Evaluation of the Current Situation of Smart Mobility in Metropolis of Mashhad

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Abstract

This paper studies and determines the current situation of Mashhad mobility through using the global criteria so that it can do a comparison between Mashhad and other cities which have some population similarities. The method of study is the Arthur D. Little’s survey which measured the socially smart mobility criteria upon the 84 cities all over the world. These measures for each of the criteria have the best and the worst value based on the expressed statistics by the world cities. Accordingly, for each city one weight score of percent has been determined.

In the present study, the information related to the smart mobility criteria of Mashhad has first been collected and then through providing an average mathematical relationship based on the minimum and maximum recorded by the 84 global cities the weight score of Mashhad was determined equal to 45% and finally Mashhad’s score was compared. The result was that the gained score for Mashhad in comparison to global cities has a suitable position and some attractiveness upon the use of the public transportation. However, the driving method of the drivers was inappropriate, and due to that reason the statistics of the accidents resulted in death is high. On the other hand, the amount of CO2 and PM10 are much more than the standard level and threatens seriously with some dangers such different cancer types, heart crises, respiratory and nervous diseases and also environmental problems.

Keywords: current situation, Smart Mobility, Weight Average, Arthur D. Little’s Criteria, Environmental Problems.
Introduction

During the last twenty years, the concept of smart city indicated that the relationship between information and technology can be used in city activities like application development and competitive stage so that to find new ways to eliminate social poverty and deprivation and secure the safety of the environment (Harimi et al., 2010). The idea of smart city originated from the integration of modern technologies to have an active role in city environment. This would lead to improvement of life quality and functions in the city environment; it also creates new opportunities in the cities with regard to innovation and creativity. So the statement “smart city has many faces” got famous (Sameti, 2010).

However, the concept of a Smart city goes way beyond the transactional relationships between citizen and service provider. It is essentially enabling and encouraging the citizen to become a more active and participative member of the community, for example, providing feedback on the quality of services or the state of roads, adopting a more sustainable and healthy lifestyle, volunteering for social activities or supporting minority groups. Furthermore, citizens need employment and “Smart Cities” are often attractive locations to live, work and visit (Dept. for business innovation & skills, 2013).

Therefore in the first steps, the idea of the smart city was in the direction of the social wealth improvement of the cities. Thus it results in increasing the capabilities of people and society. Based on this model, and through the help of the ICT infrastructure, people as the fundamental element of social capital are able to take into consideration their personal, service and social issues. Their capabilities include electronic voting in elections and bettering their life quality and the relationships with governmental organizations. These issues have been cited in the studies of many researchers (Winter, 2011; Cruick Shank, 2011; Deakin, 2011; Leydesdorff, 2011; Allwinkle, 2011; Mahizhnan, 1999).

With the onset of the 21th century, many countries like Austria, Denmark, and Germany started making smart their cities. In 2007, R. Giffinger from the Vienna University, through cooperating with Edinburgh University identified six characteristics as a strategy for further elaboration of smart cities in European Union. These characteristics are: Economy, People, Governance, Mobility, Environment and Living. These characteristics form the framework for the indicators and the assessment of a city’s performance as smart city (Giffinger et al., 2007).

Smart city is a kind of a city which is based on Information Technology, and tries to transform of life quality and activities accordingly. It can respond to the citizens’ necessities through planning, designing, development and renewing in order to enhance locality space, preserve of natural and cultural resources. Moreover, it distributes wealth equally, increases the ecological safety standards and improves the long-term and short-term life quality. This can be attained by developing and promoting urban transportation, employment, and accommodation. Some definitions of the smart city have been cited in Table 1.
Table 1. Smart City definitions by academic literature

