has transformed the layout of urban environments, resulting in new demands and needs. The "construction of the first subterranean railway in 1836, the first cable cars in 1837, and the first monorail in 1868" are examples of significant advancements in transportation systems during this time period.

The fast rise of vehicle production at the beginning of the twentieth century resulted in the development of residential regions around cities, or in other words, suburban living. As a result, city borders have lost their old meaning and purpose. With increasing village immigration, cities gradually transformed into very large demographic, economic, and political centers, and with the formation of metropolises, the need for more extensive deliberation for transportation of citizens, goods, equipment, and systems capable of dealing with this subject became clearer than ever.

However, since the 1970s, when the negative consequences of expanding personal vehicle usage became apparent, various attempts have been made to reduce this use and expand the use of other modes of transportation, notably public transit and pedestrian mobility. Furthermore, since around two decades ago, the concept of travel demand management (TDM) has been substantially discussed. This means that, rather than focusing on responding to journey execution, a form of prevention has been used, and the requirement of doing urban travels has been minimized through a variety of activities. These initiatives include a wide range of topics, including: different pricing for personal transportation, flexibility in daily work beginning and ending hours, communication development and promotion, formation of related centers, and growth of tele education. Furthermore,

with the growth of information and communication technology (ICT) in the last two decades, new issues and projections regarding the increase or decrease of transportation demand rate have been presented, along with differing and often opposing perspectives. Depending on the peculiarities of each city, road, air, rail, or even sea transportation may be utilized. Personal transportation, par transit (semi-public transportation), and public transportation are the three broad categories of urban transportation. In personal transportation, many mechanisms are used to move a person, and the travel course is decided by his will. Walking is the most basic means of transportation and the only one that is not dependent on any equipment or device: "The most natural, old, and necessary type of human disposition in the environment is pedestrian mobility." In recent years, the automobile has become the most popular means of personal mobility. Although utilizing a personal car offers more speed and private comfort when compared to other forms of transportation, dependence and reliance on the personal vehicle produce significant losses for society on a macro level. As a result, today more than ever, the importance of balanced planning in determining the role of automobiles in urban transportation systems is highlighted.

One alternative kind of personal transportation is the bicycle, which, in comparison to other modes of transportation, offers more mobility. Even when compared to public transportation, the bicycle has an advantage owing to "non-variation of habitat structure and alternating with walking (and therefore intensely preserving bodily energy)." Furthermore, with rising street traffic, the use of motorized bicycles, rockers, and electric driven bikes (noiseless and pollution-free) is developing in several pioneer towns. Of course, essential precautions must be taken when utilizing them in particular bike lines.

Personal transportation includes small-wheeled vehicles such as "skaters, skateboards, walkers, scooters, electric powered cycles, wheelchairs, and seaways". Transportation on small wheels has increased in many pioneer towns in recent years as a result of the consequences of environmental conservation, and inhabitants may be induced to utilize such vehicles through suitable design of specific lines.

Walking, biking, and utilizing different ways with tiny wheels are all examples of "non-motorized transportation," which is done for three main reasons: leisure, access to products and activities, or a combination of the two. Personal rapid transit is another newly proposed solution for individual transportation (PRT). This technique is based on the use of tiny transportation means that typically move in a defined route higher than the ground. The entire system is managed by computer and information technology, and it picks up passengers at certain stations and drops them off at preferred locations based on user input. "In general, the net length of this system and its capacity are not very long."

Taxis, minibuses, vans, and personal automobiles are examples of par transit systems (with high occupancy). These systems have a higher level of displacing capability than personal transportation, but they are more flexible in terms of timetable and moving course than public transit.

In comparison to personal transportation and par transit, public transportation networks may displace more users. "All modes of public transportation include two features: passengers do not travel in their own private automobile, and they travel in groups rather than individually." Rail and bus networks are two types of public transportation. However, in a broader sense, passenger aero planes and passenger ships are considered public transportation." Inner-city public transportation has been classified into several types, although the following are the most common: "In general, three forms of public transportation are employed alone or in combination with other vehicles in cities, including buses and electric buses, light railroads (tramway), and urban train."

