PERFORMANCE APPRAISAL OF THE URBAN SUSTAINABLE TRANSPORTATION IN FULFILLING THE SUSTAINABLE DEVELOPMENT; FOCUSING ON ENVIRONMENTAL ASPECT

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ABSTRACT

In recent decades the metropolises challenges have attracted many theories and practices. Sustainable development theory is one of these attempts to encounter such challenges. Although at first the concept of sustainable development seems to deal with the environmental problems, but its extension and its mutual relation with other urban concepts has made it an important concept in urban management discussions. Urban sustainable transportation is one of these subjects that play a role in economic aspects of the sustainable development besides its obvious environmental dimensions. This article is a theoretical study aiming to evaluate the role and position of the urban sustainable transportation in the fulfillment of sustainable development theory focusing on the environmental aspect of the subject. The methodology of this research is urban-strategic in nature and descriptive-analytic which relies on the library and archival resources and documents. The results show that the sustainable transportation includes three levels (i.e. environmental, social, and economic) and it has a close relation to the concept of sustainable development. The component of sustainability in this approach emphasizes on the reduction of energy consumption, reduction of ruining the environment, increase of the social equality for network access, and the improvement of the performance and efficiency of the economic dynamism. Moreover, we found that the most important principles of the urban sustainable transportation are the land use planning with emphasis on the abstraction, travel demand management, and the promotion of the environmental quality.

KEYWORDS: Environment, Sustainable Development, Urban Sustainability, Urban Sustainable Transportation

In 2011, more than 81% of the total world energy consumption and more than 95% of the consumed energy in Iran was formed out of the fossil fuels. This is while the consumption of such fuels causes toxic and air-polluting gases, and acid rains, resulting in contamination of water sources such as the rivers and leads to the rise of carbon dioxide levels in the atmosphere. Apart from the escalation of air, water and earth pollution, the continued consumption of fossil fuels will lead to the global temperature rise due to the increase of carbon dioxide levels in the atmosphere. This temperature rise affects the atmospheric precipitations, causing the severity and frequency of the storms and floods and the expansion and rise of the sea water level (Bahadorinejad, 1994: 137). Apart from its destructive environmental effects, the fossil fuel consumption has considerable impact on the industry and economics of the societies. Nowadays, almost 90% of the needed energy of the industrial countries is supplied from the fossil energies. If the current amount of energy consumption doesn’t be changed -many experts predict that- all fossil resources will be finished at the end of the current century while the nature needs 500 to 700 million years to regenerate them (Kaviani, 2002: 16). The global attempts to control the mentioned social, economic and environmental losses and damages led to several theories for sustainable development as mirrored in World Commission on Environment and Development report (1987) known as The Brundtland Commission Report: sustainable development is the development without jeopardizing the abilities of the future generations in supplying their needs for energy (Wheeler & Beatley, 2005: 81). In this regard, McLaren proposed the concept of sustainability and its difference with the concept of urban sustainable development. He explains that the sustainability is a desirable continuous situation. On the other hand, urban sustainable development is a process by which the sustainability can be achieved. Although there is no single definition for the concept of sustainability, and the set of factors for assessing the achievement of general sustainability objective has not necessarily be the same in different societies, but there are some fundamental characteristics for the sustainability factors that are accepted by all societies and they have to be implied in all policies and plans (McLaren, 1995: 186). According to McLaren, some of the key features of the urban sustainability are as follow: the equality of the generation, equality in preserving the natural resources (and to live in accordance with the capacity of those resources), minimal use of non-renewable resources, diversity and economic survival self-reliant society,
individual welfare, and meeting the fundamental needs of the individuals (ibid). Urban transportation and its relation to the environment is a serious problem in today’s urban management worldwide. The extension of the cities and the increase of the population is a significant challenge, in particular for the developing countries while the replacement of such a huge population in such a scale forms a very complicated problem. Apart from the structural and functional dimensions of this process, the negative effects such as the air pollution make us encounter the mentioned problem. This article focuses on the sustainable transportation in three sections. First we study the theoretical framework of our research and clarify the relevant concepts and viewpoints. Then we will evaluate the global experiences in the field of sustainable transportation, and finally we conclude our discussion and offer some suggestions for the fulfillment of sustainable transportation and the development of urban sustainability with emphasis on the environment.

