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FACILITY LOCATION PROBLEM

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ABSTRACT
Facility planning is a complex and broad subject, which concerns several engineering disciplines like civil, mechanical and industrial engineering. Also other than engineering disciplines it concerns architects, owners and managers of the production or service firms, and town council etc. Facility planning is subdivided into two main subjects as facility location and facility design. Facility location concerns of the location of the facility to be built considering the actual and potential customers, suppliers, competitors and other facilities and places. Facility design concerns with the efficient and effective replacement of every elements of the facility due to the objectives of the facility.
This paper includes Location analysis of the project study about the construction and design of a bowling alley in Magusa in Cyprus, which is an island in Mediterranean Sea. Location problem have been analyzed considering the objective and subjective factors to select the best location from five alternatives.
Keywords: Facility Location Analysis, Objective and Subjective Factors.

1. INTRODUCTION
Our problem is a discrete location problem. We have finite number of alternative locations in specific places; the alternative places are stated in the following parts of the paper. To solve this problem the method of Buffa and Sarin (1987) is used. By using this method a multi attributed single facility location model is generated.
In the model there are 3 factors: Critical Factor (CF), Objective Factor (OF), and Subjective Factor (SF). Critical factors are the factors that determine whether or not the location alternative will be considered or not. For example land availability can be a critical factor for building a facility like in our problem. If the location satisfies the critical factor under consideration CF gets the value of 1 and 0 otherwise. Objective factors are the factors that can be valued quantitatively in an objective manner. For example cost of a land on which the facility will be build, like in our example. The value given OF is the cost of the objective value at the location under consideration. For subjective factors a numeric value between 0 and 1 is given to SF under consideration to evaluate it quantitatively. For example nearness to demand point can be a subjective factor for a facility.

2. LOCATION PROBLEM ANALYSIS

2.1. Critical Factors
To locate the facility there are two critical factors. One is land availability. It is critical factor because without an available land it is impossible to construct a building. We have five possible candidate locations. In all these locations there are available land for sale so, critical factor availability is 1 for all the candidate locations. The other critical factor is construction permission. It is impossible to construct a building without construction permission. For all the candidate location it is possible to take the construction permission.

2.2. Subjective Factors

Ease of Transportation: It is a factor that can affect the demand to facility. Available transportation opportunity can make people to decide to go to the facility. It can be very important factor for a big crowded city, which can have several alternative transportation opportunities. But the city Magusa is a small city, which has only three transportation alternatives. They are by bus, by taxi, and private auto. The majority of the people use taxi and the private cars have the same opportunity for the all-possible locations. So ease of transportation is not an important factor and it has the weight of 10%.

Nearness to EMU: Eastern Mediterranean University is the biggest university in Cyprus. Eastern Mediterranean University continues to grow, to expand and be the pioneer in the area with more than 1000 faculty members coming from 35 countries, and with a student body of 14.000 comprised of 68 different nationalities. It is the most important factor that can affect the demand, as spending time in cafes and playing bowling are entertainments, which attract the young population. The majority of the demand is expected from the university students and the young population in Cyprus between the ages 15-24. The university students spend majority of their time in the university, and would like to go to places for entertainment to the places near to the university. Because of all these factors, this subjective factor has a weight of 35%.

Nearness to High Schools: Similar to the university, the high schools have the demand potential for the facility. High schools students would like to go such places that are near to their schools. As the high schools do not have the populations as much as universities, this subjective factor does not have too much weight. It has just 15% weight.

Popularity of the Place: This subjective factor is the second important factor because the popularity of the place that the facility will be located in, will affect the demand of people. People tend to go to places, which are crowded and have several alternative places around for entertainment and like to spend time in places full of cafes, bars, cinema etc. So this subjective factor will affect the demand significantly and has the weight of 30%.

Nearness to Lemar: Lemar is the most popular supermarket and the shopping center in Magusa. This place can also generate demand to our facility from its own customers. But it is obvious that the demand potential from Lemar is not very high comparing to other factors that generate demand. So this subjective factor has the weight of 10%.

2.3. Objective Factors

The only objective factor is the cost of the land to construct the building on. The cost of land differs from place to place depending on the advantages that the land will bring to facility or the building will be built on. So, every possible location has its own land cost. There is no other objective factor rather than land cost such as operating cost or building construction cost since these costs will be the same for all possible locations as we are planning to construct the facility with same specifications in all possible locations.

2.4. Alternative Locations

Opposite to EMU: The main reason that we considered this place, as an alternative location is the high demand potential of the university students. It is obvious that the university students will get the highest portion of the demand to our facility. Another reason that can generate a demand to our facility is that this place is a popular place where there are several restaurants, cafes around for people to spent time.

Gulseren: The main reason that we considered this place as an alternative location is that this place is the most popular place in Magusa. That is people are going this place since there are many cafes, restaurants, nightclubs, bars and some other places for entertainment. Besides, this place is not far away from the university, so, it is not far away from the high demand potential.

Kaliland: The reason we considered this place, as an alternative location is that there are several apartments around which can generate demand potential. Besides Kaliland restaurant is a famous place, which makes this place considerable. It is close to the highway, and there are many empty fields for the building construction.

Kaleici: The reason we considered this place as an alternative location is, it is also a popular place; there are several cafes and additionally several places for shopping and there are historical places to visit. These can generate demand to our facility. Also the cost of the land is low in Kaleici.

