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Allocation of CNG Stations in Urban Street Networks Based on GIS Approach and Prioritization with AHP and Topsis Methods (Case Study: Rasht City)

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Abstract: Today's finding a proper location of transport services widely contributes to the organization of city street networks. Fuel refueling station networks include urban services acted as urban transport supply and it accounts in terms of traffic considerations, urbanization, security and environment. In this study, with respect to CNG refuel stations and criteria for proposed guidelines some variables are the following: Land uses, Traffic networks, population, traffic volume, infrastructure facilities, accesses. Then using a Arc Map software, resources map and limiting factors to Rasht city have been overlapped and locations have been proposed. In the next stage questionnaires have been arranged in the form of pair comparisons and bipolar scales besides variables were given relative weights by experts. Afterwards, for choosing the best place, an approach called AHP in the form of Expert Choice to determine the ultimate weight of variables and spaces. Traffic volume with 34.3% and infrastructure facilities 33.4% ranked first and second respectively. Place No.8 ranked first with 19.2%. Besides to grade, criterions are scored in the form of TOPSIS using bipolar their weight determined by entropy. The most weight is with the infrastructure facilities variables at the rate of 30.9%. Then proposed places have been ranked. Place No.7 ranked first with 0.766. In the end priority order are compared and AHP is selected for ranking.

Keywords: Analytic hierarchy process, CNG station, geographical information system, Rasht city, TOPSIS

INTRODUCTION

Nowadays with increasing city population, various use developments, remarkable Autos production sparked numerous travels across the cities; it yielded many problems including traffic, time waste, environment pollutions, high fuel consumption and queue from CNG1 stations. Thus care for accurate and scientific schedules accounts is necessary for city service centers. One of the resources enjoys direct association with the decreasing unnecessary urban travels are Fuel Supply centers. With regard to Fuel stations should offer as much service as possible with the lowest fuel supply centers. On the other hand appropriate sites for the construction of fuel centers are identified as a result of the importance level of fuel supply stations, quality and quantity of distribution in shaping the traffic behavior.

At the present time CNG stations doesn't fit Rasht demands and not aimed at developing means of transports. What is more, CNG stations are not in good conditions it triggered lots of problems including increase in commuting time, fuel consumption increase, weather contamination, waste time so it is important to compensate for the losses. In order for the stations to be geographically acceptable all positioning factors should be taken into account. Present problems include lack of appropriate planning for station positioning, lack of enough relationship between station founders and urban designers, financial issues and economic embargos. As a result many stations are not as efficient as they should be because distance of station sites are not in line with appropriate use .thus in this study, CNG station positioning by multi index decision approaches an Arc Map, tried to offer maximum service to the customers.

A review of available resources has been offered within the area of CNG station positioning. In the third part, methodology and CNG station positioning frameworks have been presented .In the fourth part, information gathered in the soft ware Arch Map and then it was analyzed and driven places from AHP2 and TOPSIS3 have been ranked. In the last part, results are presented and further suggestion are proposes.

LITERATURE REVIEW

Locating is an activity that breaks down abilities and capabilities of a region in terms of appropriate land. Applied indexes vary in terms of type application but all of them are the same when choosing appropriate places. The use of such indexes requires correct information and access to the information requires comprehensive investigation. Having analyzed them then one can decide on them.

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One of the most important studies conducted within the area of area of fuel supply stations. A study conducted by Melendez and Milbrandt (2008) in collaboration with Renewable Energy Organizations and America Energy Department in 2008 entitled Regional demand and Hydrogen Stations Optimization. The goal of this study was to identify barriers to station developments, identification and qualifying resolutions potentials to overcome them. In this study Geographical information system software and excel have been used. Data are divided into two parts maps and tables for each Geographical element. Geographical information mix and table forms, used to analyze different Geographical spaces (Melendez and Milbrandt, 2008).

Christopher up church and Michael kuby applied fuel optimization in two popular ways p-median and flow-refueling. P Model is widely used it decreases the total weight of traveled distance with devoting nodes Where as the second model is based on the demand routes that chooses places to increase the number of travels in this study locating is carried out using positioning in the shortest route. The places are better than refueling commuting that is through p-median model. The difference of these two methods in the state scale is more than city scale (Upchurch and Kuby, 2010).

The study of hydrogen station optimization in Florida conducted by Kuby *et al*. (2009) using Flow-Refueling location model. This model applied to locating in the form of maximum volume of transportation. The inputs of the models includes: average speed, destination and starting line of commuting volume .Geographical information System and creative algorithm in the backup system of decision become uniform. This model have been used in Florida for primary distribution of stations in urban and state application. The results show that the increasing cooperation between the stations and their good performance help the data to become categorized (Kuby *et al*., 2009).

The study conducted by Dambatta *et al*. (2009) tilted hierarchical analysis process to manage polluted lands in 2009. The approach taken care of decision analysis, backup techniques from decision makers on management of complex issues, lack of certainties. Several methods have been used to decide on environment issues this study took care of different methods. To decide and analyzes Environment management issues. The study underscores hierarchical analysis process a growing analysis -decision techniques have been used at different levels of planning and environment and rising resources (Dambatta *et al*., 2009).

Adsavakulchai and Huntula (2010) conducted fuel positioning supply stations using GIS1 in Bangkok Current integration in GIS ranked first compared to other positioning approaches. The variables in this method directly evaluates the cost and efficiency of fuel supply stations. Some of the variables close to population centers distance between two centers auto jam, land prices, the number of gas fuels motorists. Study result overlaid from layers accumulation in the software Arc View. Each region potential determined for CNG stations and appropriate sites represented for station construction (Adsavakulchai and Huntula, 2010).