**URBAN TRANSPORTATION AND THE ENVIRONMENT**

Currently more than half of the world populations live in the cities. According to the Organization of Global Cities, the urban economic activities form 55%, 73% and 85% of the GDP in underdeveloped, developing, and developed countries respectively (Sukhdev, 2009). As one of the important factor of the urban economic life and development, urban transportation plays a vital role in the mentioned process. This is while the current patterns of urban transportation imposes heavy economic, social and environmental burden and costs to the societies. The experts predict that the spread of dioxide carbon of the urban transportation system will have 120% growth up to 2050 in comparison to 2000, and the number of the car vehicles will exceed to three times more than the current vehicles; and more than 90% of this negative growth will occur in the countries which are not a member of the Organization for Economic Cooperation and Development (UNEP, 2008).

Although the current patterns of urban transportation have several destructive impacts on the environment, but the problem of air pollution is one of the most threatening ones. The main damage to the air quality is a result of the transportation vehicles, especially the increasing growth of the private cars which lead to two types of pollution: the primary pollutants such as carbon monoxide, nitric oxide and benzene that are directly entered the air, and the secondary pollutants that are formed by the chemical changes of the primary pollutant. For example, nitrogen dioxide is a secondary pollutant that is formed by the photochemical process of the break of nitrogen dioxide for producing ozone from the nitric oxide (Cahill, 2008: 78). The produced carbon monoxide of the motor vehicles leads to the destruction of the ozone layer and it causes acid rain along with sulfur dioxide and nitrogen dioxide (Soltani, 2011: 67). The generation of the greenhouse gases such as methane and carbon dioxide is another environmental damage resulting from the transportation system leading to the imbalance of the atmosphere. The increasing consumption of fuel in the transportation system is really considerable and it accounts for approximately 40% of carbon dioxide production (Figueroa, et. al, 2005).

Human health is another environment-related issue that is highly affected by environmental damages resulting from the application of car vehicles. Apart from the car accidents and car-related mental problems, there are some other serious problems in this regard that threaten the citizens’ health and thus require serious attention among which one can refer to the respiratory infections in children, chronic diseases such as dyspnea and bronchitis, cancer, genetic disorders, asthma attacks, memory impairment and DNA damages (Bakhshi Khaniki, 14). Considering the pace of the increasing growth of urban population, the continuity of current situation in transportation section and its consequent damages to the environment, the future is not desirable and promising. This is why we have to change our approach to the transportation and rely on new approaches that can improve the current situation and lead to the sustainability of living in the cities.

**URBAN SUSTAINABLE TRANSPORTATION**

Access to urban sustainability means to rely on the sustainable development theory. Sustainable transportation is one of the results of the mentioned theory. Transportation systems serve the economic development by providing the access to the resources and consumption markets. Moreover, they affect the quality of life by connecting the citizens to the work, educational, health, and recreational facilities and services. Thus the transportation plays a key role in the socio-economic development of the societies. However, the transportation has some negative side effects such as the density of car traffic, pollution, consumption of non-renewable energies,
and the reduction of the human safety. The concept of the sustainable transportation can be derived from the concept of sustainability itself which encompasses all aspects of human life (Rassafi & Vaziri, 2005: 1). In other words, sustainable transportation looks for a type of displacing the human and commodities that is sustainable with regard to its environmental, social and economic aspects (Soltani, 2011: 79). Sustainable development and sustainable transportation have some objectives in common which make them interrelated to each other. The most important objectives of the two concepts (i.e. sustainable development and sustainable transportation) are summarized in table 1.

Commission of the European Communities defines the sustainable transportation as a system with the following conditions (Commission of the European Communities, 2006):

- Is able to provide equal accessibility of the people, groups and companies in a safe and environmentally and socially compatible way;
- Its diversity and costs are efficient enough to makes the ground for a competitive economy and balanced regional development;
- Minimizes the pollution and uses renewable resources with least side effects as far as possible.

On the other hand, Transportation Association of Canada (TAC) defines the urban sustainable transportation as including the following point (TAC, 2003):

- It is a system in which the accumulation of the wastes in a district is compatible to the absorption capacity of that district and is reinforced by the consumption of renewable resources, recyclable components, and minimal use of the land;
- It is a system which provides the equal accessibility for all people to their needed goods in order to improve their health and increase the life quality of each generation;
- It is a system with maximum efficiency and supplied financial expenses.

