

## **Environmental Indices and Their Role in Sustainable Urban Development in Tehran Metropolis**

**Mehrdad Nababaksh<sup>1</sup>**

*Professor of Sociology, Islamic Azad University, Science and Research Branch, Tehran*

**Hashem Aram<sup>2</sup>**

*Ph.D. Student of Sociology, Islamic Azad University, Science and Research Branch, Tehran*

**Mehdi Mokhtarpour<sup>3</sup>**

*Ph.D. Student of Sociology, Islamic Azad University, Science and Research Branch, Tehran*

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**Abstract:** Nowadays, Most of the cities, especially metropolises of developing countries are engaged with environmental issues like air and water pollution, waste increase and etc., that lead to the environmental destruction. Meanwhile sustainable urban development, provides the balance between development and the environment, and supplies the current generation needs while keep its eyes on the next generation rights and respects it. This survey goes through the conceptual and theoretical sustainable urban development, and the environmental index situation in Tehran, as a metropolis, based on the available data. The study's method is a combination of documentary-librarian methods and data and available studies analyzing. Regarding that sustainable urban development indexes can be divided into environmental, social and economic indices, environmental indexes is one of the most important sustainable development indexes. The data shows that based of environmental indexes, high rate of air pollution and energy consumption and high rate of waste production, Tehran is away far from the desirable sustainable development situation. Generally, the results of this study imply that Tehran is not in an acceptable situation based on the environmental index (air pollution, waste management, green and public space per- capita, clean transportation, energy consumption, water consumption, housing and patrimonial quality, sound pollution and etc.).

**Keywords:** Sustainable Urban Development, Environmental Index, Tehran.

### **Introduction**

After 70s decade, there is a rational consensus about the concept of Development saying that development is a transition process aiming to introduce changes in social system foundations and it is not necessarily included of economics development. Development is a multidimensional progress and it appears in different human lives features \_ not only in economical feature\_ and undoubtedly "Environment" is one of the important arena. Sustainable development that is one of the main controversy subjects in developing and programming is the resultant of different development ideas (Hosseinzadehdalir and Sasanpour, 2007: 86). This concept has been used in sustainable development conference in Stockholm, Sweden in 1972 (Ziari, 2000: 17) and in 1987 in UN global environment and development conference , in different reports, Brundtland, and the title " Our Common Future" sustainable development is defined as a process by which current needs provides without demolition of the next generation potentials (Tosun, 2001: 289-303). Actually, in Brundtland report consideration to equality between generations, equality within generations (social and geographical equation) environmental conservation, using the non-restorable resources at least, economical and diversity maintenance, autonomic society, individuals welfare and satisfying the fundamental needs of individuals in a society is emphasized (Shokoe & Musa Kazemi, 2000: 124). What is clear is that urban sustenance is a version of development sustainability that included urban environments and spaces.

Nowadays, Most of the cities, especially metropolises of developing countries are engaged with environmental issues like air and water pollution, waste increase and etc., that lead to the environmental destruction, significantly, from one side, disregarding of the citizens to the sustainable development principium and from the other side, their ignorance to their own tasks due to the environment as well as inattention to this principal in Urban management programming, are among the booster factors. Sustainable Urban development idea is aroused from the environmental worries and the disorientation of the balance between human and natural environment,

<sup>1</sup> Email: Mehrdad\_navabakhsh@yahoo.com

<sup>2</sup> Email: hashemaram@gmail.com

<sup>3</sup> Email: mehdi.mokhtarpour@gmail.com

environmental destruction by industries. Although sustainable development idea is not new but reflects the deep increasing scientific worries about the Urbanism effects (Kavez, 2005: 650). Sustainable Urban development T provides social and environmental orders for living that leads to decrease the environmental hazards, supplies the access to the urban resources and opportunities and effectuate the citizen partnership. This concept is not a finished situation, but it is a process by which all the urban life elements are gathered together to increase the happiness and health of the human. Sustainable urban development is not a new concept, but it is new version of utopia (Kavez, 2005: 650-651).