In the study entitled methods representations of appropriate positioning for CNG station in a city target function is defined as the total expenditure it also taken quality and quantity factors into account. Evaluation of these factors is made of AHP in the sense that important indices have been chosen from among common indices of CNG stations. They are ranked, weighted by experts they go through judgment and decision based on AHP method. They are tested by software called expert choice so the total weight can be calculated. Then PSO algorithm is used as a Meta heuristic algorithm. To solve problems encoded in the MATLAB setting. Then a case sample of is introduced for assessment.

METHODOLOGY

In this study, first all surveys are taken into account, effective factors on CNG station positioning are defined. The descriptive and spatial data are gathered. Then data are inserted into Arc Map software and analyzed. First required layers are built based on their structure, linear, point, polygon in Arc Catalog. It is added to Arc Map. Map drawing tools are used to provide appropriate and inappropriate layers of the CNG stations in order to draw areas to buffer function is used. All plans for overlaying appropriate places are used to construct a CNG stations. Hierarchical and entropy are used to determine the significance of places. Related elements are compared at the higher level in a pair. Their weights are calculated. Then total weights of each weight are calculated based on relative weights called ultimate weight. Parameters are ranked based on their bipolar scales in entropy method. So ultimate weight is reached in the form of TOPSIS it is time to calculate ranking the proposed sites. A survey conducted from experts, municipality, Oil Corporation, Gas Company, deputy urbanization, deputy transport, overall 25 questionnaire have been distributed and analyzed.

EFFECTIVE FACTORS ON CNG STATIONS POSITIONING

As CNG station locating is based on the effective factors leading to higher efficiency thus determining such factor play an important role in locating and ranking CNG stations.

Effective factors on CNG stations Positioning

- 1. Land use
  - 1-Compatible
    - 1-Green area
    - 2-Arid area
  - 2-Incompatible
    - 1- Residential uses
    - 2- Commerce uses
    - 3- Administrative uses
    - 4- Education uses
    - 5- Remedial uses
- 2. Street networks
  - 1- Distance to intersection
  - 2- Lack of settlement in sheer curve
- 3. Access
  - 1- First rate arterial
  - 2- Main second rate arterial
  - 3- Accessory second rate arterial
  - 4- Local
- 4. Traffic volume
  - 1- High
  - 2- fairly high
  - 3- Average
  - 4- Fairly low
  - 5- Low
- 5. Population
  - 1- High Congestion
  - 2- Average Congestion
  - 3- Low Congestion
- 6. Infrastructure facilities
  - 1- Proximity to gas pip
  - 2- Proximity to electricity net

Fig. 1: Factors parameters on position and CNG station ranking

Major effective factors of CNG station positioning. traffic volume, access, population, land use, street networks, facilities can cause efficiency. Above mentioned factors are going to be categorized in the sense that factors which are at the same level, are not under one category nor comparable. Therefore, the definition of each effective factor is defined categorized in Fig. 1.

Land uses: One of the factors that lead to appropriate service is the manner of placement, it's locating and neighboring uses divided into compatible and incompatible. We describe each below.

Compatible application: One of the factors that lead to a proper service is neighboring uses divided into two types compatible and incompatible including: green area, parks, arid area.

Incompatible application: Application whose proximity does harm. So they have adverse impact on citizen, mental and health condition. The applications of the CNG are residential, remedial and administrative centers.

Traffic volume: One of the effective factors of CNG station locating is the streets traffic volume leading to increasing sale of CNG stations fuels thus it encourages private sectors investors. In this study, traffic volume parameter, divided into five parts, high, fairly high, average, fairly low and low.

Facilities: One of the major factors in CNG station locating deals with access to gas pipes and electricity nets. One of the primary needs of a CNG station is concerned with electricity supply of the station.

Since all facilities use to start up the station are run by electricity, besides gas transit and composite should be accessible because the first point of founding a CNG station is proximity to 250 psi gas pipe.

Street networks: One of the most vital urban applications is street networks. All application requires access net based on their performances. The unsettlement of CNG station on the sheer curves and intersections are under access network factors.

Populations: Population congestion seemed to be the most inappropriate factor in the allocation of sites and founding different uses urban service supply. Population helps use facilities far better it is divided into three parts high congestion, average and low.

Access: One of the main variables of station locating is the manner of access to the station from expert perspectives. It is vivid that the movements of vehicles vary based on the road performances. Vehicle is driven faster on express roads than they are in the intercity roads. Thus they should be founded near main streets of the cities. As cars are widely used near main streets the need for CNG foundation are strongly felt. So that Station can offer further services. This is divided into four. First rate arterial, main second rate arterial, accessory second rate arterial and local.

LOCATING

When major variables are identified and information is gathered it is time for the geographical information base to be founded. Then appropriate layers are developed in Arc Map then outputs are produced. They are so called factor maps added to CNG Stations locating as followed and took advantage of Arc Map. First layers compatible with stations including compatible uses facilities, population and traffic volumes are added to the software in the form of polygon and linear. Then all compatible layers are selected. Then they are overlaid using a union function. A new layer composed of all compatible layers of CNG stations. Incompatible layers with the station and illegal buffer such as distance to remedial, educational centers are added to the software. Then they are overlaid with union command. A new layer including incompatible and buffer. Then using an intersect function similar sites between two compatible and incompatible layers with station use is achieved. After wards similar points are eliminated from layers compatible with station use. Compatible places for founding stations are determined as shown in Fig. 2. There are a few samples of compatible layers plans and stations area are shown in Fig. 3 to 8.