Thomas and Fordham (2003: 3) believe that the sustainability element of the sustainable transportation is equal to the reduction of the human dependency to the cars and it depends on the fulfillment of following objectives:

- Reducing the people’s need for the travels (reducing the frequency and distance of travels);
- Changing the way of traveling (reducing the use of private cars and using non-motorized vehicles);
- Increasing the efficiency of the motor vehicles (with regard to their energy consumption and pollution)

The Organization for Economic Co-operation Development (OECD) explains two different approaches to the sustainable transportation (OECD, 1996). The first is technic-oriented approach based on hyper-cars (i.e. electrical cars). It is claimed that this generation of the cars is 15 to 20 times more efficient than the current generation of the cars along with other advantages such as their increased safety, reduced price, comfort, increased durability, and beauty. The second approach is based on the reduction of the activities and consequently reduced dependency on the cars. This approach aims to reduce the interest of people in cars compared to other options, or to reduce the necessity of using the cars. This goal can be met by improving the infrastructures, promoting other traveling options, reforming the patterns of land use, and reforming the citizen’s habits and life styles (Winsters, 2004). These two approaches can be considered as reductionist approach and inclusive approach respectively (Litman & Burwell, 2006).

However, it is not suffice to each of the mentioned approaches alone. For example, even the widespread use of hyper-cars cannot solve the problem of limited accessibility to the urban services.
### Table 1: Comparing the objectives of sustainable development and sustainable transportation

<table>
<thead>
<tr>
<th>General objective</th>
<th>Sustainable development objective</th>
<th>Sustainable transportation objective</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental compatibility</td>
<td>Reducing the pollution and climatic changes</td>
<td>Reducing the pollution resulting from the car vehicles and infrastructures</td>
<td>To standardize the cars, Pollution tax, Alternative fuels</td>
</tr>
<tr>
<td></td>
<td>Environment protection</td>
<td>Reducing the level and scale of using the cars</td>
<td>Reducing the scale of parking lots, Reducing the standards for the roads capacity, Smart planning of the roads, Encouraging the people to compressed inter-contextual development</td>
</tr>
<tr>
<td>Human health</td>
<td>Reducing physical damages</td>
<td>Reducing the car accidents</td>
<td>Preventing car accidents, Traffic demand management</td>
</tr>
<tr>
<td></td>
<td>Reducing the air pollution</td>
<td>Controlling the pollution level</td>
<td>Pollution standards, Alternative fuels, Traffic demand management</td>
</tr>
<tr>
<td></td>
<td>Increasing physical body movement</td>
<td>Developing human-based transportation</td>
<td>Improving the sidewalks and bicycle lines, Traffic Calming</td>
</tr>
<tr>
<td>Economic welfare</td>
<td>People’s displacement</td>
<td>Providing expected transportation services, increasing the people’s choices, reducing the traffic density and removing the obstacles</td>
<td>Providing desirable road capacity, Providing suitable transit services, Encouraging the walking and bicycling</td>
</tr>
<tr>
<td></td>
<td>Efficiency</td>
<td>Facilitating the displacement of the commodities and primary materials, extending the choices</td>
<td>Increasing the capacity of marine, land, air and rail roads, Efficient distribution of the activities, Prioritizing the shipping</td>
</tr>
<tr>
<td></td>
<td>Increasing the public capital and reducing the taxes</td>
<td>making the transportation services more efficient</td>
<td>Management and planning for the economic efficiency, Purposeful pricing</td>
</tr>
<tr>
<td>Equality</td>
<td>Horizontal equality</td>
<td>Catching the taxes from the users</td>
<td>Cost-based pricing, Providing the needs of internal consumers</td>
</tr>
<tr>
<td></td>
<td>Vertical equality</td>
<td>Hierarchical pricing</td>
<td>Low price and taxes for basic transportation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Facilitating the displacement for non-drivers</td>
<td>Providing different options for the travels, Designing mixed urban spaces</td>
</tr>
<tr>
<td>Social welfare</td>
<td>Vitality and social consolidation</td>
<td>Facilitating inter-neighborhood displacements</td>
<td>Traffic Calming, Designing human-oriented streets, Mixed land uses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increasing the public spaces by reforming the roads network</td>
<td>Traffic Calming, Designing human-oriented streets</td>
</tr>
</tbody>
</table>

Source: Litman & Burwell, 2006: 343-344
Above all, due to their low prices and low expenses, the citizens would be more dependent on these cars. By and large, three scenarios are usually proposed for fulfilling the sustainable transportation (Geurs & Wee, 2000):

- Technological scenario (changing the transportation technology; e.g. to create some cars with more optimized and better fuel consumption)
- Human scenario (changing the behavioral patterns of the consumers)
- Mixed scenario (changing the technology and behaviors simultaneously).