<table>
<thead>
<tr>
<th>Definition</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rail/subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.</td>
<td>Hall, 2000</td>
</tr>
<tr>
<td>A smart community initiative becomes an integrated approach to helping entire communities go on-line to connect local governments, schools, businesses, citizens, and health and social services in order to create specific services to address local objectives and to help advance collective skills and capacities.</td>
<td>Coe, et al., 2001</td>
</tr>
<tr>
<td>A Smart City or region is one that capitalizes on the opportunities presented by Information and Communication Technology (ICT) in promoting its prosperity and influence.</td>
<td>Odendaal, 2003</td>
</tr>
<tr>
<td>A smart environment is an environment that is able to acquire and apply knowledge about its inhabitants and their surroundings in order to adapt to the inhabitants and meet the goals of comfort and efficiency.</td>
<td>Marsa-Maestre et al., 2008</td>
</tr>
<tr>
<td>The Smart City provides new instrumentation that enables observation of urban systems at a micro-level.</td>
<td>Harrison and Donnelly, 2011</td>
</tr>
<tr>
<td>“Smart Cities” would be metropolitan areas with a large share of the adult population with a college degree.</td>
<td>Winters, 2011</td>
</tr>
<tr>
<td>The concept of the Smart City of which there are many initiatives, projects and demonstrators, is generally underpinned by one or more ambient systems parts that require a mediation process to deliver The interconnectedness required by an ambient system.</td>
<td>Gui and Roantree, 2012</td>
</tr>
<tr>
<td>a city that is managed by a network and which supplies its citizens with services and content via the Network using both fixed and mobile Smart City infrastructure, based on high-performance ICT.</td>
<td>Lee et al., 2013</td>
</tr>
</tbody>
</table>

Source: Mosannenzadeh and Vettorato, 2014.

Context and research methodology

According to the studies of Giffinger et al. (2007), smart city has six dimensions. In this study, the smart mobility issue is taken into consideration. The aim of study is to determine the current situation of smart mobility in Mashhad metropolis by the usage of Arthur D. Little
assessment criteria in urban mobility and comparing the total score of Mashhad by 10 similar cities in the world.

The smart mobility can be understood as every kind of transportation inside the city. With the help of information and communication technology (ICT) facilitation of issues related to servicing, everyday life, and the relationships among people will result. Advantages of the smart mobility inside the city are as follows:

- Smart Transportation Systems,
- Reducing the traffic knots through simplifying the city routes,
- Creating cultures such as using the new motor vehicles like sunny cars, electric motorcycles, and public transportation vehicles (Bargh-Hormoz, 2013).

Consequently, the smart mobility is about changing the ways which reduce the destructive and negative effects of the mobility upon the environment and society by the provision of various solutions and alternative approaches to business sector, economy and people's need for daily mobility.

**Review the current situation of Mashhad**

Iran is not away from this global urban change. Therefore, reviewing and analyzing the smart mobility is an undeniable and unavoidable requirement, especially in Mashhad city with a population of 2984491 people (DPDMM, 2014). The city’s infrastructure is very incoherent. It has culture difference, habits and customs that increase the complexity of city environment. This is the strongest reason behind the growth of studies related to the smart mobility so that to be able to reduce the challenges, and give more comfort to the citizens who live in this city.

Arthur D. Little Institute has determined some criteria for smart mobility inside the cities (Table. 2) based on the outcomes of relevant studies. It determined a weight score for each of these criteria, in a way that the total weight scores of all criteria is equal to 100. Accordingly, Arthur D. Little measured the situation of the smart mobility in 84 cities (Arthur D. Little, 2014).
Table 2: Assessment Criteria of Arthur D. Little Urban Mobility

<table>
<thead>
<tr>
<th>o.</th>
<th>Criteria</th>
<th>Weight</th>
<th>o.</th>
<th>Criteria</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Financial attractiveness of public transport</td>
<td>4</td>
<td>1</td>
<td>Initiatives of public sector</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Share of public transport in modal split</td>
<td>6</td>
<td>2</td>
<td>Transport related CO2 emissions</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Share of zero-emission modes in modal split</td>
<td>6</td>
<td>3</td>
<td>NO2 concentration</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Roads density</td>
<td>4</td>
<td>4</td>
<td>PM10 concentration</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Cycle path network density</td>
<td>6</td>
<td>5</td>
<td>Traffic related fatalities</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Urban agglomeration density</td>
<td>2</td>
<td>6</td>
<td>Increase of share public transport in modal split</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Smart card penetration</td>
<td>6</td>
<td>7</td>
<td>Increase of share of zero-emission modes</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>Bike sharing performance</td>
<td>6</td>
<td>8</td>
<td>Mean travel time to work</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Car sharing performance</td>
<td>6</td>
<td>9</td>
<td>Density of vehicles registered</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>Public transport frequency</td>
<td>6</td>
<td></td>
<td>Total</td>
<td>00</td>
</tr>
</tbody>
</table>