Science, industry and environment are co-related subjects. Paralleled to science and technology development in current human life, environment is invaded by human. Based on Heidegger interpretation, technology is the author of human invasion to environment and its conversion to a type of conserved resource. Among the countries, environmental contaminations in developing countries and third world are much more than developed and first world countries, a part of this is caused by the inequality between developing and developed countries and another part of is caused of malfunction of management and incorrect and non-scientific programming in third world countries.

In Iran, unfortunately, environment subject is a neglected subject in developmental policy-making especially in cities. This issue is two dimensional, one is related to the citizens while another one is related to some inappropriate policy-making, programming or not accomplishing the appropriate laws.

Tehran as the capital of Iran, and as one of the 10<sup>th</sup> undeveloped metropolises among 124 metropolises in the world is engaged with so many difficulties like air pollution, sound pollution, water pollution, traffic problems housing shortage, environmental destruction, vulnerability against unexpected incidences like earthquake, earth running, lack of facilities, precipitates, urban installations and equipment, poverty and malformation. Sustainable urban development which seeks the equilibrium between development and environment, not only provides the numerous needs of this generation, but also keeps a keen eye on the future generation's rights and respects it. We are looking to find answer for the following questions based on materials previously discussed:

- What is sustainable urban development and what are its indices?
- How is the status of sustainable urban environmental development indices in Tehran?

### Theoretical Considerations

Based on Amartya Sen there are two understandings from development. One that considers it a "brutal and violent" process and the other that considers it "friendly". Amartya Sen supposes the second consideration the preferred one (Sen, 2002:56). Primarily, the first development approach is followed mechanically while in the second one it is followed next to society and protection of people. The newest theories are closer to the second approach. Still, a sustainable development is pattern from economic, structural and social developments through which contemporary benefits of the society can be ameliorated without potentially endangering the future. This kind of development, is a process which members of a society can augment their personal and basic abilities in order to unify their resources and management through which and their own ideals they could gild their quality and distribution of life. Despite being primarily defined by emphasizing on natural environment, sustainable development was later seated with the study of women, education, science, ethics, security and cooperation with a sustainable analysis. The meaning of sustainability is the feasibility of an action through a time line, without taking into account many of complimentary measures, also economic sustainability which was emphasized by previous conceptualizations would be unfeasible. The concept of sustainable capital is also evolved in development and mankind, social groups, environment, culture and history will also be included. (Fazeli, 2011) Therefore the approach to a sustainable development will go beyond the dichotomy of economy and environment and will attempt to involve social elements as well. As a result, the concept of sustainability includes the concepts of justice, equal distribution of opportunities, environment protection and economic effectiveness equally and with a same level.

Brundtland offers five vivid principles for development to policy makers;

1. Changing the patterns of economic growth, theological, productive and managerial which could possibly affect the demographic and environment negatively.
2. Providing employment, food, energy, healthy water, and health care for everyone.
3. Controlling world population growth
4. Protecting natural resources for future generations.

5. Recollecting population, environment and economic problems in political planning's and decision-making's (Gottdiener & Budd, 2005: 159).

Sustainable urban growth means the changing of density and usefulness of urban terrains in order to erase people's principal problems in housing, transportation, vacation, etc. in fields of making a livable city, a powerful economy and an equal society in a way that these technological and industrial changes include keeping jobs, houses and a sufficient environment (Papeliyazdi & Rajabianjerd 2004: 343).

## Theoretical Framework

There are four approaches towards sustainable urban development:

1. *Autonomous City Approach*: it means to localize economic and environmental activities in a way that urban and other activities are adapted with local ecology and urban adequacy.
2. *Compact City Approach*: this approach is accepted among designers and city architects for its economization in energy consumption and exhibiting services.
3. *City Relying on External Resources*: because cities look for their resources in rural areas and the suburbs and return those resources as waste and polluting materials, inevitably they need to pay back for the pollution caused by this.
4. *Justice-oriented City Approach*: equality between demand and consumption; because cities use natural resources, there needs to be a system to reduce the regional damages to its minimum (Haughton, Farhadi et. al, 2012).