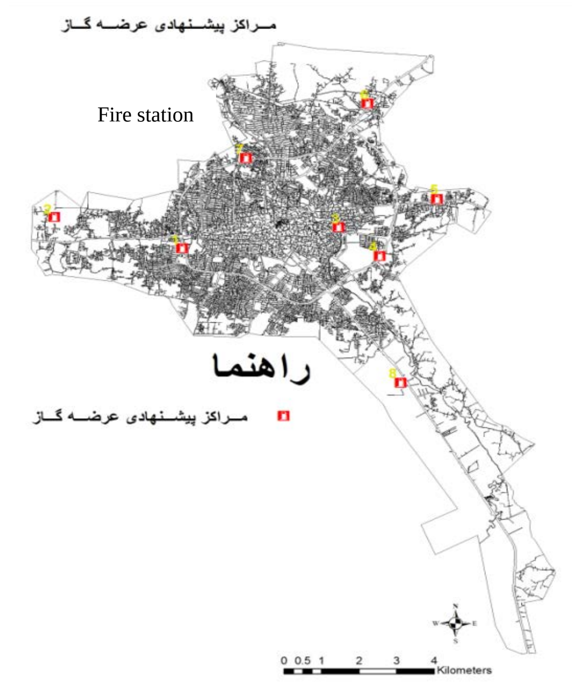

Fig. 2: Compatible places plans for founding CNG stations

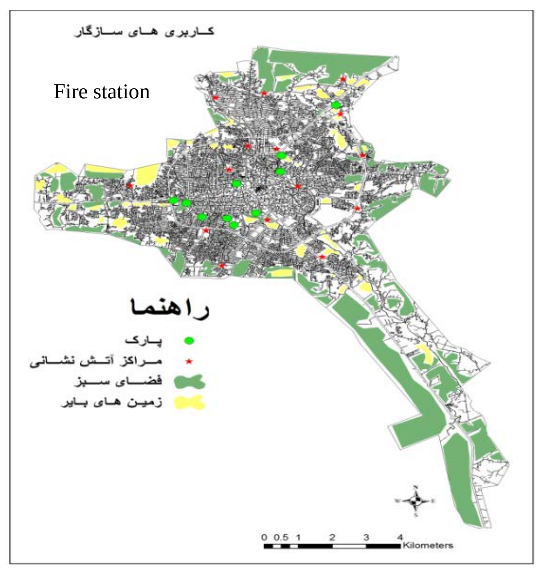

Fig. 3: Plans for compatible land uses with stations

THE DEGREE OF SIGNIFICANCE FACTORS ON AHP RANKING

In this section, effective parameters on each factor and proposed places are ranked. It goes without saying that to facilitate operation; AHP and Expert choice software are used. Using software called traffic volume access, network, land use, population and facilities. The results show that there are 7% inconsistencies when it is 10% lower than the standard one. It is an indicative of accurate questionnaire design.

The extent of effective factors and parameters: Questionnaire results show that the extant of importance are as follow:

The first traffic volume factor amounts to 34.3% are the most important one. Then the facilities amount to 33.4% ranked second. Access amounts to 15.3%

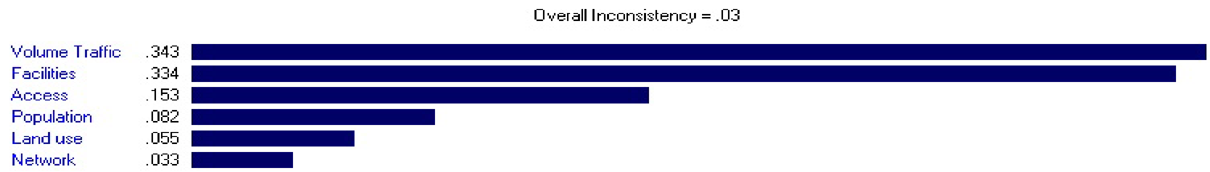

Fig. 4: The degree of significance of effective factors on station ranking

Fig. 5: For privacy residential area

Fig. 6: Plans for access ranking plans

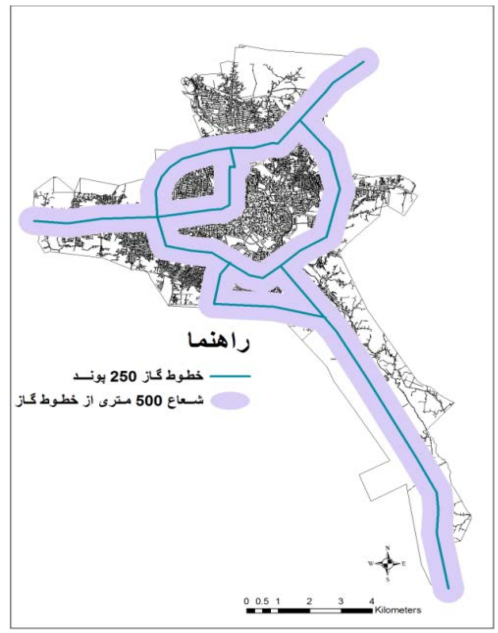

Fig. 7: Plans for compatible distance from gas pipes

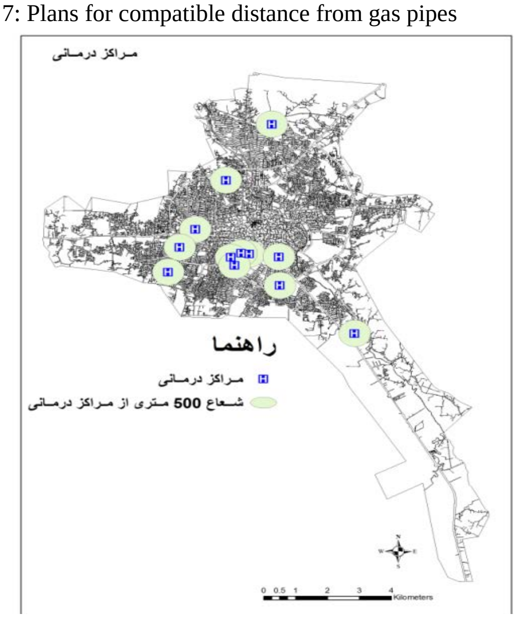

Fig. 8: Remedial uses area

ranked third. Street networks ranked last with 3.3%. Thus traffic volumes and facilities play a very big role when stations are ranked. Lack of these two factors is unjustifiable. The degree of significance is shown in Fig. 4.