Source: Arthur D. Little, 2014.

These criteria formed the basis of measuring current situation of Mashhad city. Through referring to the statistics of relevant organizations, the field data were collected to calculate the amount of each of these criteria. In Table 3, the definitions of each of those criteria and the statistical amounts of Mashhad have been stated.
Tab. 3: Definitions of Criteria and Method of Calculate for Mashhad Metropolis

<table>
<thead>
<tr>
<th>No.</th>
<th>Criteria</th>
<th>Definitions and Calculates</th>
<th>Reference</th>
</tr>
</thead>
</table>
| 1   | Financial attractiveness of public transport | • Ratio between the price of a 5 km journey with private means of transport and the price of a 5 km journey with public transport within the agglomeration area.  
• The cost of each trip = entrance average + meter average (based on the 200 meters), average delay (on the basis of minute)  
• The cost of trip with motorized individual transport + fuel usage average every 5 kilometers (the average is 10 liters in each 100 kilometers) + cost of depreciation every one kilometer (based on the average 0.01 $)  
Calculating the cost of public transport= 0.368 $  
Calculating private means= 0.25 $  
0.368 $ / 0.25 = 1.5 | Arthur D. Little, 2014; Mashhad transportation statistics book, 2014; DPDMM, 2014.                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 2   | Share of public transport in modal split      | • Percentage of the total number of person trips which are made with public transport in the last available measurement.  
• According to the transportation statistics book (2014), this percent was equal to 43.43% . | Arthur D. Little, 2014; Mashhad transportation statistics book, 2014.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 3   | Share of zero-emission modes in modal split   | • Percentage of the total number of person trips which are made by bicycle and walking in the last available Measurement.  
• This amount is 4% percent according to the current statistics of Mashhad. | Arthur D. Little, 2014; Mashhad transportation statistics book, 2014.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 4   | Roads density                                 | • Ratio between the total road length in an urban agglomeration and the urbanized surface area.  
• The length of urbanized surface area in Mashhad= 695 kilometers  
• Traffic regions level= 285.7 square kilometers  
695km ÷ 285.7 km²= 2.43 | Arthur D. Little, 2014; Mashhad transportation statistics book, 2014.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 5   | Cycle path network density                    | • Ratio between the total length of cycle lanes and cycle paths in an urban area | Arthur D. Little, 2014; Mashhad transportation statistics book, 2014.                                                                                                                                                                                                                                                                                                                                                                                                                      |
| **Urban agglomeration density** | agglomeration and the urbanized surface area of this urban agglomeration.  
- The urbanized surface area in Mashhad: 695 kilometers  
- Traffic regions level: 285.5 square kilometers  
  \( 10 \text{ km} \times 285.7 \text{km}^2 = 0.035 \)  
| --- | --- |
| **Smart card penetration** | Ratio between the total number of transit smart cards in circulation in an urban agglomeration area and the population of this area.  
- The number of the smart cards (Man Cards) to use in bus and subway in Mashhad is equal to 3200000 pieces according to the last statistics.  
  \[
  3200000 \div 0.3333333 \approx 1.066
  \]  
| **Bike sharing performance** | Ratio between the total number of bikes in bike sharing systems in an urban agglomeration area and the population of this area.  
- At present, the number of shared bike is equal to 3000 bicycles according to the statistics of the public bicycle system.  
  \[
  3000 \div 3 = 1000
  \]  
Arthur D. Little, 2014; Mashhad public bicycling system, 2015. |
| **Car sharing performance** | Ratio between the total number of cars in car sharing systems in an urban agglomeration area and the population of this area.  
- This system is not available in Mashhad.  
| **Public transport frequency** | Frequency of the busiest public transport line in an urban agglomeration.  
- The busiest public transportation vehicle was considered bus, and the frequency average of arriving to station is equal to 15 minutes during the rush hours.  
<table>
<thead>
<tr>
<th></th>
<th>Initiatives of public sector</th>
<th>(7 * 60) / 15 = 28</th>
<th>Arthur D. Little, 2014;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Qualitative evaluation of strategy and actions of public sector with regard to urban mobility along 5 dimensions: General sustainability and restrictions; Alternative engines; Multimodality; Infrastructure; Incentives.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Based on the current routine in these designs, we should consider a grade between 0 up to 10 which after interviewing with authoritative experts the Mashhad grade is considered 3.7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Transport related CO2 emissions</td>
<td>Ratio between the total amount of carbon dioxide emitted by the agglomeration area p.a. as a consequence of its transport activities and its population.</td>
<td>Arthur D. Little, 2014; KRMOEP, 2014; DPDMM, 2014; Shokohian and Ghazinejad, 2010.</td>
</tr>
<tr>
<td></td>
<td>According to the receipt statistics from the related organizations, the average of these pollutants is 1950 kilograms for each citizen, per year.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>NO2 concentration</td>
<td>Annual arithmetic average of the daily concentrations of NO2 recorded at all monitoring stations within the agglomeration area.</td>
<td>Arthur D. Little, 2014; KRMOEP, 2014; Shokohian and Ghazinejad, 2010.</td>
</tr>
<tr>
<td></td>
<td>The average of pollutant amount is 24 micrograms per square meters.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PM10 concentration</td>
<td>Annual arithmetic average of the daily concentrations of PM10 recorded at all monitoring stations within the agglomeration area.</td>
<td>Arthur D. Little, 2014; KRMOEP, 2014; DPDMM, 2014; Shokohian and Ghazinejad, 2010.</td>
</tr>
<tr>
<td></td>
<td>According to statistics, this amount is equal to 73.7 micrograms per square meters.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Traffic related fatalities</td>
<td>Number of deaths related to transport i.e. an annual number of people killed as a result of transport accidents that occurred in an urban agglomeration area p.a.</td>
<td>Arthur D. Little, 2014; Mashhad transportation statistics book, 2014.</td>
</tr>
<tr>
<td></td>
<td>The rate of traffic fatalities in</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mashhad was equal to 356 people based on the last transportation statistics. 
\[ \frac{356}{3} = 118.7 \text{ person per million people} \]