In another version, Hatfield Dodds offers another set of approaches:

1. Sustainable Income Approach which is the most frequent one
2. Maintaining Ecological Integrity Approach
3. Inequality, Bases and Environmental Effects Approach
4. Participation and Sustainable Well-being Approach
5. Alternative Ethical Approaches

Sustainable development' fundamental policies could be divided into these four categories in terms of what they could follow;

1. Minimalizing non-renewable resources' consumption like fossil fuels and adequate sources
2. Stabilizing non-renewable resources' consumption like mineral waters, soil and vegetation
3. Respecting the limit of producing wastes and pollution agents in local and universal absorption capacities like greenhouse gases, chemical substances which could destroy ozone layer and hazardous wastes.
4. Providing basic human and social needs like access to stores, social cooperation and access to a healthy environment and basic services (Hadavi from Sheikh ol Eslami et al, 2009).

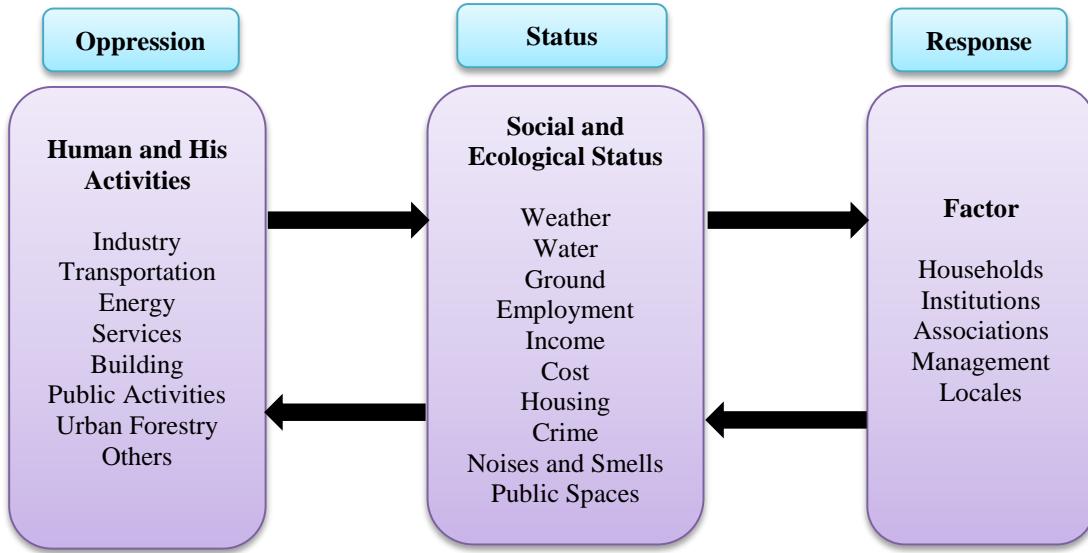
In regards to the differences in the aforementioned theories and approaches, measuring and indexing are also difficult for an urban sustainable development, especially when these indices are exposed by local values and norms. But since sustainable development index evaluates the consistency of human development and can show the distance among the sustainable development's objectives through which prevents the happening of bio-humane events (Noori, 2008 & Owen, 2007 from Farhoodi et. Al, 2012) analyzing these indices is important.

In a study done in 25 American cities, Portnoy has taken these indices into account; Organization of an extensive planning related to a zone, environmental objectives, hygienic objectives, functional, objectives related to local economic development, the quality of life indices and social justice, subjects related to ruling and local cooperation in decision makings, weather quality, energy and climate changes, destruction of ozone layer, parks, population growth, public information and thought distribution through education, dry wastes, transportation, water quality, maintaining environment and emancipatory costs, number of the homeless, number of violent crimes, total crime rate, child abuse frequency, public transportation development, biking, voluntary activities rate etc. (Gottdiener & Budd, 2005: 163).