Given the aforementioned, urban transportation may be broadly classified into three modes: personal transportation (walking, bicycle, and private automobile), par transit (carpooling, minibuses, and vans), and public transportation (bus, light rail transit and metro). Furthermore, each city's transportation system must be chosen while taking into account the various traffic, social, economic, physical, and cultural situations and research.

Walking In the City and Its Advantages

Walking has several meanings in various contexts. Walking and pedestrian are defined as follows in the urbanism dictionary: "The degree to which the

interests of persons on foot are taken into account is crucial in defining the effect of planning policy and practice." Rebecca Solnit (2001) quotes a Los Angeles planner as one extreme. "The pedestrian," he or she stated, "remains the most significant single impediment to unrestricted traffic flow."

This concept implies two things: first, the indisputable influence of pedestrians in cities on urban design, and second, taking pedestrian movement into consideration as opposed to riding mobility. Walking is one of the few human activities that has retained its original shape despite the emergence of many technology, communication, and transportation equipment. Meanwhile, all city trips, regardless of mode of transportation, begin and conclude with walking. Meanwhile, walking is often regarded as the ideal form of human contact with the urban environment: "What distinguishes pedestrians is that they are open and leisurely." These characteristics allow walkers to properly explore and engage with their urban surroundings. Walking is what connects a city's architecture, places, and people."

Walking is preferable than riding activity in terms of both physical flexibility and synchronization with the way and mental reflection and communication with the place. "Walking is a practice without requiring a practice site, a prescription without pharmaceuticals, weight control without diet, and an elixir that no alchemist has produced," says John Boucher, founder of the International Conference of Walking in the Twenty-First Century. Furthermore, walking produces minimal pollution, utilizes less natural resources, and is very efficient. Walking is simple and requires no extra equipment; it is self-sufficient and inherently safe. Walking is as natural as breathing."

The extent of the cities and the distance between its various centers in the old cities were such that citizens walked from one place to another, and the only means of displacing people or goods was livestock. Because of their speed and moving mode, there was no need to distinguish pedestrian and riding roads and spaces from each other. Such city mobility patterns not only created an interactional, emotional, and tasting tie between city and residents, but also describe urban roadways and passageways as social and cultural elements. Prior to the industrial revolution, the form and figure of towns across the world largely followed topographical

circumstances, streams, and travel ways. And urban buildings followed human size and pedestrian circulation capabilities for humans and cattle. As a result, urban roads and places were designed to accommodate inhabitants' human proportions as well as their social and emotional needs.

However, due to the increase of automobiles into cities and enlarging roadways for the comfort of motorized vehicle movement, different past purposes of urban areas have been devoted primarily to the passage of products and passengers, as has been done thus far. As a result, walkers' thousand-year priority right to use public urban channels and realms was frequently neglected, and pedestrians were banished to autonomous islands while cars dominated urban spaces.

Walking is an element of man's natural behavior that dates back as far as human history. Walking, contrary to popular belief, activates not only the human movement organs, but also the brain and cerebral systems. Thus, creating circumstances for pedestrians to travel around the city comfortably and enjoy the activities and happenings around them appears to be vital both for meeting human intrinsic needs and for improving the quality of public urban places. This problem has been significantly symbolized at the present and at the beginning of the third century since automobiles have dominated cities and machine life, and as a result, individuals' separation from their natural needs is increasing day by day.