It is very important to find out which of the mentioned scenarios has more sustainable effects. But even more important is to find out which of the scenarios is more acceptable for the public; particularly when the goal is to change the citizens’ behavior structurally. The implementation of such a scenario depends on how people’s expectation of the improvement of their quality of life is met. It is crucially important for the policy- and decision makers to understand the effects of transportation plans on the people’s quality of life. Any discussion about the sustainable transportation is justified if and only if it doesn’t lead to the deterioration of the people’s quality of life (Steg & Gifford, 2005). The Brundtland Commission emphasizes on the importance of the quality of life in defining the sustainable development: it is to fulfill the current needs without limiting the future generation in fulfilling their own needs (WECD\(^1\), 1987). This latter definition emphasizes on the quality of life of the current and future generation simultaneously. Thus the mission of the sustainable transportation has to be human values and to meet their needs. On the other hand, the current sustainable transportation policies have to be evaluated based on the present men and their values and needs. Beside the effects resulting from the planning for sustainable transportation on the quality of life, there are some other factors that affect the acceptance of sustainable transportation policies by the people (Soltani, 2011: 87-88):

1. The sustainable transportation policies will be accepted if the citizens understand the current and future problems and their possible solutions.

2. The awareness of car users about their role and responsibility against the society is very important. The sense of individual responsibility can facilitate the making collective decisions.

3. Social norms and tendencies are also important in the acceptance of transportation plans and policies. If the people’s perception of the car is positive, then the other options and alternative would have less chance to be used by people. This point related to the sense of superiority and better quality of life in case of using private cars.

4. It is also too important to offer alternative options. Restrictive plans and policies will be resisted if they cannot offer suitable options and alternatives. This suitability of other options is not merely limited to their accessibility but their quality has to be considered compared to the quality of current options.

5. Sustainable transportation plans would be accepted by the public if they prove to be effective on solving the urban problems. Many people believe that such plans will inevitably fail due to the central role of the cars in our lives. In other words, the citizens use cars because they have to use cars since they have no other option (Steg and Gifford, 2005). Thus in a situation where no other suitable and advantageous alternative is being offered, the mentioned plans will fail to work.

The Center for Assessment and Decision Making for Sustainable Transport describes the sustainable transportation as a safe, accessible, environmental-friendly, and affordable system (ECMT\(^2\), 2004). Other resources have referred to diverse objectives for the sustainable transportation some of which are summarily as follow (Litman, 2020):

- Diversity of transportation system: the travelers can chose different methods, places, and prices for their travel, especially when the offered options are more efficient, more affordable, more healthy and driver-independent.
- System integration: several components of the transportation system (like walking, bicycling, and public transportation) can facilitate the integration of

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1 World Commission on Environment and Development

2 European Conference of Ministers of Transport (ECMT)
transportation plans and land uses in order to regulate an integrated transportation system.

- Affordability: transportation services has to provide affordable options and alternatives so that low-income families have not to assign more than 20% of their total budget to access to their needed goods, services and activities.

- Resources efficiency (energy and land): transportation planning encourages the efficiency of land and energy. In this regard, some of the suggested strategies include the minimal use of non-renewable resources and replacing them with recyclable and renewable resources, increasing reduction of the fossil fuel consumption, reduction of the environmental pollutants.

- Pricing in accordance with prioritizing efficient systems: to re-price the roads, parking lots, insurance in order to encourage their efficiency and to manage the travel facilities more efficiently and more desirably.

- Land use access (intelligent growth): sustainable transportation policies support the compressed and mixed development in order to improve the access to land uses and alternative transportation options.

- Efficiency in practice: the transportation system and the providers of the services and facilities have to be managed efficiently in order to minimize the costs and maximize the quality of the services.

- Comprehensive and inclusive plans: the transportation planning has to be comprehensive (with regard to the objective, effects and main options), integrated (coordination in the decision that are being made in different sections and offices by different authorities), and inclusive (all people can participate in the plans).

In this regard, we can refer to the Comprehensive Vision toward the Sustainable Transportation Report for 2035 which looks for the following goals in accessing the sustainable transportation (CST1, 2005):

- Focusing on the accessibility: in a society where the transportation is sustainable, the people can easily access to the alternative transportation in order to access their needed goods and services and the social opportunities, in particular the low-income people and disabled and handicapped citizens.

- Motor transportation: most accessibilities are motor-independent aiming the displacement of people in urban regions. Walking, bicycling, skateboarding, and other non-motorized ways of transportation are accepted and encouraged.

- Motor transportation by common vehicles: some accessibilities are being done by using very different technologies at large scale and in a routine base which would include renewable fuels (such as solar energy and hydric products) intelligent transportation systems, automatic highways, railway services, and other new technologies.

- Commodity displacement: the displacement and shipment of the commodities are being done by suitable transportation methods based on the distance. Cargo ships and other carries can create a desirable environment for meeting the economic goals.