Masnavi, also, divides the sustainable urban development indices into three categories: Urban form (Building form, street patterns and ground functionality), areal sustainability (Energy consumption, transportation and air pollution) and social sustainability (Social interaction, separate local satisfaction, health and security) (Masnavi,

2007). Based on previously discussed issues, the following pattern is the conceptual framework of environmental sustainable urban development indices which are effective:

**Figure (1): Conceptual Framework of Environmental Sustainable Urban Development Indices**



According to conceptual framework at the environmental indices and parameters regarding the urban sustainable development are as follows:

- Weather Quality Index:* This index refers to certain days annually which surpass the alert level that should be lower.
- Urban Transportation Index or Healthy Transportation Index:* This index means using the environment-friendly vehicles.
- Waste Management Index:* This index refers to the amount of waste produced by an individual annually.
- Energy Consumption Index:* This index refers to the amount of energy consumed by an individual annually. This consumption includes household use, industrial, third sector and public use.
- Water Consumption Index:* This index refers to the amount of water consumed by an individual annually. This consumption includes household use, industrial, third sector and public use.
- Nuisance Index:* This index refers to visual, olfactory and auditory polluters. These noises are usually the result of industry, railways traffic, road traffic and air traffic. Olfactory disturbance is usually created by industry and traffic. Visual pollution is caused by derelict lands and social erosion.
- Housing Quality Index:* This index refers to residents who suffer inappropriate housing situations. It also entails the percentage of people who lack houses or those who are under the influence of inappropriate housing zone. The number of the homeless appear in this index.
- Heritage, Public and Green Spaces Index:* This index refers to heritage, public and green space for each individual in metropolitan areas.

### Research Method

This research is based on the documental study method in which the data and information are the descriptive and analytical data according to the analysis of studies and previous data and the use of the findings of previous research. Therefore, method of research is a combination of documental-library and analysis of data (available). It's worth noting this research has been evaluated according to the researcher's argument and conclusion based on the theoretical framework of environmental indices (air quality, transportation, landscaping, waste management, and visual, olfactory and auditory polluters, housing and historic past).