People stroll throughout cities for a variety of reasons. "In an urban context, a pedestrian journey is rarely one-way: on our way someplace else, we pause to purchase a newspaper, chat to a friend, enjoy a view, or simply watch the world go by." Bill Hillier refers to the possibility of such alternative activities as a "byproduct of movement," that is, the possibility of additional (optional) activities in addition to the core activity of travelling from origin to destination. Walking around the city serves two distinct purposes: first, transportation to a certain location, and second, entertainment in the form of seeing attractive sights or athletic events. These two goals can be mixed and matched. Walking, on the other hand, has the following advantages over other forms of transportation:

- Not using the nonrenewable energy resources;
- Not disordering and polluting the urban environment;

- Low cost for supplying appropriate walking network comparing to other transportation means;
- Pedestrian pathways are urban natural spaces and generally don't occupy separate location;
- The walking is reliable and people can handle their works on time;
- Considering the walking acts towards fair distribution of accessing the urban facilities;
- The walking helps the health and cheerfulness of people;
- The walking creates dynamism and movement in urban spaces.

Walking, by providing the opportunity to discover new locations and stimulate curiosity, may have a significant impact on the establishment of peacefulness and mental health for man. Meanwhile, it is stressed that while other modes of transportation, such as bicycle, might guide people to specific destinations, only walking has a close and active contact with public areas, which leads to true awareness and perception of urban locations.

In general, pedestrian features and primary criteria may be split into two groups: physical (connected to physical themes and quantitative components of the human) and mental (deal with qualitative and perceptional factors). Furthermore, pedestrians have distinct behavioral patterns depending on their age range, which urban planners should take into account. Florida's planning and design instruction has divided pedestrians into seven age groups based on their characteristics, including infants and toddlers (ages 0 to 4), young children (ages 5 to 12), preteens (ages 13 to 14), high school aged (ages 15 to 18), adults (19 to 40), middle-aged adults (41 to 65), and senior adults (65+), and has mentioned some issues such as "impulsive and unpredictable, limited in their peripheral vision, limited in tra as walking features in early children Thus, pedestrians are essential to the existence of a major city, and the rate of inhabitants walking, in addition to all other advantages, is now regarded as one of the most significant determinants of a city's quality of life. According to Sir Colin Buchanan, "the ability of a person to stroll freely in an urban area and gaze around is regarded as the most crucial indicator of its civilization character." [16] Finally, with the start of the third century, urban planners and designers should include walking as an autonomous mode of transportation, as well as other modes such as public transit that rely on it.

The Concept of Sustainable Transportation and Its Indicators

Various meanings of the phrase "sustainable development" have been given. One of the most perfect and dependable expressions, as articulated by the United Nations in 1987, is "development that fulfils the demands of the present without jeopardizing future generations' ability to satisfy their own needs."

Whereas transportation is one of the most essential aspects of urban structure building, transportation sustainability plays a significant part in sustainable urban development. Various definitions of sustainable transportation have been proposed, each emphasizing a particular element of the issue. The following are some of the most essential definitions:− Sustainable transportation is policies and infrastructures for economic development, conservation of environment and social equality with the objective of optimizing the transportation system for achieving the economical, social and environmental purposes without endangering the future generations.

- Sustainable transportation is the most effective and easiest way for displacing the people and vehicles with the least rate of energy consumption (fuel and human efforts) with most acceptable cost, minimum traffic and the minimum environmental disadvantages such as air and noise pollution.

- A type of transportation including three approaches; any measures taken towards reduction and omission of inner city travels, moving towards non-motorized transportation modes such as walking and bicycling instead of using motorized transportation system and approaching the modern transportation systems in the energy sector is referred to as sustainable transportation. Sustainable transportation refers to circumstances in which the necessary displacing requirements of all people can be met and can be fulfilled in the foreseeable future without damaging human health or reducing basic local or earth resources.

Considering the above definitions and the main concept of sustainable development, sustainable transportation can be defined broadly as a type of transportation that meets the current needs and demands of human societies for displacement without wasting future generations' capabilities for obviating their needs.

As a result, any mode of transportation or policing in transportation matters that is environmentally friendly and takes into account the least amount of nonrenewable energy resources, as well as economic, social, and physical difficulties in cities, is considered sustainable transportation.

On the other hand, sustainable transportation does not imply the abolition of the vehicle. However, taking this problem into consideration and focusing on non-motorized transportation modes such as walking and biking would instantly lower traffic volume and, as a result, the need of personal automobiles.

