Local Parking Positioning by Using the Linear Assignment Method
(Case Study: Qazvin, Iran)

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ABSTRACT: Concerning the population growth and urban development, significant growth in the rate of personal car usage has caused more transportation and thus growth in occupying the street areas for parking vehicles. This has caused much transporting problems and traffic. Hence concerning the parking issue is crucial in traffic and municipal management.The important issue is the suitable place for the parking areas. If there would not be any demand for assessment and evaluation of the traffic and municipal criteria, the constructed parking area would not be much usable and cause some difficulties in transferring lines,thus the expenses paid for building the parking will be wasted.Hence, in this article, the influential indexes for parking place in three different areas of Qazvin are introduced and discussed. Regarding the qualitative municipal criteria, we have used the multi-criteria linear assignment method for comparing and considering the indexes and region, and finally rating these regions for parking.

INTRODUCTION

Parking areas are one of the most important municipal infrastructures and play a main role in reducing the traffic rate and traffic management. Today,big cities because of the limited area are developmental approaches in constructing modern parking lots in order to increase services forlots of vehicles. Parking areas are one of the most important tools in traffic management which can reduce the air and noise pollution, because the time that vehicles are parked is much more than they are driving. Briefly, the strategy of parking vehicleshas a great contribution to the amount of the energy usage, the traffic jam, and public transportation. Parking management includes different strategies which motivates beneficial usage of the modern parking facilities. One of the modern parking forms are the multi-storey parkingthat because of the limited land pieces and high expenses is the best alternatives for constructing public parking. But multi-storey parking can have a beneficial usage only when they are constructed at suitable places.

Until now, in Iran, the only factors for constructing a parking lot have been the availability and the low price of the land,

thus so many other important factors have been ignored or denied. From the technical view, traditional approaches not only have put an end to the parking and traffic problems, but also have caused different problems in transportation systems (Arnott&Inci, 2005).

That's why the tendency to use methods which can put a variety of factors altogether at once, such as multi-criteria decision making method, has highly increased.

Hence in this research we work on choosing the location for local parking areas especially in the crowded places and shopping centers, that there is a huge mass of vehicles, and using the linear assignment decision making method. Here we discuss on fundamental factors of traffic managementto find the suitable place for constructing parking at three different areas of Qazvin and concerning that these factors are qualitative.The evaluation of the factorsis based on the experts' suggestions that are gathered by preparing forms, questionnaires and finally we will choose the most beneficial approach by using the multi-criteria decision making method (MADM) and the linear assignment method. At the end, after comparing these three and using this method, they are rated and the best one will picked out.

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Table 1: Application of local parking positioning

Author/s and country	Application area
[1] Weant , R ,A(1978)	Parking Garage Planning and Operation
[2]Kligman, R. (2002)	TrafficEngineering in Newton Retrieved
[3]Tam, C.M., Tong, K.L.T., & Chiu, W.C.G.(2006)	Comparing non Structural Fuzzy Decision Support System and AHP in Decision Making for Construction Problems
[4] Malczewsk, J. (1999)	GISand Multi Criteria Decision Analysis
[5]Bowen,W. (1993)	AHP: Multiple Criteria Evaluation, in Klosterman, R.et al Eds, Spreadsheet Models for Urban and Regional Analysis,
[6] Arnott, R &Inci, E. (2005)	An Integrated Model of downtown Parking and Traffic Congestion
[7]Arnott, R. (2006)	Analysis of Geographical information system
[8] Yang, J., & Lee, H .(1997)	AHP decision model for facility location selection

Research Background

Several varied studies have been done taking different application areas into consideration. Table 1 illustrates the brief results of past studies.

MATERIALS AND METHODS
Parking Positioning in Urban Management

High rate of the population growth and increasing the possession of personal vehicles have caused cities development. In such cities, the public transportation system isvery importance and is designed in a way to have maximum ability in order to present services to the citizens. The current traffic management and organizing,always attract more concentration in comparison with the stable traffic (parked vehicles), and not focus on its influence on the current traffic. The reason of the case is more focusing on the current traffic and ignoring parking management. Thus, one of the most important problems in traffic managementis management of the stable traffic which now a days,is one of the crucial municipal issues.

Hence, the need for managing suitable place for organizing the city traffic is very important in order to design a system for the traffic in the city.

Different kinds of suitable place for the parking, based on kinds of their services (Weant, 1978):

Non-Governmental Services

The service agencies settle at places where they can maximize their benefits.