## Achievements and Findings

### The status of Environmental indices of metropolitan Tehran

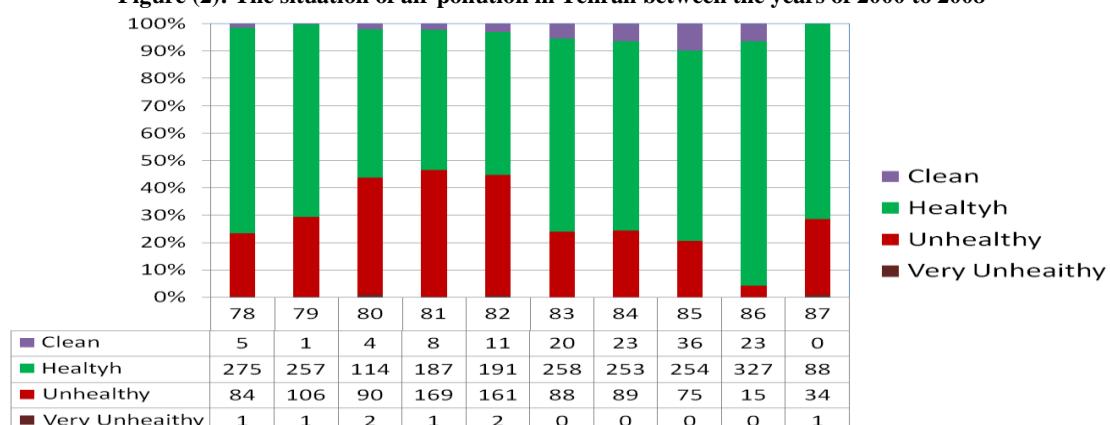
- **Air Pollution Index**

The most important environmental challenge in Tehran is air pollution because it has serious effects on the human health and has a major impact on quality of citizens' life. Emissions of carbon monoxide, suspender particles and sulfur dioxide are the main factors associated with increase or intensification of heart disease and lung disease insofar as for example, in days with increased air pollution, number of patients with respiratory problem increase drastically. In 1386 the daily average of pollutants released into the air of Tehran was 4,770 tons. The greatest contribution was for carbon monoxide emissions with 3,463 tons for every day. Comparing the international sustainability indices among 146 countries, Iran is ranked 132th in the world and its pollutant is 8 times bigger than international standards. Thus, Tehran isn't in a stable situation. Tehran is a perfect example of a consumer city so that 40 percent of economic activity in the country is done in this city. It is one of the most polluted cities in the world in terms of air pollution and the UN knows it as a one of the most polluted city in the world.

According to World Health Organization's statistics each year about 340,000 people in the cities die from air pollution in the home and about 400,000 thousand people die from outdoor air pollution (Lisa and Reniyeh, 2008: 184). The below figure shows deaths caused by air pollution in the world. These deaths occur mainly in third world countries in Asia. The following cities are the five most polluted cities for children under five years old: Mexico City, Beijing, Shanghai, Tehran and Calcutta (Ibid: 184). According to these statistics Tehran is fourth in the world in terms of air pollution. The statistics show in terms of development indices Tehran doesn't have a good situation in the clean air status.

Based on statistics and various reports (including air quality incorporation), Tehran is one of the most polluted cities in the world. Today, not only the concept of urban air pollution means that urban environmental isn't sustainable but in addition of that the concept of connivance of the citizen's social rights ,because of its economic and social costs and its threat to citizen's health, means that too. The following diagram shows air pollution in Tehran in a period of 10 years (Khaksari, 2009).

**Figure (2): The situation of air pollution in Tehran between the years of 2000 to 2008**



(Source: Tehran Weather Quality Control Firm)

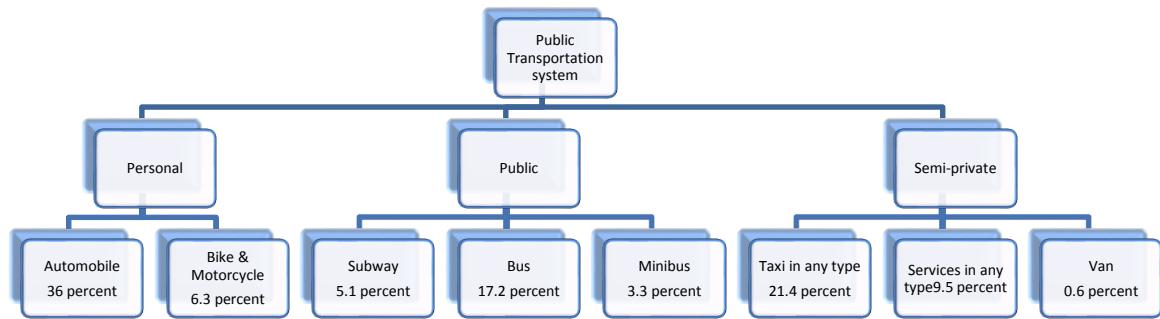
- **Clean Transportation Index**

One of the major challenges of the big cities is the lack of efficient transportation system in them. The high rate of population growth, increase of daily trips and the motorization process of the cities have created situation in which the main challenge of the accommodations is the issue of transportation. Moreover, competition of metropolitan in global markets and the negative effects of traffic problems on the economic interests in one hand and the direct effects of traffic volume and road transportation on weather and environment in the other hand have prompted urban management to try to find ways to get out of this crisis. Tehran as a largest metropolitan in the Middle East region has struggled serious problem in the field of urban transport. In one hand the lack of appropriate infrastructure to manage population, weak public transportation system and the lack of suitable culture as

prevention barriers and in the other hand the specific spatial structure of Tehran, cheap petrol and facilities to buy car as incentive factors, are increasing the expansion of car use in the city frequently. The absence of comprehensive plan for transportation and traffic management and the lack of urban culture fueled the problems and make them more complicated every day. Hence, in the present study we try to investigate the main problems facing transportation in Tehran and its origin and cause of them.