- Less need for the displacement of people and commodities: generally, the travels that are being done for displacing the people and commodities by the motor vehicles will be reduced considerably, because the cities are compressed with suitable and desirable land uses. Most accessibilities are being conducted through telecommunication tools and thus the displacement of people and commodities will decreased considerably.

- Reduced or removed negative effects on the environment and human health: a result of the sustainable transportation is the reduced negative effect at the local and global scales. For example, currently the spread of the greenhouse gases (such as carbon dioxide) resulting from the transportation system is one-fifth of the corresponding level in 1990.

Based on the previous discussions, we can propose three dimensions (i.e. environmental, social, and economic dimensions) for defining the indicators of sustainable transportation. For example, the most important indicators of the environmental unsustainability include energy consumption, carbon dioxide production, unrecyclable wastes production, soil destruction, noise pollution, water pollution, soil pollution, and natural resources destruction (soltani, 2011: 79). By and large,

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1 Center for Sustainable Transportation
the sustainability in transportation includes the reduction of the energy consumption, reduction of the environmental destruction, increase of the social equality, access to network, performance improvement, and efficiency of the dynamic economy. Moreover, we have to re-emphasize that the urban sustainability of the transportation has to be based on two simultaneous approaches, that is, to change the behavioral patterns of the people and to improve the technical dimensions of the transportation (e.g. reduction of the energy consumption).

**APPROACHES TO IMPLEMENT THE SUSTAINABLE TRANSPORTATION**

According to the proposed definitions of the urban sustainable transportation we find that most known approaches and policies on the sustainability of the transportation are based on the reducing or removing urban travels, moving toward non-motorized transportation methods (e.g. bicycling), using modern energy-related technologies. In this regard, we can classify the most important approaches of the urban transportation sustainability as follow:

**LAND_USE PLANNING EMPHASIZING ON THE COMPRESSION**

The need for reducing the travels is an important part of policy-makings, and the land use planning can play a significant role in fulfilling this objective (Banister, 1997). The mix of the land uses encourages the walking and bicycling and hence discourages the people in using the cars for their routine and daily shopping. At a strategic level, the location of new developments (with regard to the current cities and their infrastructural facilities) would affect the amount of travel demand, and the size and form of the new technologies and the mixture of the land uses would affect the travel patterns (Williams, 2004: 269, 307). The life will be sustainable in places whose size are suitable (more than 500,000 population) in which a complete range of the services would be available in a specific distance on foot, by bicycle, and/or public transportation (Banister, 2002: 20). The change of the urban structure and land uses, increasing the densities, using available empty spaces in the urban fabric, creating mixed land uses, reducing the dependency on the private cars by creating shorter travel distances, and encouraging the walking, bicycling and public vehicles are among the strategies that can be implemented both on the macro-(whole city) and micro-level (neighborhoods). Three main approaches have been proposed for fulfilling the objectives of the urban sustainable transportation (Jahanshahlu and Amini, 2006):

- To change the vehicles: less use of the private cars and more use of other options that are less polluting for the environment
- To change the destination: to shorten the distances which can lead to easier access to the destination by public or non-motorized vehicles
- To mix the travels: it occurs when a single travel is being done for doing several activities instead of doing several travels for the same activities. This strategy can decrease the number of daily travels and shorten the distances of the travels.

Policy-making on macro-scale requires a long-term (30-50 years) urban planning. In this planning, all social, ecological and economic needs have to be met and to be integrated with the transportation and land uses. The components of such planning can include the followings:

- Creating some developments with high densities and mixed land uses along the public transport routes
- Prioritizing the establishment of public transportation in areas where the densities and the demands allow such prioritization
- Creating a network of the highways and roads in accordance to the traffic needs of the cars and pedestrians, and meeting the needs for walking, bicycling, and public transport (ibid).

For micro-scale policy-makings we need short or mid-term (5-10 years) planning in neighborhood units in order to find a good direction toward deciding on the future demands of the development. This planning can include the followings (Jahanshahlu and Amini, 2006):

- Encouraging high-density extensions with mixed land uses for the neighborhoods in a network where the pedestrians have the highest priority.
- Designing networks for the local streets based on the access to public transport
- Suitable designs for the pedestrians, bicyclers and vehicles, including the sidewalks, bicycle lines, parking lots, locating high-density regions near the
public transport stations, and considering some special places for unloading beside the streets.

The urban compression emphasize on the mixed land uses and densification. Both these two factors are among the suggested principles by ITDP for the sustainability of the transportation in the cities. In the mixed land uses, we focus on the integration of work, recreational and routine activities of the life. Based in this strategy, when all destinations of the daily travels are located and integrated in a specific area, then the travels will be shorter and accessed on foot in a shorter time. Moreover, in such a case, the attractiveness of the streets will be increased and the livability of the cities will be improved (ITDP, 2010).