Public Services

The public service agencies place where they can maximize level of their benefits and provideservices for every citizenthat isvery importance (Goli et al., 2010).

Essential Indexes in Constructing Local Parking Areas in the Placement Issue

The right place is a very important issue in peoples' decision making. Suitability of a place for providing a service is highly dependent on some factors and agents that have been chosen and evaluated during the positioning process that include many different and variable items that are influential in decision making for the suitable positioning. In theresearch, five different indexes are considered for well positioning the parking areas. These indexes include being available to the city center (downtown), the area of the piece of suitable land for constructing the parking lot, the distance between the center, the value of the land, and the population.

Populations

Less population is in the city, and equally scattered the whole region, more people would have capacity to use the sources, services and facilities; and on the other hand, the growth of population at one spot in the region means increasing the demand for goods and services. In less crowded places, there are more room and apace available for constructing parking lots at public areas. However, in highly crowded places, the number of drivers is too much and thus it causes traffic and so many other problems in the streets and public areas (Ebadi, 2011).

The Distance between Parking Area and the City Center and to be Available from the Central Parts of the City

If there were not such an issue as walking to the parking area, there would not be any parking lots at all.Because by taking longer ways, people could park their cars at suitable places without interruption. A person takes long way to go somewhere;would take long way to the parking (Shahi, 2004).

The Price of the Lands Suitable for Constructing the Parking Lots

With the population growth, the city gets larger and larger, too. This also causes the competition over possessing the land at suitable places and getting more benefit. The population

growth, the high building concentration, increasing demands and so many other factors cause an increase in the lands price in the whole city and thus the lands which are located at suitable business centers and commercial areas or have the better availability and facilities, would be more expensive and valuable (Arnott, 2006).

Considered Alternatives
A1 area (Bazaar)
A2 area (Velayat)
A3 area (northern Khayame)

Multi-Criteria Decision Making
In multi-criteria decision making which is the applied approach in this research, the criteria are the norms for the decision making; the explicitly mentioned goals, and the indexes are also gathered by preparing forms and questionnaires; and determined based on the experts and construction engineers' opinions and suggestions about the most important goals and criteria of managing construction projects.

In MADM model, we have to select one alternative among several ones. Generally, these features are common among all the different MADM issues:

Alternatives
Several alternatives are considered in these issues; and they are ranked, selected or rated. The number of these alternatives could be limited or numerous.

Multiple Criteria
Every MADM issue has several criteria, that the decision maker should determine them.

Non-Scale Units
For the benefit of the computations and results by the practical methods, data are being non-scaled, though the relative importance of the data is remained.

The Weight of the Criteria
Every methods arenecessarily based on the data gathered by the relative importance or priority of each index.

The weight of the criteria could be directly determined by the decision maker or the scientific methods. These weights determine the relative priority of each index.(Ghodsipour, 2000).

RESULTS AND DISCUSSION
Design Modeling by Using the Linear Assignment
The data gathered after the statistics done and entered into the research after review and correction. It is necessary to mention that those forms, which are considered incoherent, have been corrected and normalized in comparison with the majority of the other forms and finally the data gathered for the propose of being process. Because the statistics in this research are gathered from the questionnaires and the opinions of the experts and operators of the Delphi group based on the suggestions in these forms.

These data include the titles of the criteria, which have the most influence on the traffic management at parking placement. For the beneficial usage of the gathered indexes, this research has observed and considered the role of these criteria and their importance. Following this, the research has determined and evaluated the influential criteria for choosing the best place for the discussed issue. And after this stage, it has scored these indexes and strategies based on the questionnaire forms which have been filled in by the experts, managers and operators, and then the modeling is done based on the linear assignment method.

In this method the thesis alternatives of one issue are ranked based on their scores of each available index, and then their final scores are determined by one linear compensation process (Bus &Tvrdik, 2009).

The following algorithm determines the final score of an alternative by concerning the other rankings of the other alternatives.

First Step
You have to determine each alternative's score (ranking) for each available index. In this case it is supposed that there is a MADM problem with three alternatives in relation with five beheindexes. In a way that the score (ranking) of each

Table 2: The rank of each alternative per the available score in each criterion

The distance between the parking and down town	A3	A2	A1
The area of the land	A1	A3	A2
Availability to downtown	A3	A2	A1
Population in the region	A3	A2	A1
The value/price of the land	A3	A2	A1
The rank of the index	First	Second	third

Table 3. The reference matrices suggesting the frequency rate at the Kth score

The third score	The second score	The first score	The score of the applied approach
3	0	2	A1
1	4	0	A2
1	1	0	A3

alternative per the score that lies within each index is concluded in the following way, which the approaches are ranked/scored and categorized based on the importance level and priority of the indexes in Table 2.