Excessive use of these devices causes air pollution and environmental issues. Today in most cities in the world, environmental friendly personal and non-motorized transport systems such as a bicycle are considered by urban planners. However these vehicles have the minimum role of urban movement in Tehran. This issue is very important for consideration. Today a useful device such as bike faces many challenges to use by citizens. For example, Tehran has high air pollution therefore, the use of bicycles cause the person respires more in this air. The city has no clear line for bike and probably will cause injury and accidents and will endanger person's safety and finally, the geographical location of Tehran shows there are plenty of slopes from south to north of the city and It requires the use of high power to bicycle. It is necessary to considerate the above points in development of the personal, non-motorized transportation system such as bicycles. Below chart and table below indicate that cars have important role in Tehran air pollution (Khaksari, 2009).

**Figure (3): The percentage of daily trip distribution in Tehran**



The Tehran's transportation problems in a general view can be summarized in the following cases:

1. High volume of single passenger cars
2. Limited development of public transport network
3. Lack of demand management
4. Lack of integrated transportation systems and single management of urban
5. Problems of static traffic
6. The lack of planning of Land use and transportation simultaneously
7. Spatial structure of Tehran
8. Lack of observation of access hierarchies
9. Lack of Traffic culture in Tehran

- **Landscaping Index**

One of the environmental indices of sustainability developments is the existence of green areas and its integration in whole of the city. Statistics show that the southern areas in Tehran such as 9, 10, 11, 12, 7, 8 and 17 districts have inappropriate situation in terms of per capita green space. Figure (1) shows that 22 and 19 districts have a higher per capita than other areas.

**Figure (4): Per capita green space in Tehran's districts**



- **Past history Index**

Historical Spaces and places are one of the important themes and elements in an urban identity. The investigation of Tehran survey Shows that Tehran has cut its relation with its historic past so that today there is little trace of the historical buildings and monuments in Tehran. But instead, what will become the city's identity are modern structures such as Freedom Tower and Milad Tower. Therefore the preservation of historic past is just possible by maintenance of historical monuments.

- **Energy consumption Index**

Per capita energy consumption investigation in Tehran shows Per capita electricity consumption in Tehran is equal to 2,900 kilowatts while the international standard is 900 kW. Iran's ranking among countries with high consumption of electricity is 19. Also per capita water consumption is 250 liters in Tehran while international standard of Water consumption per day in the world is 150 liters. The Percent of subscribers in Sewage system of Tehran represents that only 30 percent of city households are subscribe in wastewater system while the percent in the industrialized world, is more than 80 percent. Per capita gasoline consumption in the city is 10.8 liters. Global average rate is 4 liters and in developed countries is between 2 to 4 liters for each vehicle. This issue is closely related to air pollution in Tehran (Urban management in Tehran website, 2012). These statistics show there is a high rate of energy consumption In Tehran suggesting that the metropolis is far from environmental indices of sustainable development.

- **Waste Management Index**

Trash and waste production is one of the indices of environmental urban sustainability development. Statistics show that each day, about 7,000 tons and annually 2.5 million tons waste is generated in Tehran that shows the high rate of waste production in Tehran (Taqavi & Farzideyri, 2011). The statistics show the largest production areas in Tehran are 4 and 18 districts and Region 9 has the minimum production of waste. Among cities of the world Mumbai with 875 kg, New York with 720 kg, and after that Tokyo with annual production of 610 kg per capita have the highest rate of waste production. Among the cities of Iran, Tehran, Mashhad and Isfahan have the highest proportion of waste production (Eskandarinoude et. al, 2002).