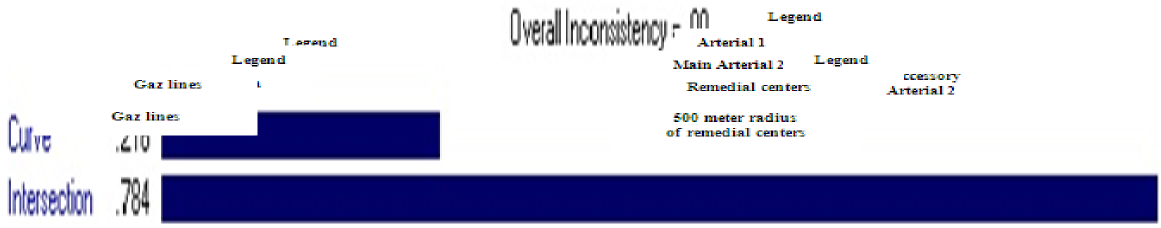

Fig. 9: Significance of traffic network parameters

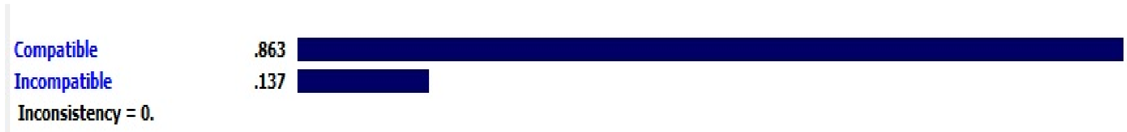

Fig. 10: Significance of land use parameter

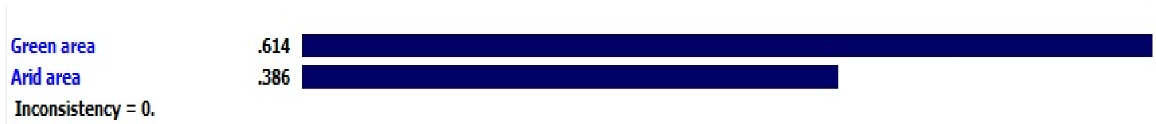

Fig. 11: The significance of land use

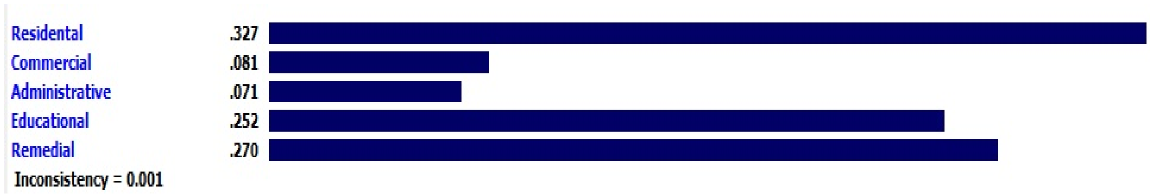

Fig. 12: The significance of incompatible use parameter

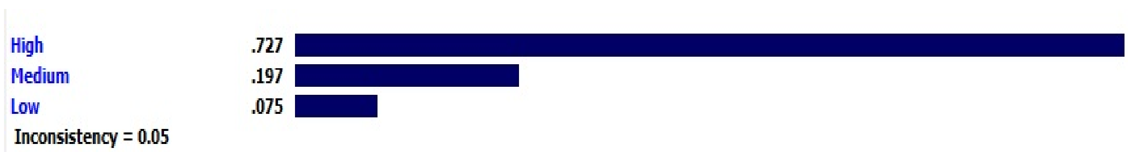

Fig. 13: The significance of population

The degree of street network significance: The significance is shown in Fig. 9. As shown unsettlement parameters amount to 21.6% called curve, unsettlement parameter amount to 78, 4% on the intersection.

Significance of land use parameter: The significance is shown in Fig. 10. As shown, Compatible parameters amount to 13.7% and incompatible use parameters amounts to 13.7%.

Significance of compatible use parameter: Figure 11 indicates the significance of the parameter, green area, parks amount to 61.4%. And arid area amounts to 38.6%.

The significance of compatible use parameter: In compatible use parameter is shown in Fig. 12. Residential use amounts to 32.7% then remedial use amounts to 27% ranked second. Educational use amounts to 25.2% ranked third Commercial use amounts to 8.1% ranked fourth, administrative use amounts to 7.1% ranked fifth. Thus keeping station distance from residential, remedial, educational uses play a role in station ranking.

The significance of population: It is shown in Fig. 13 high signals high congestion amounts to 72.7%. Medium character- rustic's average congestion amounts to 19.7% ranked the second, low characteristics low congestion amount to 7.5% ranked last. Therefore, high congestion has an impact on places and station ranking.