| 6 | Increase of share public transport in modal split | • Increase of the percentage of the total people trips which are made daily by public transport in the last available measurement compared to its share in the last but one measurement.  
• According to the collected questionnaires of experts, increase up to 20% is possible. | KRMMOE P, 2014; Mashhad transportation statistics book, 2014. |
|---|---|---|---|
| 7 | Increase of share of zero-emission modes | • Increase of the percentage of the total people trips which are made daily by bicycle and walking in the last available measurement compared to its share in the last but one measurement.  
• According to comparing the two last statistics, this amount can be increased up to the 15 percent. | Arthur D. Little, 2014; Mashhad Transportation statistics book, 2014. |
| 8 | Mean travel time to work | • Total number of minutes that it usually takes the person to get from home to work each day during the reference week.  
• According to the questions asked from the experts, this time amount is equal to 40 minutes. | Arthur D. Little, 2014; Mashhad Transportation statistics book, 2014. |
| 9 | Density of vehicles registered | • The ratio between the total numbers of passenger motorized vehicles (incl. cars, motorcycles, taxis) within the urban agglomeration and its population.  
• The numbers of these vehicles during a day is recorded up to 2504649 vehicles. 
\[ \frac{2504649}{3000000} = 0.83 \] | Arthur D. Little, 2014; Mashhad Transportation statistics book, 2014. |

Source: Research studies based on Arthur D. Little Urban Mobility 2.0.