- **Housing Quality Index**

The quality of buildings in the prospect of life and structures show In some urban areas, such as 12, 11 and 10 districts more than 50 percent of the units are over 40 years old and more than half of the structures are made of flimsy or weak materials that show the high level of vulnerability of buildings in the case of a disaster phenomenon. The following table shows a summary of the quality of buildings in Tehran:

**Table (1): The status of building in term of structure type**

| Districts        | Type of Structure |          |        |         | The percent of Robust Structures |
|------------------|-------------------|----------|--------|---------|----------------------------------|
|                  | Steel             | Concrete | Others | Unknown |                                  |
| The whole Tehran | 41                | 11       | 45     | 3       | 52                               |

(Source: *The detailed design of district 11, Jom'epour, 2009*)

The table shows that about half of the buildings in the city made of less durable materials and in the older parts of the city, more than 60 percent of them are made of weak materials. By regarding the quality of the buildings, the seismic vulnerability of the housing units has been determined based on the various scenarios in the table below:

**Table (2): The seismic vulnerability percent of the housing units based on various scenarios**

| Districts                   | Rey Fault | Fault of The north of Tehran | Masha' fault | Model      | Total building units |
|-----------------------------|-----------|------------------------------|--------------|------------|----------------------|
| Tehran                      | 55.2      | 35.7                         | 12.9         | 50.9       | 875509               |
| The highest damage(in area) | 82% (17)  | 61.6% (1)                    | 31.6% (12)   | 67.7% (12) | -                    |
| The lowest damage (in)area  | 28 (4)    | 25.3 (18)                    | 6.8 (22, 19) | 42.2 (19)  | -                    |

(Source: *The detailed design of district 11, Jom'epour, 2009*)

Statistics show that in the fault Rey, District 17 has the highest damage because of the density and the number of buildings. Also damaged area in 11, 12, and 16 to 20 districts is about 80 percent. The reason is that vulnerability and robustness buildings in these districts.

There are other problems in the housing sector in Tehran: Household density of residential units in the central and southern parts of the city and weak buildings in vulnerable areas. Survey data show that the average of residential household and quality of housing in urban areas of 15, 18, 19, 20, 17 and 16 districts are placed in the lowest category (same). Geographical distribution of families with four people or more in one room at Tehran's districts show that 11.2 percent of households in 19th districts, 4 or more persons have only one room to live. The corresponding figure for 5th district of Tehran is equal to 1 percent. The average rate for Tehran is 6.5 percent. Seven Areas, including 12, 15, 16, 17, 18, 19 and 20 districts are worse than the city average. Thus, in areas that are geographically located in the south of city there is more poverty and economic deprivation in terms of housing.

### Conclusions and Recommendations

As was mentioned many cities especially those that are located in developing countries and the third world metropolises are facing with environmental issues such as air pollution, water and waste development issues that are destructive for the environment. Specifically, the citizens neglecting of the principle of sustainable development on the one hand and their neglecting of their duties towards the environment and neglecting of this principle in the planning and urban management intensify these factors. Certainly the idea of sustainable development of urban is one of the environmental concerns and the problems of unbalancing between humans and the natural environment as well as the destruction of the natural environment come from industry.

Conceptual and theoretical investigation of Urban Sustainable Development shows that this concept has three major indices: environmental, social and economic indices. The most important idea used in the study of environmental factors includes: air quality, urban mobility and clean transportation index, waste management, energy use, water use, harassment, housing quality, and historical indices, and green public spaces. Evaluation of these nine indices shows that Tehran is one of the most polluted cities in the world in the terms of air pollution and a large part of this pollution is related to the use of personal vehicles in the city of Tehran.

The data showed the environmental indices of sustainable development in the city of Tehran are poor and far from ideal point. In particular, to achieve the optimum point, urban management, private sector and citizens have clear duties and responsibilities and none of them cannot put this responsibility to other shoulders. Given the above, we offer the following suggestions: Create the database: In this database, data should relevant indices of environmental, social and economic that are indicated monthly and yearly.

Inform Managers and experts and citizens from these data. Collected data should be transferred to the citizens through the media to be aware of their duties towards the current generation and future generations. A committee must monitor the status of sustainable development indices. This Council should work as a coordinator of each of the relevant organizations and discuss the duties of each of them.

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