Furthermore, it has been specified in applied researches that avoiding the use of automobiles and embracing clean transportation is not sufficient solely for the creation of sustainable urban development: "using public transportation, bicycling, and walking is not sufficient for sustainable urban development; and along with them, restricting plans such as urban development control, traffic limitation for car riding, parking control, speed control, and increasing Reviewing the sustainable transportation indicators mentioned by associations and various reputable societies such as the Sustainable Transportation Center of America, the World Business Council for Sustainable Movement, the European Union's Environmental Mechanism and Transportation, and the European Commission's Sustainable Movement indicates that they can be classified generally according to the existing common points to three main aspects including: social, economic, and environmental. Furthermore, taking into account the research used in the international literature, as well as the native conditions and following the maximum abbreviations, it is possible to gather 9 indicators for sustainable transportation and measures for examining each of them. Table 1 contains information on these factors.

Table 1

Proposed Indicators and Measures for Sustainable Transportation

Aspect	Indicators	Relative measure
Social	Social safety and security	Car accidents and death caused by driving and crime rate
	Individual and social health	Body fitness and assisting the improvement of physical and mental conditions
	Accessibility	Accessibility of children, women and

		affordable for all
	Vitality and general desirability	Mean value of peoples' satisfaction with transportation systems
Economical	Transportation costs (users/load)	Lateral costs, fuel costs, transportation costs
	The land allocated for the infrastructures	Transportation and parking spaces
Environmental	Air pollution- noise pollution	Gases exiting from vehicles (Co2, Co, No)
	Environmental interventions rate	Conservation of natural settlements and environmental elements
	Use of renewable resources	Use rate of fossil and non-fossil energies

The Effect of Walking On the Transportation Sustainability in the Cities

For evaluation of various modes of inner city transportation according to the introduced sustainable transportation indicators, analytic hierarchy process (AHP) and Expert Choice software have been used. Therefore, all modes of inner city transportation have been divided in three main groups (personal transportation, par transit and public transportation) and for observing the abbreviations and achieving the maximum applied results divided in 9 modes (walking, bicycling, personal vehicle, van, minibus, trip taxi, car pooling, bus systems, light rail systems and metro) and were analyzed and compared in relation with each other and each one of the factors.

Whereas towards the maximum validity of research findings via AHP method, it is necessary to the experts and scholars to give score, out of a 10-member group including masters of transportation and traffic deputy of Tehran who in addition to necessary specialty had relative executive records, were requested to act for evaluation of 9- item sustainable transportation factors to each other. In figure 1, the result of comparison and final ranking of all transportation modes in relation to the 9-item indicators of sustainable transportation aiding Expert Choice software has been exhibited. The inconsistency ratio is equaled to 0.07 and is acceptable. (less than 0.1) The results indicate that among all transportation modes, the walking has gained the highest rank and bicycling and metro are placed in the next positions. Para transit (minibus-van) has obtained the lowest rank.

