Site Selection of Public Parking in Isfahan City, using AHP Model

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Abstract—Nowadays, one of the most important problems of the metropolises and the world large cities is the habitant traffic difficulty and lack of sufficient parking site for the vehicles. Esfahan city as the third metropolis of Iran has encountered with the vehicles parking-place problems in the most parts of fourteen regions of the city. The non principled and non systematic dispersal and lack of parking sites in the city has created an unfavorable status for its traffic and has caused the air and sound pollutions increase; in addition, it wastes the most portions of the citizenship and travelers' charge and time in urban pathways and disturbs their mental and psychical calmness, thus leads to their intensive dissatisfaction. In this study, by the usage of AHP model in GIS environment, the effective criteria in selecting the public parking sites have been combined with each other, and the results of the created layers overlapping represent the parking utilitarian vastness and widths. The achieved results of this research indicate the pretty appropriate public parking sites selection in region number 3 of Esfahan; but inconsequential dispersal and lack of these parking sites in this region have caused abundant transportation problems in Esfahan city.

Keywords—Public parking lots, Parking site selection, Geographical Information System (GIS), Hierarchical Analysis Model, Isfahan city.

I. INTRODUCTION

In majority of the large cities, the few widths of the pathways and the street margin parking-places, the dupli ceasing and furtive movement of the vehicles finding a parking site have caused an intensive disturbance in the passing traffic. The problem of vehicle parking sites shortage in the cities and the inconsequential dispersal and inappropriate parking sites selection are among the intricate and difficulties which have encountered daily life of this city's citizenship and travelers with problems. Esfahan as one of the large cities of Iran contains the intensive population's accumulation and centralization; on the other hand, it has many tourist attraction applications which cause of the coordination shortage and inappropriateness between this city's attraction applications and the parking lot usages, in addition the inaccurate locating and the inconsequential dispersal of the parking lot application, it has faced the intensive traffic problem. This difficulty in number 3 region of Esfahan which from the view point of tourist attractions outtranks among the existent fourteen regions is critical and includes abundant inappropriate condition.

Vang and Sung [1] in an article named "Combinatorial Optimization of Congested Road and Parking Charging" point to the congestion of the traffic as a dominant problem which has stockade the permanent development of the urban transportation; in addition, they have surveyed the analysis of the transportation network, travel charging and cost, and the traffic demand; They have come to this conclusion that TDM is an effective solution to reduce the traffic congestion of the urban regions and it is possible to lessen this congestion notably by the usage of the combinatorial optimization model.

Also, Farzanmanesh and etal [2] in an article named "Parking Site Selection Management Using Fuzzy Logic and multi Criteria Decision Making" have surveyed the parking site selection in traffic jam regions of Esfahan and they have come to this conclusion that among various multi criteria decision making models for parking site selection, the usage of AHP model and fuzzy logic in GIS are the best public parking Sites Selection implements.

Casido [3] in an article named "Real-Time Parking Information Management to Reduce Search Time, Vehicle Displacement and Emissions" has surveyed the real time parking information management in order to reduce search time; in addition, he has pointed to the considerable environmental pollution emanated from the vehicles' search time finding a vacant parking site. He has concluded that by surveying the drivers' behavior and the accessible parking sites, also by evaluating the management and utilization of the parking site information, we can reduce the time and distance for parking site searching and lessen the environmental pollution emanated from this searching.

Lai and etal [4] in an article have considered the fire fighting stations' selection by the combination of GIS and AHP. They came to this conclusion that combination of the above methods for the urban applications selection are very useful and simplify the complicated problems.

Sayed Moosavi [5] in his MS thesis proposal named "The Geographical Analysis of the Problems and the Public Parking Sites Difficulties in Esfahan" studied and analyzed the public parking sites and their shortages and problems in Esfahan; in addition, by considering the problems in creating the public parking sites in Esfahan he concluded that parking sites in Esfahan do not have a logical emission, there is a considerable shortage in this regard and the vehicles parking sites demand in this city has not been accomplished.

Ghanbari [6] in an article named "Parking Site Emission and the Optimized Function in Urban Transportation Network" by emphasizing on parking sites location and selection and the usage of GIS, in addition, by utilization of Network Analysis method and according to the permissive speed of the vehicle's movement in the pathway network and
the length of the related pathways in GIS environment has
studied and evaluated the space emission, the establishment
site, and the existent public parking sites' function vastness in
Esfahan city. Eventually, in order to collate the gained data
and information, he has announced the hierarchical analysis
model the best one.

Mokhtari [7] in an article named "An analysis in Functional
Planning of the Parking Site in Esfahan City" by usage of the
regional planning and functional models has surveyed a
comprehensive statistical model about the applicability of
parking sites in Esfahan with regard to three models of
regional planning; in addition, has studied the other 11 regions
of Esfahan from the view point of the applicable parking site
capitation. From the results of this research, we can allude to
the regions exploration about the parking space and capitation,
also the regions precedence from the view point of the parking
site shortage.

The purpose of this study is to survey and recognize the
existential status of the parking site applicability and its present
emission in number 3 region of Esfahan, the utilization
method of the new parking site selection technologies and its
role in parking site organization in number 3 region of this
city; in addition, survey of the logical emission of public
parking sites has been considered.

II. METHODOLOGY

In this research, at first the effective criteria in parking site
selection have been declared; then in GIS environment, the
related layers to each criterion have been provided and by
the usage of the multi criteria decision making model of AHP, the
layers with regard to their importance coefficient have been
combined and overlapped with each other. The ultimate layer
is the plan of parking width utilitarian.