The next step is calculating weight score averages. In this study, according to the Best Value and the Worst Value models, in each of the 19 criteria identified by Arthur D. Little’s study, Linear Interpolation Relationship was used.

Linear interpolation has been used since antiquity for filling the gaps in tables, often with astronomical data. It is believed that it was used by Babylonian astronomers and mathematicians in Seleucid Mesopotamia (last three centuries BC), and by the Greek astronomer and mathematician, Hipparchus (2nd century BC). A description of linear interpolation can be found in the *Almagest* (2nd century AD) by Ptolemy. Linear interpolation is often used to approximate
a value of some function using two known values of that function at other points, or used to fill the gaps in a table. Suppose that one has a table listing the population of some country in 1970, 1980, 1990 and 2000, and that one wanted to estimate the population in 1994, linear interpolation is an easy way to do this.

If the two known points are given by the coordinates \((x_0, y_0)\) and \((x_1, y_1)\), the linear interpolate is the straight line between these points. For a value \(x\) in the interval \([x_0, x_1]\), the value \(y\) along the straight line is given from the equation (Meijering, 2002).

\[
\frac{y - y_0}{x - x_0} = \frac{y_1 - y_0}{x_1 - x_0}
\]

Equation 1:

This equation is rewritten again based on the values obtained for the worst and the best value in Arthur D. Little study of 84 cities (2014) for the equation (2) and (3):

\[
\frac{\text{Worst.Weight} - \text{Best.Weight}}{\text{Worst} - \text{Best}} = \frac{\text{Mashhad.Weight} - \text{Best.Weight}}{\text{Mashhad} - \text{Best}}
\]

Equation 2:

And finally:

\[
\frac{R_W - R_B}{W - B} = \frac{R_X - R_B}{X - B}
\]

Equation 3:

According to the resultant statistics from field studies, in Equation 3, \(X\) is the calculated number for Mashhad and \(R_X\) is weight score that regarding each criterion is calculable. In Table 4 the best value \((B)\) and the worst value \((W)\) for every type of the 19 criteria are observable. Also, in order to avoid excessive decimal numbers, \(RW\) value of 1 is considered.

Now by the help of minimum and maximum amounts of Table 4, and calculated weights for Mashhad in tab. 3 and by using equation 3, we find the weight scores for each criterion and earn the overall score for Mashhad. This gained overall score for the Mashhad Metropolis in comparison to 15 selected cities is observable in Table 5.
Table 4: Best and Worst Values of 84 Worldwide Cities

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Worst Value</th>
<th>Best Value</th>
<th>Criteria</th>
<th>Worst Value</th>
<th>Best Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Financial attractiveness of public transport</td>
<td>0.7</td>
<td>0.2</td>
<td>11-Initiatives of public sector</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2-Share of public transport in modal split</td>
<td>%</td>
<td>4%</td>
<td>12-Transport related CO2 emissions</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>3-Share of zero-emission modes in modal split</td>
<td>%</td>
<td>5%</td>
<td>13-NO2 concentration</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>4-Roads density</td>
<td>12</td>
<td>0.1</td>
<td>14-PM10 concentration</td>
<td>200</td>
<td>11</td>
</tr>
<tr>
<td>5-Cycle path network density</td>
<td>0</td>
<td>467</td>
<td>15-Traffic related fatalities</td>
<td>193</td>
<td>4</td>
</tr>
<tr>
<td>6-Urban agglomeration density</td>
<td>0.7</td>
<td>17.8</td>
<td>16-Increase of share public transport in modal split</td>
<td>-53%</td>
<td>+186%</td>
</tr>
<tr>
<td>7-Smart card penetration</td>
<td>0</td>
<td>3.1</td>
<td>17-Increase of share of zero-emission modes</td>
<td>-61%</td>
<td>+148%</td>
</tr>
<tr>
<td>8-Bike sharing performance</td>
<td>0</td>
<td>238</td>
<td>18-Mean travel time to work</td>
<td>62.1</td>
<td>18.4</td>
</tr>
<tr>
<td>9-Car sharing performance</td>
<td>0</td>
<td>131</td>
<td>19-Density of vehicles registered</td>
<td>0.69</td>
<td>0.03</td>
</tr>
<tr>
<td>10-Public transport frequency</td>
<td>32</td>
<td>512</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Arthur D. Little FUM 2.0, 2014.
Table 5: Overall Score and Population of Compared Cities