Lemar: The reason we considered this place as an alternative location is, there are several apartment, which can generate demand for our facility. Also Lemar is the most famous shopping center in Magusa and own customers of Lemar can generate a demand to our facility.

2.5. Evaluating the Alternatives

While applying the method of Buffa and Sarin (1987) we need the values of Critical Factor Measure (CFM), Objective Factor Measure (OFM), Subjective Factor Measure (SFM). These are calculated by using the formula given below for each:

After the factors are classified, they are assigned numeric values:

CF_{ij} = 1 if location satisfies critical factor j
0 otherwise
OF_{ij} = cost of objective factor j at location i.
SF_{ij} = numeric value assigned (on a scale of 0-1) to subjective factor j for location factor i.
W_j = weight assigned to subjective factor j ($0 \le W_j \le 1$)

Assume that we have *m* candidate locations and *p* critical, *q* objective, and *r* subjective factors.

$$CFM_i = CF_{i1} * CF_{i2} * \ldots\ldots\ldots * CF_{ip} = \prod_{j=1}^{p} CFij \qquad i= 1,2,3,\ldots,m$$

$$OFM_i = \frac{Max(i)(\sum_{j=1}^{q} OFij) - \sum_{j=1}^{q} OFij}{Max(i)(\sum_{j=1}^{q} OFij) - Min(i)(\sum_{j=1}^{q} OFij)} \qquad i=1,2,3,\ldots,m$$

$$SFM_i = \sum_{j=1}^{p} WjSFij \qquad i = 1,2,3,\ldots,m$$

The Location Measure LM_i for each location is then calculated as:
$LM_i = CFM_i (\alpha\ OFM_i + (1-\alpha)\ SFM_i)$
Where α is the weight assigned to the objective factor measure.
Using the formulas above CFM, OFM, SFM and LM values for each alternative location are calculated as below.

	FACTORS							
	Critical		Objective	Subjective				
LOCATION	CF1	CF2	OF	SF1 0,10	SF2 0,35	SF3 0,15	SF4 0,30	SF5 0,50
1.Opposite to EMU	1	1	25000	0,95	0,95	0,5	0,8	0,5
2. Kaliland	1	1	13000	0,7	0,7	0,6	0,45	0,75
3. Gurselen	1	1	20000	0,85	0,7	0,6	0,9	0,7
4. Kaleici	1	1	10000	0,8	0,4	0,8	0,6	0,8
5. Lemar	1	1	15000	0,65	0,55	0,7	0,65	1

Critical Factors:

- CF1: Construction permission
- CF2: Land availability

Objective Factors

- OF: Land cost

Subjective Factors

- SF1: Ease of transportation
- SF2: Nearness to EMU
- SF3: Nearness to high schools
- SF4: Popularity of the place
- SF5: Nearness to Lemar

Calculations:

Critical Factors:

CFM1 = CFM2 = CFM3 = CFM4 = CFM5 = 1*1=1

Subjective Factors:

SFM1= (0.95)(0.10) + (0.95)(0.35) + (0.50)(0.15) + (0.80)(0.30) + (0.50)(0.10) = 0.7925
SFM2= (0.70)(0.10) + (0.70)(0.35) + (0.60)(0.15) + (0.45)(0.30) + (0.75)(0.10) = 0.615
SFM3= (0.85)(0.10) + (0.70)(0.35) + (0.60)(0.15) + (0.90)(0.30) + (0.70)(0.10) = 0.76
SFM4= (0.80)(0.10) + (0.40)(0.35) + (0.80)(0.15) + (0.60)(0.30) + (0.80)(0.10) = 0.60
SFM5= (0.65)(0.10) + (0.55)(0.35) + (0.70)(0.15) + (0.65)(0.30) + (1.00) (0.10) = 0.6575

Objective Factors:

Our maximum objective value is 25000 and minimum is 10000.So;
OFM1 = (25000-25000)/ (25000 – 10000) =0
OFM2 = (25000-13000)/ (25000 – 10000) =0.8
OFM3 = (25000-20000)/ (25000 – 10000) =0.33
OFM4 = (25000-10000)/ (25000 – 10000) =1
OFM5 = (25000-15000)/ (25000 – 10000) =0.67

After calculating CFM, OFM and SFM values it is time to decide for the "α" value and calculate the LM values which is the last step of the model. As mentioned before α is the weight assigned to the objective factor measure. "α" value is decided to be as 0.10 that is objective factors got 10% importance where as the subjective factors got the 90% importance. The reason is objective factor is a one time pay land cost, whereas the subjective factors are directly related with the demand which will affect now and future income of the business. After assigning the α value LM factors are calculated as below.

LM1 = 0.10(0) + (1-0.10) 0.7925 =0.71
LM2 = 0.10(0.8) + (1-0.10) 0.615 =0.63
LM3 = 0.10(0.33) + (1-0.10) 0.76 =0.72
LM4 = 0.10(1) + (1-0.10) 0.0.60 =0.64
LM5 = 0.10(0.67) + (1-0.10) 0.6575 =0.66

LM values can be thought as the overall value given to the candidate locations. Here location with the maximum LM value is the best location to select depending on the all criteria mentioned. If we look at the LM values the two alternatives "Gulseren" and "opposite to school" got the two highest very close LM values. But Gulseren got the highest LM and the selected location to build our facility is Gulseren. With the model driven may be the hardest question of the project " where to locate thr facility" has been answered.

3. REFERENCES

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