In evaluation of each subject we need the measurement
criterion or index. The appropriate criteria selection gives us
this possibility to compare the alternatives and locators
appropriately. But when one or some criteria will be
considered for evaluation, this function gets complicated. This
complexity increases when one or some of these criteria will be
evaluated by each other and from various kinds. In this case, the
evaluation and comparison function exist from the simple
analytical shape which mind is able to perform it; therefore, a
strong analytical implement will be needed. One of the
capable implements for such situations is the hierarchical
analysis process [8]. The hierarchical analysis model is one of
the strongest multi criteria decision making techniques which
in 1980 was represented by a researcher named Thomas Sa'atti
a professor from Petersburg University. In spite of some
critics, it was complimented and praised by many scientific
cliques. This method which reflects the natural human's
behavior and thought will make the decision maker able to
offer the cooperation between various criteria in complicated
and non systematic situations. This technique simplifies the
decision making through the emotion, cognition, assessments
and judgments organization. In addition, it identifies the
effective powers on decision making [9].

III. DISCUSSION

In this study, three main criteria and four sub criteria have
been selected as the most effective public parking sites
selection. Chart number 1 shows the hierarchical structure of
the problem. The exchange of the subject or the surveyed
problem to a hierarchical structure is considered as the most
important part of hierarchical analysis process, because in this
part by the analysis of the complicated and difficult problems,
the hierarchical analysis process will change them to a
simplified form in order to conform to the human's mind and
nature.

By application of AHP side program in software Arc Map,
during the dual comparisons and in two phases, the ultimate
model and the parking site selection result have achieved in
layer figure. In the first step, the dual comparison between
the sub criteria of tourism attraction centers was performed and in
the other phase its result was dual compared to the distance
criteria from the pathways network and also the region estate
value; according to the results of their overlapping with each
other, the utilitarian widths of the parking sites structure have
been achieved. In table 1, the dual comparison matrix of the
distance sub criteria from the tourism attraction centers, the
layers weight vector and the accordance ratio of the dual
comparison from the first step have been presented.

According to the hierarchical model calculations in sub
criteria phase of tourism attractions centers and the above
table, number 1 formula is achieved:

\[ l = 0.5511(a_1) + 0.2642(a_2) + 0.1171(a_3) + 0.0676(a_4) \]  \hspace{1cm} (1)

In number 1 formula, a1 is the sub criteria of the distance
from the commercial centers; a2 is the sub criteria of the
distance from the sanitary-therapeutic centers, a3 is the sub
criteria from the official-governmental centers and a4 is the
sub criteria of the distance from the educational-recreational
centers.

In table II, the dual comparison matrix of the distance main
criteria from the tourism attraction centers, the criteria of the
distance from the pathways network, the criteria of the estate
value importance, the layers weight vector and accordance
ratio dual comparison of the main criteria from the second step
have been presented.

According to the calculations and dual comparisons of the
main criteria in above table, formula number2 as the second
phase formula for the overlapping functions has been utilized.

\[ l = 0.6548A + 0.2498B + 0.953C \]  \hspace{1cm} (2)

In formula number 2, a stands for distance from the tourism
attraction centers, B is the distance criterion from the
pathways network, and C stands for the criterion of the region
estate value.

Figure 1 displays the public parking sites utilitarian widths
of region number 3 in five levels; in addition, Figure 2
represents the suggested parking sites in abundant appropriate
widths of this region which there are no parking lots in them.
### TABLE I
THE DUAL COMPARISON OF THE DISTANCE SUB CRITERIA FROM THE TOURISM ATTRACTION CENTERS

<table>
<thead>
<tr>
<th>Sub criteria</th>
<th>Distance from the commercial centers</th>
<th>Distance from the sanitary-therapeutic centers</th>
<th>Distance from the official-governmental centers</th>
<th>Distance from the educational-recreational centers</th>
<th>Weight Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from the commercial centers</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>0.5511</td>
</tr>
<tr>
<td>Distance from the sanitary-therapeutic centers</td>
<td>0.3333</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>0.2642</td>
</tr>
<tr>
<td>Distance from the official-governmental centers</td>
<td>0.2</td>
<td>0.25</td>
<td>1</td>
<td>3</td>
<td>0.1171</td>
</tr>
<tr>
<td>Distance from educational-recreational centers</td>
<td>0.1667</td>
<td>0.3333</td>
<td>0.3333</td>
<td>1</td>
<td>0.0676</td>
</tr>
</tbody>
</table>

CR=0.0878

### TABLE II
THE DUAL COMPARISON OF THE MAIN CRITERIA

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Distance from the tourism attractions centers</th>
<th>Distance from the pathways</th>
<th>Estate Value</th>
<th>Weight Vector</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance from the tourism attractions centers</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>0.6548</td>
</tr>
<tr>
<td>Distance from the pathways</td>
<td>0.3333</td>
<td>1</td>
<td>3</td>
<td>0.2498</td>
</tr>
<tr>
<td>Estate Value</td>
<td>0.1667</td>
<td>0.3333</td>
<td>1</td>
<td>0.0953</td>
</tr>
</tbody>
</table>

CR=0.0176

Fig. 1 Public parking sites utilitarian

Fig. 2 Suggested parking sites
IV. CONCLUSION

The achieved results of the field studies and the locative analysis in this research represent the unbalanced distribution of the tourism attraction users and also, the inconsequential dispersal of the public parking sites in the region. In northern ranges (around Ghods Square and at the head of Majlesi street), in eastern ranges (Bozorgmehr street and the head of Hashtbehesh street) and also, the southeastern ranges (Bozorgmehr street and Zayanderood River margin) of this region despite the existence of many important applications which are the abundant urban tourism attractions, there is no parking site.

REFERENCES