<table>
<thead>
<tr>
<th>No.</th>
<th>City/Population (Million people)</th>
<th>Overall Score</th>
<th>Compare with Mashhad</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Los Angeles / 3.8</td>
<td>38.1</td>
<td>+6.9</td>
</tr>
<tr>
<td>2</td>
<td>Toronto / 2.6</td>
<td>44.4</td>
<td>+0.6</td>
</tr>
<tr>
<td>3</td>
<td>Buenos Aires / 3</td>
<td>42.4</td>
<td>+2.6</td>
</tr>
<tr>
<td>4</td>
<td>Caracas / 2.2</td>
<td>40.1</td>
<td>+4.9</td>
</tr>
<tr>
<td>5</td>
<td>Berlin / 3.5</td>
<td>51.7</td>
<td>-6.7</td>
</tr>
<tr>
<td>6</td>
<td>Madrid / 3.2</td>
<td>50.3</td>
<td>-5.3</td>
</tr>
<tr>
<td>7</td>
<td>Rome / 2.8</td>
<td>40.9</td>
<td>+4.1</td>
</tr>
<tr>
<td>8</td>
<td>Addis Ababa / 3.4</td>
<td>36.5</td>
<td>+8.5</td>
</tr>
<tr>
<td>9</td>
<td>Baghdad / 4.2</td>
<td>28.6</td>
<td>+16.4</td>
</tr>
<tr>
<td>10</td>
<td>Dubai / 2.5</td>
<td>40.6</td>
<td>+4.4</td>
</tr>
<tr>
<td>11</td>
<td>Melbourne / 4</td>
<td>41.9</td>
<td>+3.1</td>
</tr>
<tr>
<td>12</td>
<td>Osaka / 2.7</td>
<td>38.5</td>
<td>+7.5</td>
</tr>
<tr>
<td>13</td>
<td>Singapore / 3.5</td>
<td>55.6</td>
<td>-10.6</td>
</tr>
<tr>
<td>14</td>
<td>Bangalore / 4.3</td>
<td>38.9</td>
<td>+6.1</td>
</tr>
<tr>
<td>15</td>
<td>Lahore / 5.2</td>
<td>33.1</td>
<td>+11.9</td>
</tr>
<tr>
<td>16</td>
<td>Mashhad / 3</td>
<td>45</td>
<td></td>
</tr>
</tbody>
</table>


Results and Discussions

As it is expressed above, the overall determined score of Mashhad is equal to 45, which is inappropriate weight score. But if we refer to the Arthur D. Little study regarding the mobility in the 84 world cities, it is observed that the most privileged score of 58.2 belonged to Hong Kong, and therefore, comparatively, the weight score of Mashhad is considered an ideal weight score. It is very acceptable in comparison to many other world cities. To know why smart cities in regard to mobility or other smart components have not evolved yet, we refer to the European Parliament Report:

“Almost 2/3 of the sample European smart cities are in the stage of planning and testing (Pilot Testing)…, most cities under the process of testing which focus upon the energy goals of the year 2020” (European Parliament, 2014).

Therefore, no city of the European cities has reached the final stage of implementation. So achieving low scores doesn’t seem too much unreasonable. But in other parts of the world, especially in countries which do not have not any planning and visions to create a smart city is not an easy task. Obtaining the low weight score is an indicator of the lack of planning and lack of correct understanding of the future situations and interrelations of the world and future cities.
Mashhad city has some specific situations. This city has had a plan from 2004 to become an electronic city which was arranged by Mashhad Municipality. But this plan was not implemented due to some reasons. However there are different plans and suggestions for Mashhad to become electronic and smart city. During the last 5 years, the municipality has done many activities for making Mashhad a smart city (DPDMM, 2014), and these activities continue. Relevant infrastructures also have been provided for this issue, such as ICT infrastructures like: increase of availability to internet, high-speed internet, Wi-Fi and so on.