TRAVEL DEMAND MANAGEMENT (TDM)

The most important issue in relation to the changes in the travel demand is to change the traveling behavior of the people. In current situations where the people are dependent on their cars, the fulfillment of this objective is a big challenge for the urban management. With regard to the travel demand management and the attempts to change the behavioral pattern of the citizens in their urban travels the following points are to be stated (R. Black, 2010).

- Promoting the use of telecommunication tools and devices
- Traffic calming: reducing the speed of the motor vehicles in the residential areas in order to reduce the traffic load and to increase the traffic security of the neighborhood
- Vehicle Replacement or Retirement: renovation and replacement of the cars with some less polluting vehicles
- Fee bates: reducing the taxes and costs for purchasing more efficient vehicles
- Carpooling: joint using of a single car by the individuals whose work places are near to each other
- Car sharing: using a car by those who have booked it
- Cash-out programs: the employees can receive the value of their parking lot as an added income while using carpooling or public transport system to go to their work
- Parking Restrain and Taxes: increasing the parking fees will lead to change the traveling pattern of the people and their motivation to use public transport system
- Transit vouchers: tax-free vouchers that can motivate the employees to use public transport system

PROMOTION OF THE ENVIRONMENTAL QUALITY FOCUSING ON USING NEW ENERGIE

Since the environment is one of the three dimensions of the sustainability and since it is highly affected by the pollutions of human activities, thus the sustainable transportation system has to move toward protecting the environment and its non-renewable resources. In order to reduce the consumption of fossil fuels and other underground resources we can use the following methods (Banister, 2002; Black, 2010).

- Reducing the travels by motor vehicles and shortening the distances in light of the high-density extensions and mixed land uses
- Using other alternative such as walking, bicycling and public transport system instead of the private cars
- Promoting the use of recyclable resources for the vehicles
- Reducing the pollutants by using clean energies and new technologies
- Avoiding the destruction of open spaces in the cities
- Using environment-friendly fuels, particularly for the buses. The best fuels in this regard are methanol, ethanol (derived from the crops and biomass oils), compressed natural gas (CNG), liquidated gas-oil (propane or LPG), biodiesel fuel, solar energy, hydrogen, reformulated gasoline, and ETBE/MTBE compositions.

EC’s policies for the reduction of the greenhouse gases spread by the motor vehicles and the reduction of human’s dependency on the fossil fuels are considerable. According to the available agreements with the European automakers, the automakers have been obliged to reduce the average carbon dioxide output of the exhaust of their manufactured cars up to 20% in 2008. Moreover, this reduction has to be improved for the next period and include all public vehicles as well. The other option to be
implemented in Europe is to supply alternative fuels, particularly the biologic fuels and to promote its demand and consumption (EU Publishing Office, 2004: 99).

R&D studies in Europe on the vehicles which work by clean energies has achieved considerable improvements. These achievements can be seen in some cities like Paris, Florence, Stockholm, and Luxemburg where the buses work by biodiesel or zero-sulfur diesel. According to the predictions, the private cars and heavy vehicles of the future can work by alternative energies as well. For the short- and mid-term applications, the best alternative fuels are bio-fuels and for the long-term applications, the best alternative is to use natural gas and finally, the hydrogen. One of the main objectives as proposed in the preliminary report of the EU has been to replace 20% of the current fuels with the alternative fuels up to 2010. Manufacturing the new generation of the hybrid-electric cars, the cars working by natural gas and (in long-term period) the cars working by hybrid fuel cell are among the policies that the EU report is following. Moreover, electric rechargeable cars are a good example of using the technology of applying clean energies in the transportation system (ibid, 100-101). The application of such policies can be effective on the other solutions for the transportation sustainability. As an example, with regard to the travel demand management, in Geneva the government is going to issue some regulations according to which, the higher priority of parking will be given to the cars working by clean fuels.

AN OVERVIEW OF THE GLOBAL EXPERIENCES ON THE FULFILLMENT OF THE SUSTAINABLE TRANSPORTATION

Reviewing the transportation-related experiences of the other countries which have focused on the sustainability approach can lead to more clarification of the mentioned concepts and visions, and helps us identify weaknesses and strengths of the implemented policies and solutions. In this regard we have studied the experiences of Singapore (Singapore City), South Korea (Seoul), Brazil (Curitiba), USA (Manhattan), and England (Redditch).