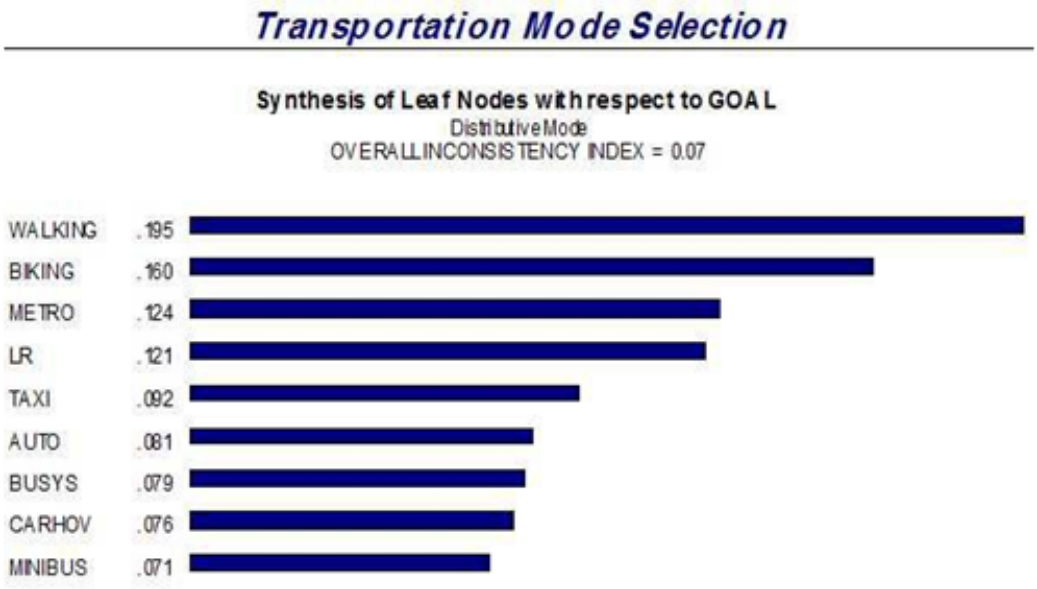

Fig. 1 Comparison and ranking of all transportation modes in relation to the 9-item sustainable transportation indicators

Displacement in the cities is not solely a purpose. The people move for accessing the other people or things. But in the car-oriented cities, the activities incline to the promotion. This will force the people to more and more trips for the same level of previous access. The healthiest and most sustainable modes of transport are walking: "The healthiest and most sustainable modes of transport are walking and cycling. Even car drivers become pedestrians to complete a trip, and effective public transport depends on people being able to walk comfortably to stations and stops."

One of the essential points in sustainable transport is focusing on the access instead of movement. In other words, whatever the possibility of arriving the destination with less trips and less movements are provided, the transport mode will be more sustainable.

In the pedestrian-oriented the cities against the car-oriented the cities that the purpose of them is facilitating the vehicle movement even for further movements, arriving the people to the destination is the main emphasis and consequently the activities instead of promotion incline to the compression.

Verifying these that walking is interfered in achieving all of principles indicated for sustainable transportation directly or indirectly: pedestrian movement provides direct access to the destination, is the best

mode of displacing as regard to causing equality and social justice between all the persons in the society, causes to the health and is the safest and cleanest transportation mode, through simulating the curiosity and involving all visual senses causes the public participation and through integrated planning and complete linking the urban pedestrian networks may take actions for rehabilitating some land uses and preventing destruction of natural resources.

Today and specially at the beginning of third millennium, disappointment of people from machine-oriented life and the consequences thereof in the world has distinguished the requirement to the pedestrian transportation and car-free zones. For instance, in Barcelona of Spain, wide streets have been constructed with the priority of pedestrians in proportion to the cars. In Paris, for zones which have been located on the cars traffic road and have been exhausted, improvement plan has been executed. Thus, "it is forecasted that until the end of 21st century, upon limiting the energy sources, the plan of constructing car-free the cities will be transformed to a worldwide subject and leads the cities towards constructing pedestrian neighborhoods."

Considering the foregoing may conclude that the pedestrian movement comparing to the other transportation modes in the cities from among all indicators, is the most sustainable mode and includes all conditions of sustainable transportation measures. Therefore, paying further attention to the expansion of infrastructures of pedestrian movement and upraising their efficiency will be an essential step for achieving the sustainable transportation.

CONCLUSION

Transportation on a macro scale refers to the movement of people and things based on physical and geographical factors, as well as the transfer volume of a passenger or load. However, in cities, the most popular transportation categories are road and rail transit, each of which includes a variety of systems and modes. Studies on the history of inner-city transportation show a consistent and nearly uniform trajectory before to the industrial revolution, followed by a period of abrupt and significant change. Personal transportation, par transit, and public transportation are the three types of urban transportation.