In the field of smart mobility, applications are designed for the smart city of Mashhad.

But the main problem in the municipality organization to implement the smart mobility is excessive and exclusive reliance just on the ICT experts. Unfortunately, the advices of humanities scholars and experts have not been given major role, and due to this reason the approach largely technical; social problems and needs took less attention.

After calculating the overall weight score based on Arthur D. Little mobility criteria (2014), for determining the current situation in smart mobility of Mashhad, the score should be compared with some other cities in order to be able to judge the current situation of Mashhad. For this reason, it was necessary to select the cities which have similarities with Mashhad and then do the comparison. Mashhad city has 3 million fixed population (Mashhad-statistics, 2014), which it is not a very exact foundation, because this city, because of pilgrimage and tourist characteristics, have 20 millions pilgrims and tourists yearly. On the other hand, about one million people live in sidelines of Mashhad and they use the welfare and official facilities of this city. These are the reasons why Mashhad has a floating population. Therefore, the cities which were selected for comparison with Mashhad have populations between 2.5 and up to 5.2 million people. Among the 84 cities studied by Arthur D. Little, 15 cities similar to Mashhad were selected. The results of the comparison are as follows:

As a whole, the weight score of Mashhad is in the fourth rank and after the three cities of Berlin, Madrid, and Singapore. It also has a weight score equal to Toronto. In the weight score of Mashhad metropolis, financial attractiveness of public transport and share of public transport in modal split (1st and 2nd criteria) is located in a suitable status and the smart cards’ penetration (7th criterion) is also high, because 3200000 smart cards related to transportation has been issued in this city (Transportation Statistics Book, 2014). But the Share of zero-emission modes in modal split (3rd criterion) is very low, because the citizens, in spite of the suitable number of bike sharing (8th criterion), limitation of cycle path network (5th criterion) and the high risk of bicycling due to the high numbers of traffic related fatalities (15th criterion) use bicycles and walk less in their daily trips. Thus we can’t be very hopeful about increasing the share of zero-emission modes (17th criterion) in Mashhad. Also, 15 percent improvement prediction for the next 10 years is very little progress.

The road density (4th criterion) is high. Thus, considering the high numbers of roads and pathways, the frequency of the most public used vehicle, namely buses (10th criterion) to reach
the stations, is about 15 minutes in urban routes and sub-routes. That is an acceptable time. However, the density of vehicles registered (19th criterion) is high, and therefore passengers don’t wait much time to get on these transportation vehicles.

The other point which is related to the road density and their high traffic is the fact that there isn’t any car sharing system (9th criterion) available in Mashhad. Also there is no planning to implement this car sharing system because, on one hand, it increases the traffic, and requires new parking spaces of these cars which are a real problem in Mashhad. On the other hand, because of the lack of suitable parking places for personal cars, motorcycles, and bicycles in Mashhad metropolis, especially in the central core of this city, traffic jam is always in the increase. This would produce more transportation disorder and weather pollution.

The mean travel time to work (18th criterion) has been calculated 40 minutes for Mashhad. Compared to the Worst Value, that is 62.1 minutes and the Best Value that is 18.4 minutes, it isn’t a favorable time. But taking the traffic difficulties in account, such time is considered acceptable.

Concerning weather pollutants caused by the traffic namely CO2, NO2, and PM10; the results yielded are as following:

The amount of transport-related CO2 emissions (12th criterion) for each citizen is 1950 kilograms yearly, namely about 2 tons every year which it is a very grievous number. The worst value in the Arthur D. Little study (2014) was recorded equal to 7390 kilograms, however it is related to the few numbers of cities (maybe one or two cities) and it can’t be a generality. But given the difficulty of controlling CO2 emissions globally, the gained weight score for Mashhad compared to other cities is on average amount. However, it remains an inappropriate the amount.