Singapore

Singaporean experience is very important and considerable because it has managed to solve the challenge between planning for the automobile developments on one hand the sustainable transportation on the other hand. Singapore has offered several options for the transportation has made its citizens chose their own desirable transport method. The Singaporean policies for the urban transportation sustainability are as follow (Rouhi, et al. 2011):

- Integrated transportation and land use planning: this process has been done by designing a public transport network and road system in combination to the land uses. At a macro-level, the planners have paid attention to the coordination between mass rapid transportation (MRT), and at the micro-level they have focused on the areas around the MRT stations.
- Motorization process control: the main reason for controlling the motorization process in Singapore has been the limited spaces as an obstacle for the movement of cars rather than the environmental considerations. This control is conducted by implementing Vehicle Quota System (VQS) (that controls the car ownerships) and the policy of road taxes (that limits the use of private cars).
- Efficient diverse public transit system: the infrastructure of the Singaporean public transportation includes mass rapid transportation (MRT) as the backbone of the system; light rapid transportation (LRT) and buses as the supporting services; and MRT and taxis as the final services. This hierarchy of public transportation is very efficient. The mentioned system along with the diversity in the prices and the quality of the public transportation has created several options for the citizens.

Seoul

Despite its 10.3 million citizens and more than 29.68 million daily travels, Seoul has managed to overcome the urban traffic problems at an acceptable level by developing its railway network. At the beginning, the Korean government imposed very heavy taxes for the ownership and use of the private cars in order to solve the urban traffic problems, but considering the inefficiency of the Korean transportation supply management system (TSM) the government looked for new approaches. One of the alternative approaches was transportation demand management (TDM) as an option for increasing the use of public transport system and to minimize the use of the private cars. Currently, the urban management of Seoul attempts to balance the two mentioned patterns. The
Korean policy for the urban sustainable transportation in Seoul includes the following strategies (Kim & Rim, 2000):

- Improving the urban bus and rail lines
- Continuous development of the rail lines and bus-exclusive lines
- Improving the speed and comfort of the public services
- Efficient controls over the private cars
- Encouraging the people not to use their private cars by imposing heavy road payrolls and fuel taxes
- Controlling the parking lots in high-density areas
- Developing the infrastructures and introducing Intelligent Transportation System (ITS) and its application in order to demand-supply management
- Integration and coordination between the transportation systems in metropolitan areas
- Facilitating the connectivity of different transportation systems
- The connectivity of the urban lines and highway networks to each other in order to respond the demands for regional travels
- Reduction of the car accidents and traffics
- Improving the sidewalks
- Encouraging the green ways of travel and improving the transportation facilities

Seoul experience shows that the transportation supply management cannot respond to the increasing and pace of the cars in the metropolises and so it has to move toward controlling the transportation demands and changes the development of the transportation systems by strengthening the public transportation. In Seoul case, this development has been mainly based on the extension of rail network. For a city like Seoul with intensive population and very high level of daily transports, the rail network plays an important role with regard to its speed and capacity. Another important point about the Seoul experience is the conducted change of the pattern of rail line management based on the pattern of the population distribution and the increased population of the suburban areas (Rouhi, et al, 2011).

Curitiba

Curitiba is a Brazilian city that experienced three decades of purposeful attempt to be changed from an underdeveloped city to a developed one. Currently Curitiba is a successful pattern and sample in the global system of urban planning. Two important factors are effective in the urban transportation in Curitiba:

a. Integrated bus system: this system includes a network covering 5 main streets equipped with rapid buses leading to the city center. The mentioned network acts like a metro network due to its qualitative and quantitative development. Moreover, the integrated transportation network of Curitiba is a centralized system making of transit terminals, express roads, supporting streets, and inter-regional routes.

b. Combination of the road network and the land use regulations: the density and the type of the land uses are determined in relation to the Curitiba public transportation network. The city center is the departure point of rapid transport network and has suitable open spaces, shopping centers, pedestrians’ exclusive streets, while the land uses in the main streets have more density.

In 1979, only 7% of the urban transporst were done by the public transportation system. This value increased to 25% in the mid-1980s, 75% in 1995, and up to 80% in 2006. This fascinating growth of the public transportation system leads to 25% and 30% of reduction in the fuel consumption in Curitiba compared to other Brazilian cities. Moreover, the use of green fuels in the buses led to 45% of reduction in the light reflection by aerosols (Tehran Center for Urban Planning and Studies, 2012: 40).

Curitiba transportation system is a combinational system that has created relationship between the house, land use, road networks, recreational developments, and commercial developments (Hosseini & Soltani, 2008). Curitiba focused on choosing the most effective transportation system instead of focusing on any specific method and approach. The city began its development through the bus lines because it had relatively suitable bus transportation network and didn’t move toward expensive plans such as metro. Indeed Curitiba approached a set of ordinary and small activities in order to improve its transportation network (Rouhi, et al, 2011).