The significance of access: Figure 14 shows the significance of access .As it is shown, arterial 1 amount to 54.4% represents the most important parameter,

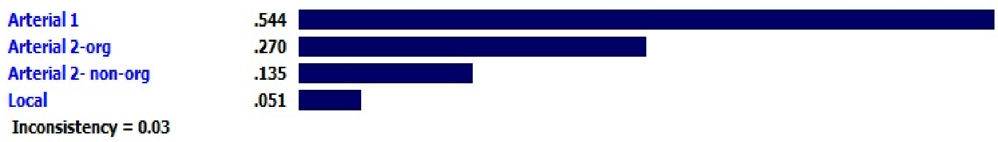

Fig. 14: The significance of access parameters

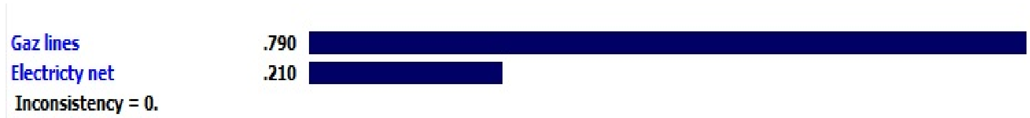

Fig. 15: The significance of facilities

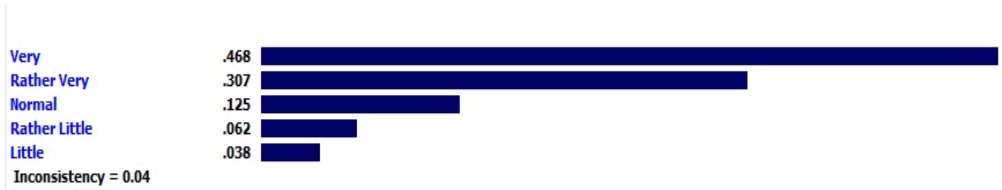

Fig. 16: The significance of traffic volume parameters

arterial 2-org amounts to 27% ranked second, Arterial 2-non-org amounts to 13, 5% ranked third and local amounts to 5.1% ranked the lowest .Thus it is very important to have access to Arterial and proximity to main routes.

The significance of facilities: Figure 15 shows the significance of this parameter. Proximity to gas pipes 250 psi called weight 79% ranked first and proximity to electricity net weighing 21, 0% ranked second. Thus proximity to gas pipes is four times as important as proximity to electricity net regarded as important station locating and ranking.

Traffic volume: The significance is shown in Fig. 16. Very shows high volume amounts to 46, 8% is the top important parameter. Then Rather very shows high volume amounts to 30, 7% ranked second, Normal shows average amounts to 12, 5% ranked third. Little shows low volume amounts to 3, 8% ranked last. So high traffic volumes plays a very big role in ranking and locating.

The significance of all proposed places presented in Table 1 in isolation. Presented figures are indicative of above mentioned places. Significance compared to ranking parameters.

Table 1: The significance of parameter and places related to them

Parameter	Places/ Weight	1	2	3	4	5	6	7	8
Green area and parks	61.4	24.9	10.0	13.1	9.6	10.2	4.4	20.0	7.7
Arid area	38.6	22.7	18.2	14.9	10.4	7.4	8.4	11.6	6.5
Residential use	32.7	26.2	15.4	11.8	11.3	11.1	4.5	15.1	4.6
Commercial use	8.1	26.0	11.9	11.5	8.9	12.9	4.7	18.3	5.8
Administrative use	7.1	17.8	14.8	11.7	15.1	9.6	4.4	19.8	6.9
Educational use	25.2	23.8	10.6	11.6	11.1	15.6	4.1	17.6	5.6
Remedial use	27.0	25.1	14.6	6.9	13.0	8.6	5.0	22.0	4.7
Unsettlement on sheer curve	21.6	17.4	8.4	16.9	13.9	5.5	7.1	18.4	12.3
Unsettlement on the intersection	78.4	8.2	14.0	12.1	9.0	16.7	13.9	7.1	19.0
First rate arterial	54.4	24.4	17.2	6.1	5.7	17.6	5.4	5.0	18.6
Main first rate arterial	27.0	24.3	17.0	8.9	5.2	14.9	5.3	4.8	19.4
Accessory second rate arterial	13.5	24.0	17.2	6.2	5.8	17.7	5.7	5.0	18.5
Local	5.1	11.8	8.4	12.4	13.4	10.5	14.8	9.5	19.3
High–traffic volume	46.8	14.3	3.7	9.8	5.7	27.7	23.5	2.8	12.5
Rather high–traffic volume	30.7	14.6	3.6	15.5	5.3	25.0	18.6	4.0	12.3
Average –traffic volume	12.5	14.3	3.1	9.5	5.4	28.2	24.7	2.7	12.1
Rather low-traffic volume	6.2	13.9	3.2	12.4	5.8	25.0	23.9	4.0	11.9
Low-traffic	8.3	13.8	3.1	12.0	5.9	24.9	24.0	4.1	12.3
High congestion-population	72.7	3.7	14.6	4.6	5.2	12.6	14.4	10.2	34.6
Average congestion-population	19.7	3.2	13.4	4.7	5.3	13.5	13.6	11.0	35.3
Low congestion-population	7.5	3.3	13.6	4.9	5.4	13.3	13.4	11.1	35.0
Gas pipe proximity	79.0	24.3	15.2	11.6	5.6	12.1	3.7	12.9	14.6
Proximity to electricity net	21.0	27.3	19.2	14.5	5.3	9.8	3.5	17.1	3.3