Authors believe that according to Province Main Office of Environmental Preservation reports, the amount of transport-related CO2 emissions in Mashhad is very high. It causes many environmental and health problems. Among the most important health problems, as a result of high mass of CO2, are heart, cordial, and nervous diseases, respiratory and lung problems and also various types of cancer (KRMOEP, 2014).

Another criterion related to the weather pollutants due to the traffic is the NO2 concentration (13th criterion). The standard amount of NO2 is 21 mcg/m3; in Mashhad weather is measured about 24 mcg/m3. Compared to the worst and best values gained for the cities studied by Arthur D. Little (2014), Mashhad weight score is acceptable.

According to Lahsaizade (2014), NO2 results into irritating of lungs. Short-time contact with the NO2 pollutant causes coughing and functional disorder of lungs and long-time contact with NO2 increases the likelihood to suffer from respiratory infections and leads to structural changes in lungs. Nitrate and NO2 ingredients also result in disordering of sight, and nitrogen sedimentation leads to acidity of ground, lagoon and marine systems (Lahsaizade, 2014).
The current nitrate in atmosphere in the form of acidity products emits ingredients that sediment as acidity rain, fog, snow, or other ingredients.

The last studied pollutant is the PM10 concentration (14th criterion). The suspended ingredients are little than 10 micron which can be produced from the ignition of cars’ fuel, industrial and power plant processes, wood fireplaces, Shumen, agronomical and forestry activities, routes dusts, and conflagrations, and jungles (Lahsaizade, 2014).

The yearly reported average for these pollutants in Mashhad is equal to 73 mcg/m3, which its normal amount is 20 mcg/m3 (KRMOEP, 2014). It can be concluded that the density of these ingredients in Mashhad is very high.

Suspended ingredients affect the respiratory and immune systems of body and intensify the respiratory, heart and cordial illnesses. The size of these ingredients is the main reason of lowering the sight ability and they have damaging effects on herbage ecosystems (KRMOEP, 2014; Lahsaizade, 2014).

**Conclusions**

Based on the findings of this research, we can conclude that, the gained weight score of Mashhad regarding the smart mobility was about 45% percent and compared to the cities located in the population range of Mashhad it is almost a favorable score. But it cannot be indicative of many problems due to increasing mobility. In spite of suitableness of public mobility system in Mashhad and the lowness of wait time of citizens to get on the public vehicles, some factors such as high density of Mashhad city are causing trouble. The city, being a good tourist place, high number of public and personal cars roams in this city. The inefficient use of new electronic and technological tools does not reduce inside trips, and the lack of smart system for guiding and directing citizens inside the city contributed to such traffic jam. Finally, the lack of correct understanding of the smart mobility by the city managers causes the absence of startegic planning related to smart-making and smart mobility in Mashhad.

On the other hand the pollution created by the traffic and aimless mobility inside the city increased the emission of CO2 mass for every citizen to reach nearly 3 tons yearly which is likely to cause health and ecological catastrophes. The PM10 density, which is three times more than the standard amount, also causes contributes to this catastrophe. Therefore, the only way to avoid this catastrophe is using the intelligence regarding mobility in order to be able to reduce the inside trips and take out gradually some of the polluting cars from the transportation system to reduce slightly the pollution and traffic problems.
Acknowledgement and disclaimer

Many resources used in this article were in English but they were translated into Persian by researchers during the last year to be used in this article. Sometimes, due to non-availability of the main text, they were translated from Persian to English again, and because of this, it is likely that they have word differences with their main text. But we have regarded trusteeship and authors’ names are cited completely in all places.

We also thank the Arthur D. Little Institute which has done a very valuable study regarding the smart mobility and in this study it has been used frequently. We also mention the valuable study of Giffinger about the smart city in Vienna University that paved the way to us and many other researchers in this regard.
References