Walking, as the most common mode of non-motorized and personal transportation

in comparison to other modes of inner city transportation, has numerous features and advantages such as non-urban environment pollution, equity in access to urban facilities, increased individual and social health and cheerfulness, stimulation of urban spaces, creation of social interaction, and so on. As a result, in the beginning of the third century, walking as the healthiest, most economical, and dynamic displacement method in cities was taken seriously by the relevant authorities, and numerous strategies and inventions for the development of such transportation mode are in the works.

Sustainable development, which implies meeting present human needs while also addressing the needs of future generations and includes multidimensional notions such as social, economic, and physical factors, has become the dominating discourse in all activities and scientific levels today.

Meanwhile, particularly in the recent two decades, sustainable mobility has been heavily stressed as a key element of sustainable urban development. According to applied research in numerous countries, the indicators of sustainable transportation may be categorized into three groups: social, economic, and environmental. These metrics, which include 9 concerns, were proposed with native circumstances, maximal distinctions, and minimal interventions in mind. Meanwhile, a comparison of all modes of inner-city transportation in Tehran, according to transportation and traffic experts, revealed that non-motorized transit, notably walking, is the most sustainable form of displacement in cities.

REFERENCES

1. C. Clark, “Transport: maker and breaker of the cities”, town planning review, no. 28, pp. 237-250, 1957.
2. http://en.wikipedia.org/wiki/transportation, 18/04/2007.
3. R. Azizian. The principles of Traffic Engineering. Tehran: Sharif University Learning Center, 2007, p. 1.
4. http://traincity.blogfa.com/cat-1.aspx3-3, 14/08/2010.
5. J. Pakzad, Design Guideline of Urban Spaces in Iran. Tehran: Payam Sima Design & Publish Co., 2005, p. 271.
6. H. Knoflacher. Fusgeher- und Fahrradverkehr: Planungsprinzipien. Tehran: Tehran University Publications, 2003, p. 319.

7. http://www.vtpi.org/tdm/tdm93.htm, 22/10/2010.
8. B. Richards. Future Transport in The cities. London: Spon Press, 2001, p.9
9. M. Taghizadeh. Correct Approach to Traffic Issues. Tehran: Sharif University Learning Center, 2007, p. 6.
10. R. Cowan. The Dictionary of Urbanism. London: Streetwise Press Ltd, 2005, p. 284.
11. http://spacing.ca/ped-dylan01.htm, 09/05/2009.
12. http://www.walk21.com, 23/03/2006.
13. M. Carmona, T. Heath, T. Oc, and S. Tiesdell. Public Places- Urban Spaces, Amesterdam & Others: Architectural Press, 2003, p. 170.
14. Ministry of Housing and Urban Development. Manual of Urban pathways Designing (Section 10). Tehran: Urban Planning & Architecture Research Center of Iran, 1997, p. 3.
15. http://www.ttic.ir/Florida pedestrian planning & Design Handbook, 06/04/2009.
16. F. Tibbalds. Making People-Friendly Town, Improving the Public Environment in Towns and Cities. Tehran: Khak Publications, 2005, p. 75.
17. World Commission on Environment and Development, Our Common Future, Oxford University Press, 1987, p. 8.
18. M. Saffarzadeh, "Innovation in Urban Public Transportation towards Sustainable Development," in Proc. 8th Conf. Transportation & Traffic Engineering of Iran, Tehran, 2009, pp. 3–4.
19. http://www.vtpi.org, 12/11/2010
20. R. Ahmadian, V. Saiedian, "Transportation Effect on Urban Land Uses in relation to Sustainable Development," in Proc. 8th Conf. Transportation & Traffic Engineering of Iran, Tehran, 2009, pp. 1–2.
21. http://www. pbworld.com, 01/07/2008.
22. M. Vagner, "Transportation and city development: bilateral effects of access and development", Shahrdariha Journal, no. 41, pp. 86-88, 2001.
23. http://www.gdrc.org/uem/sustran/key-issues.html, 11/10/2007.
24. http://www.uan.ir/news, 28/06/2006.