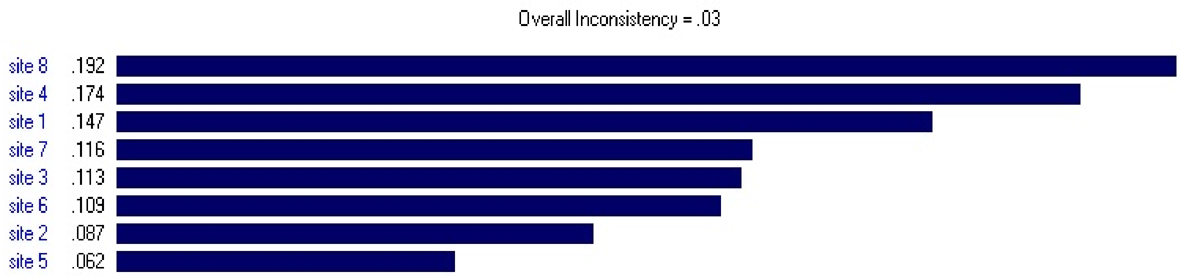

Fig. 17: Weight and the final ranking places

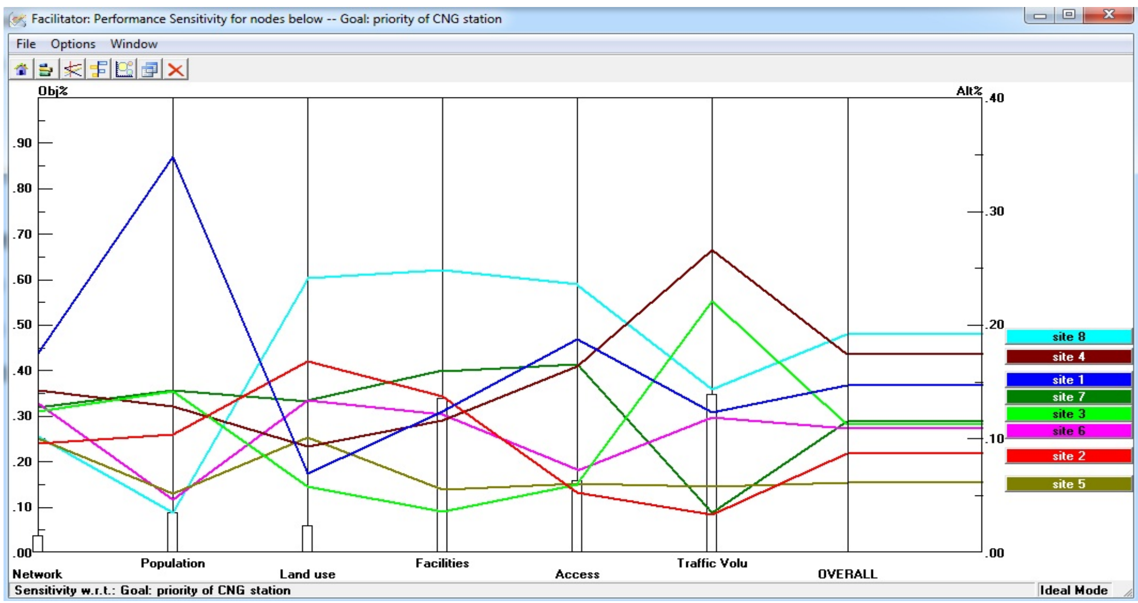

Fig. 18: Diagram for places weight and ranking based on their whole factors

Ultimate ranking of places: When relative weighing of places in relation to parameters are done and ultimate weight of each place is conducted. It is mixed at the end of software with all final weights. As shown in Fig. 17 places No.8 amount to 19.2% ranked first, place No.4 amounts to 17.4% ranked second and place No.1 amounts to 14.7% ranked third. Place No.5 amounts to 6.2% ranked lowest. Graph for places weights are their ranking based on the whole criteria shown in Fig. 18.

TOPSIS TYPED RANKING

This method of ranking take advantage of entropy techniques so that variables are weighed from experts prospective in the form of bipolar variables. So that decision matrix of expert poll and their Compilation are composed of geometric average. For a positive variable zero expressive minimum value and 10 expressive value maximum for negative variable zero signifies value maximum and 10 signifies value minimum. Thus decision matrix is as following:

Incompatible) (Traffic Volume) (Access) (Facilities) (Compatible) (Population) (Traffic network)

X1	X2	X3	X4	X5	X6	X7
7.96	8.65	5.31	4.93	8.32	7.32	4.31
7.32	6.32	7.32	6.65	6.65	3.91	7.32
4.64	7.32	4.31	1.82	5.65	7.96	4.93
4.31	6.65	5.65	5.65	7.65	8.65	5.31
6.65	4.64	6.65	5.31	6.32	5.31	6.32
7.32	5.65	7.32	7.32	5.94	6.65	6.65
5.65	7.32	7.32	8.32	7.65	5.24	6.95
7.65	3.63	7.32	8.65	8.32	7.96	8.32

in the first step, a matrix lacking scale is as following:

$$\mathrm{Pij} = \frac{\mathrm{rij}}{\sum_{i=1}^{m} \mathrm{rij}};\ \forall\ \mathrm{i, j} \qquad (1)$$

In the second step we use P_i possibility shown in Table 2:

$$E_j = K \sum_{i=1}^{m} [\mathrm{Pij}\ .\ \ln \mathrm{Pij}]\ \forall\ \mathrm{j} \qquad (2)$$