Second Step
You have to consider the reference matrices with the non-negative elements in a way that each of its elements suggests the frequency rate which is ranked as the Kth score according to the variable indexes in Table 3.

Third Step
Determining the weights of the indexes based on the results gathered from the questionnaires which have been filled in by the managers, operators, and experts of Delphi groupin Table 4.

Table 4: The weights of the indexes based on the questionnaires

Total	1
The area of the land of the parking	0.188
Availability from downtown	0.189
Population of the region	0.197
The value/price of the land	0.212
The distance between the parking lot and downtown	0,214
Index	Weight

Fourth Step
Placement of the weights of the indexes at matrices Y, in the case that for the Jth score, the applied approach for the indexes that could achieve this score would have to add the weights of those indexes and put them at the matrices Y in Table 5. (Asgharpour, 2009)

Table 5. Placement of the weights of the indexes at matrices

The score of the applied approach	A1	A2	A3
The first score	0.4	0	0.6
The second score	0	0.812	0.188
The third score	0.6	0.188	0.212

Fifth Step
Computing the final score for the element of matrices Y shows the influence of it for the final Kth score in the way that giving it to the final Kth score would be more harmonious in case of the increasing value. Thus the problem is that we find for each Kth score (K=1,2,…,m) that has the most influence on that score and maximize the final goal of the function of the L-P program concerning the possible exchanges.

For this aim we use the L-P modeling in the following way:(Asgharpour, 2009)

Equation 1: $\text{Max} : \sum_{i=1}^{m}\sum_{i=1}^{m} \gamma_{ik} \cdot h_{ik}$

Equation 2: $\sum_{i=1}^{m} h_{ik} = 1 \qquad ;i = 1,2,…,m$

Equation 3: $\sum_{i=1}^{m} h_{ik} = 1 \qquad ;k = 1,2,…,m$

Equation 4: $h_{ik} \begin{cases} =1 \\ =0 \end{cases}$

In this way, we consider one square matrice in a way that it would be delivered to the final Kth score in Table 6.

Table 6: Formation of the square matrices

0	0	1
0	1	0
1	0	0

Sixth Step

If the benefits from the mentioned L-P are like this, then the order of the beneficial alternatives would be concluded from the multiple. The results of their final ranking (scoring) are shown in the Table 7.

Table 7: The final ranking "scoring"

score	Kinds of the approaches
First	A3 area
second	A3 area
third	A3 area

CONCLUSION

In present study, a well discussed analysis was done on potential locations for local parking areas especially in crowded places using linear assignment decision making method. In the research, five different indexes are considered for adequate positioning of parking areas, consisting of accessibility to center of city, sufficient space, and distance between the center, land and population. The indexes were determined at three different areas of Qazvin using questionnaires, MADM. Based on the obtained results the following conclusions can be drawn. Regarding the results gathered from the modeling,final comments on three different regions A1, A2, and A3 illustrated as below:

Region A, for its easy availability to the shopping centers and also the great number of drivers there, the wide passage would lessen the distance between the parking and the centers. However, it is necessary to mention that, too high land prices and also often shortage of the land in such areas, have caused constructing modern and multiple-storeyparking lots, and concerning huge demand rate of the parking area.

Region A2 for its average land price, not so much population, and its availability to city centers has made the distance between parking and centers lesser, thus requires the second priority for constructing a parking lot. Regarding that, there would be no shortage of land at this area.Thus, constructing a traditional kind of parking is both suitable and applicable at this area; but concerning the view of the city and its developing sites require construction of somehow modern and multi-storey parking lots.

Region A1 for its rather low price lands in comparison with the two other considered regions at this research, low availability to the main city centers, limited textures, narrow passages, and widely scattered sites, is suitable for constructing parking lots.Unsuitable population spread, constructing parking lots at this region would face many problems and difficulties.

According to the above mentioned reasons, this study determines the priority of alternative areas for A3 region as the first one, A2 region as the second one, and A1 region as the third one, as each alternative area generally requires great attention in comparison with other areas according to the considerations of this research.

The current traffic management and organizing, always attract more concentration in comparison with the stable traffic (parked vehicles), and not focus on its influence on the current traffic. The reason of the case is more focusing on the current traffic and ignoring parking management. Thus, one of the most important problems in traffic management is management of the stable traffic which now a days, is one of the crucial municipal issues.

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