Manhattan
Manhattan is the historical core of New York and the center of the global economy. In past, there was a high level of interference between the roads and sidewalks leading to limited space for the walkers. In particular, the lack of safety for pedestrians threatened the movement of walkers in the sidewalk spaces. High density and economic spirit have made the space inefficient but it found new attractive aspects when the authorities and urban planners decided to redefine the urban spaces for the tourists. Then the sidewalks changed to be the dominant space and the needed facilities were provided for the pedestrians. One of the mentioned facilities was the development of public transportation system as a supporting factor targeting the following objectives:
- To increase the rapid access of the pedestrians by improving the metro services, adjusting the intersections, increasing the access to open spaces, and diversifying the sidewalk spaces
- To improve the quality of the streets by strengthening local activities and improving fixed elements such as the urban furniture and lightings
- To increase the pedestrians’ safety by traffic calming
- To use diverse attractive plans
- To use the spaces and locations that reinforce the identity of the walking routes

Redditch

Buchanan’s report titled Traffic in Towns started a new thought on the new cities and the development of current cities. Although the content of the report was not new, but it was the first time that the urban planning ideas were gathered under a system in form of a general philosophy whose impact was completely visible. The objective of the report was a futuristic vision to the problem of traffic in urban areas and its role on the urban life. The report aimed to meet the following points:
- Reduction of the motor vehicle use
- Reduction of the motor vehicle accidents
- Reduction of the negative impacts of car traffics on the urban environments and preventing their destruction

The mentioned plan emphasizes on the use of public transportation system by the citizens and so the sidewalks and walking routes occupy an important position.

CONCLUSION AND DISCUSSION

Decentralization of the sustainable development theory from the mere environmental dimensions and its subsequent dealing with other fields and disciplines (particularly the urban management fields) has brought new dimensions to the concept of sustainability. In other words, the social, economic and environmental dimensions of the sustainability relate the concept to diverse issues and problems that our current cities face. In this regard, urban transportation is one of the most important problems because it affects the social, economic and environmental conditions of the cities directly or indirectly. According to the available literature, urban sustainable transportation is an approach aiming to crate and preserve the balance between social, economic and environmental parts of the city. This approach is generally based on two simultaneous
solutions: changing the behavioral pattern of the citizens, and improving the technical dimensions of the transportation; while attempting to remove or reduce the urban travels, moving toward non-motorized transportation (such as bicycling) and using modern technologies in the field of energy are the most fundamental solutions for the mentioned problem. An overview of the global experiences of the cities that have approached to urban sustainable transportation shows that the most effective strategies include the establishment of more road networks for facilitating the movements, the reduction of the car traffic by encouraging the people to use public transportation system, encouraging the people to rely on non-motorized vehicles by traffic calming in the residential areas, travel demand management, and traffic management. Considering the main objective of the sustainable development theory (i.e. to use the available resources based on the environmental capacities and to avoid any negative effect on the heritages to be delivered to the future generation) it seems necessary to adopt modern optimized approaches in all dimensions of the urban management, particularly in the urban transportation area. With regard to the mentioned issues, theoretical viewpoints and global experiences, we can offer the following suggestions considering the current situation of Iranian transportation system in order to fulfill the urban sustainable transportation approach:

- To use mixed pattern of land uses in the urban neighborhoods with diverse range of the services
- To provide suitable physical requirements for walking and bicycling along with paying attention to cultural elements and to encourage the citizens to follow urban sustainability goals
- To improve the public transportation quantitatively and qualitatively, especially to increase the effective factors of the public transportation such as the increased safety, increased speed, sufficient and suitable geographical coverage, ease of access, comfort, and being on-time
- To establish and extend the public transportation terminals and to provide public services for these terminals
- To change a false vision implying that low-income people use the public transportation system and wealthy people use their own private cars
- To imposing taxes for the parking lots in the street margins
- To predict and consider the needs of disabled citizens for the urban transportation in order to fulfill the social equality of the sustainable development theory
- To attempt to use clean energies in the public transportation, especially the solar energy with regard to the climatic conditions of the country
- To design suitable network of roads focusing on the width of the sidewalks and their permeability for critical conditions such as the earthquake
- Coordinated and simultaneous planning for land uses and transportation (based on the principles of comprehensive urban plans)
- To restrict the movement of single-seater cars (e.g. to restrict such cars to drive only in the highways while to allow the multi-seater cars to enter other urban roads).

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