Table 2: Ej possible distribution

	x_1	x_2	x_3	x_4	x_5	x_6	x_7
E_j	0.99	0.982	0.99	0.997	0.995	0.986	0.99

Table 3: dj deviation degree

	x_1	x_2	x_3	x_4	x_5	x_6	x_7
d_j	0.01	0.018	0.01	0.03	0.005	0.014	0.01

Table 4: Variables weights

	x_1	x_2	x_3	x_4	x_5	x_6	x_7
W_j	0.103	0.185	0.103	0.309	0.051	0.144	0.103

$$P_{ij} = \begin{vmatrix} 0.155 & 0.172 & 0.104 & 0.101 & 0.147 & 0.138 & 0.086 \\ 0.142 & 0.126 & 0.143 & 0.137 & 0.118 & 0.074 & 0.146 \\ 0.09 & 0.1 & 0.08 & 0.04 & 0.1 & 0.15 & 0.09 \\ 0.08 & 0.132 & 0.110 & 0.116 & 0.135 & 0.163 & 0.106 \\ 0.129 & 0.09 & 0.130 & 0.109 & 0.112 & 0.1 & 0.126 \\ 0.142 & 0.112 & 0.143 & 0.15 & 0.105 & 0.125 & 0.133 \\ 0.11 & 0.146 & 0.143 & 0.17 & 0.135 & 0.099 & 0.139 \\ 0.148 & 0.07 & 0.143 & 0.149 & 0.147 & 0.15 & 0.166 \end{vmatrix}$$

In the next step, uncertainty or deviation degree of djis calculated in Table 3:

$$dj = 1\text{-}Ej;\forall\, j \tag{3}$$

We use No.4 relation to calculate available variables and presented in Table 4:

$$Wj=\frac{dj}{\sum_{j=1}^{n} dj};\forall\, j \tag{4}$$

Most weight related to facilities amount to 0.309 minimum weight is related to 0.051 the lower weight of w_5 enjoys Ei indicates that the efficacy of variables are the same. Its significance is negligible when a decision is made. Then ranking is conducted. In the first step decision matrix is conducted using relation No.5 becoming a matrix that lacks scale then it uses relation No.6 to become a non-scale weighted matrix. In the third step ideal positive and matrix solutions are calculated based on relations 7 and 8:

$$nij=\frac{rij}{\sqrt{\sum_{i=1}^{m} rij^2}} \tag{5}$$

$$V=ND.Wn \times n \tag{6}$$

The positive ideal option = S+= $\{(maxiVij|j \in J), (\, miniVijj \in J')i=1, 2, \ldots, m\}$ (7)

The negative ideal option=S-= $\{(miniVij\|j \in J), (maxiVij|j \in J')|i = 1, 2, \ldots, m\}$ (8)

$$ND = \begin{vmatrix} 0.428 & 0.474 & 0.289 & 0.271 & 0.412 & 0.38 & 0.238 \\ 0.394 & 0.346 & 0.398 & 0.366 & 0.329 & 0.203 & 0.405 \\ 0.25 & 0.401 & 0.234 & 0.1 & 0.28 & 0.413 & 0.273 \\ 0.232 & 0.364 & 0.308 & 0.311 & 0.379 & 0.45 & 0.294 \\ 0.359 & 0.254 & 0.362 & 0.292 & 0.313 & 0.276 & 0.35 \\ 0.394 & 0.31 & 0.398 & 0.403 & 0.294 & 0.345 & 0.368 \\ 0.304 & 0.401 & 0.398 & 0.458 & 0.379 & 0.272 & 0.385 \\ 0.412 & 0.199 & 0.398 & 0.476 & 0.412 & 0.414 & 0.46 \end{vmatrix}$$

Table 5: Positive intervals

$d_5+ = 0.076$	$d_1+ = 0.067$
$d_6+ = 0.043$	$d_2+ = 0.055$
$d_7+ = 0.036$	$d_3+ = 0.121$
$d_8+ = 0.051$	$d_4+ = 0.062$

Table 6: Negative intervals

$d_5- = 0.064$	$d_1- = 0.081$
$d_6- = 0.101$	$d_2- = 0.065$
$d_7- = 0.118$	$d_3- = 0.048$
$d_8- = 0.133$	$d_4- = 0.08$

Table 7: Relative proximity of ideal solution

$cl_5+ = 0.457$	$cl_1+ = 0.547$
$cl_6+ = 0.701$	$cl_2+ = 0.541$
$cl_7+ = 0.766$	$cl_3+ = 0.284$
$cl_8+ = 0.723$	$cl_4+ = 0.563$

$$V= \begin{vmatrix} 0.044 & 0.088 & 0.03 & 0.084 & 0.021 & 0.055 & 0.024 \\ 0.04 & 0.064 & 0.041 & 0.113 & 0.017 & 0.03 & 0.042 \\ 0.026 & 0.074 & 0.024 & 0.031 & 0.014 & 0.06 & 0.028 \\ 0.024 & 0.067 & 0.032 & 0.096 & 0.019 & 0.065 & 0.03 \\ 0.037 & 0.047 & 0.037 & 0.09 & 0.016 & 0.04 & 0.036 \\ 0.04 & 0.057 & 0.041 & 0.124 & 0.015 & 0.05 & 0.038 \\ 0.03 & 0.074 & 0.041 & 0.14 & 0.019 & 0.039 & 0.04 \\ 0.042 & 0.037 & 0.041 & 0.147 & 0.021 & 0.06 & 0.047 \end{vmatrix}$$

0.047، 0.065، 0.021، 0.147، 0.041، 0.088، 0.044 = {S+}
0.024، 0.030، 0.014، 0.031، 0.024، 0.037، 0.024 = {S-}

In the next step separation calculation is made through relations 9 and 10 and Shown in Table 5 and 6 at negative and positive intervals.

di+ = Distance of i positive idea option = $\{\sum_{j=1}^{n}$ (Vij-Vj+)2}0.5; i = 1, 2, …, m (9)

di-= Distance of i negative idea option = $\{\sum_{j=1}^{n}$ (Vij-Vj-)2}0.5; i = 1, 2,…, m (10)

In the next step calculation is made ideal solution of relative Si proximity according to relation 11. Its results shown in Table 7:

CLi+= (di-)/ (di++di-) , 0 ≤CLi+≤1, i = 1, 2 ,…, m (11)

Places ranking are as the following:

S7> S8> S6> S4> S1> S2> S5> S3

In this method place No.5 amount to 0.766 ranked first. Later on, place No.8 amounts to 0.723 and place

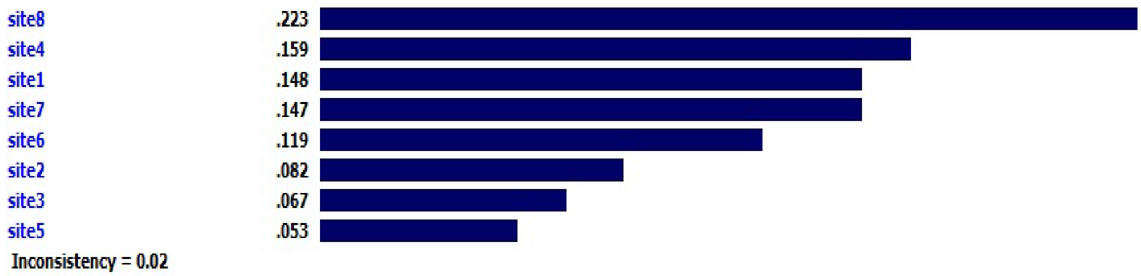

Fig. 19: Places ultimate weight based on expert view

No.8 amounts to 0.701 ranked second and third respectively. Place No .3 amounts to 0.284 ranked last.

METHODS TO SELECTION OF RANKING PROPOSED PLACES

The proposed places are given priority by Arc Map software. The results of the two methods differ from one another. For instance place No.6 of TOPSIS ranked third and sixth in the AHP respectively. The major reason of difference is that variables where mostly enjoy the same point in TOPSIS method. The weight is also down. It is likely to have slight effect on spatial ranking. The variables are weighed based on pair compare-Icons in the AHP method. The higher the variable points the higher the weight is. It is more likely of effect in terms of spatial ranking. To have criteria for method ranking is to use expert views.

Pair comparison questionnaire of municipality experts, deputy urbanization, deputy transport, gas and Oil Company who are well aware of the proposed places ranking conducted between eight places. So that expert could carry out ranking carefully, the value and status of each place were submitted to the expert in six main layers.

Then their geometric average was put into EC software through gathering expert views. So places ultimate weight and the order of priority have been determined by expert perspectives. In Fig. 19 places ultimate weight and their significance order have been determined.

It is obvious that place No.8 amounts to 22.3% ranked first place No.4 amounts to 15% ranked second, place No.1 amounts to 14.8% ranked third, place No.5 amounts to 5.3% ranked last. Inconsistency rate is 2% lower less 10% than standard level.

AHP priority method and TOPSIS priority method 5 and 2 similar cases are found respectively. Since AHP priority is closer to expert priority, thus the method fits into spatial priority better.

CONCLUSION

AHP ranking traffic volume of locating variables amount to 34.3% ranked first. Facilities amount to 33.4% ranked second. Then access parameter ranked third with %15.3. Population ranked fourth with 8.2% use ranked fifth with 5.5%, urban networks ranked lowest with 3.3%. Among proposed places, No.8 ranked first with 19.2%, place No.4 ranked second with 17.4%, place No.1 ranked third with 14.7%, place No.7 ranked fourth with 11.6%, place No.5 ranked eighth with 6.2%.

In TOPSIS ranking, first variable weights were taken into account using entropy techniques. Most weight devoted to facilities with 30.9%. Then population with %18.5 and traffic volume with 14.4% access was given the lowest weight with 5.1%. Then ranking started through TOPSIS method. Results are as following: place No.7 ranked first with 0.766 places No. 8 ranked second with 0.723 Place No.6 ranked second with 0.791 Place No.4 ranked fourth with 0.563 and place No.3 ranked eighth with 0.284. It is observed that AHP method and TOPSIS are similar to expert view in case 5 and 1 respectively.

AHP method is more compatible. GIS and locating variables leading to founding CNG stations fair distribution of the station, high efficiency and services.

Suggestion:

- The application of pollution is one of the positioning parameter and use of these layers in GIS Prioritization of places it is possible to use multi attribute decision making method like LINMAP and SAW and other different method to score to take care of ultimate weight of variables special vectors and minimum weighted squares are used.
- PSO, genetic algorithm need for encoding within the area of MATLAB used to rank places and select appropriate places
- Fire station locating is used to offer services to the stations in crisis paves the way for further services

Appendixes

- Compressed Natural Gas
- Analytical Hierarchy Process
- Technique for order-Preference by Similarity to ideal Solution
- Geographic Information System

REFERENCES

Adsavakulchai, S. and C. Huntula, 2010. Optimum site selection of natural gas vehicles station in Bangkok using geographic information system. J. Petrol. Gas Eng., 1(5): 89-94.

Dambatta, B., A.R. Farmani and B.M. Evans, 2009. The analytical hierarchy process for contaminated land management. Adv. Eng. Inform., 23: 441-447.

Kuby, M., L. Lines, R. Schultz, Z. Xie and S. Lim, 2009. Optimization of hydrogen stations in florida using the flow-refueling location model. Int. J. Hydrogen Energ., 34: 6045-6064.

Melendez, M. and A. Milbrandt, 2008. Regional consumer hydrogen demand and optimal hydrogen refueling station siting. Golden, CO: National Renewable Energy Laboratory; Report: NREL/TP - 540-42224.

Upchurch, C. and M. Kuby, 2010. Comparing the p-median and flow-refueling models for locating alternative-fuel stations . J. Transp. Geogr., 18: 750-757.