

Optimum Location Selection of University of Thakurgaon

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Abstract

Since the role of universities in advancing the field of education is immense, the goal of establishing a university will be achieved only if the university is established by selecting the right place, considering related important criteria. To improve the education system of a country, there is no alternative to a good quality university and at the same time the location of the university is very important so that the students do not have to face any kind of suffering while coming to study in that university. In this study we conduct a survey to the people of different upazila of Thakurgaon district and based on the results of that survey we select the alternatives of this study. This study presented a model with the help of a matrix with different criteria and alternatives to select the optimal location of the University of Thakurgaon. To complete the process, a large amount of existing data was collected and prepared to apply the VIKOR method based on the MCDM (Multi Criteria Decision Making) method to solve the current problem. By solving the model, Ranishankail Upazila selected the optimum location for the Thakurgaon University.

Keywords

Facility location, VIKOR Method, Multi Criteria Decision Making and Rank choice.

1. Introduction

If we look at the progress of every developed country in the world today, we see that education plays a major role behind their progress. That education depends entirely on university education. Our Bangladesh is not behind in that direction. Therefore, to take the education system of Bangladesh one step further, it is an important aspect to place the university in the right place. In that case, facility location is an important process. Facility location is the method of recognize the best geographic location for a service or while establish a new organization. Facility location is the accurate location for a manufacturing facility that is sufficient access to customers, workers, transportation, material cost, labor cost etc. (Wu *et al.* 2006). The study of facility location problems (FLP), is informed as location analysis, is an affiliate of operation research and a section of computational geometry that vocation with dangerous materials Considering factors for example eliminating placing close to housing related to optimal placement of facilities to reduce transportation costs, and competitors' facilities The techniques are also applicable to bunch analysis (Zhang *et al.* 2016). Whether a casual chain is sitting on a new outlet, a manufacturer choosing where to locate an industry, factory or an urban planner selecting a location for a fire station, strategic planners, university, school, college etc. are often challenged by difficult local resource setting decisions. As populations change, market trends evolve, and other environmental factors change, the need to relocate, expand, and accommodate facilities confirm the publication of new planning infringement. Judgment may be given to discovering the best feasible location for a new university as this has proven to be a problem for residents living in its vicinity. Among all the possible locations, the one that may prove least harmful to the residents may be selected. Each location has certain costs that can be taken into account. Following this process, the new location of the university will be selected soon so that the development of the country continues.

1.1 Objectives

To find the maximal location of the University of Thakurgaon.

2. Literature Review

Manny researchers have already applied different methods such as TOPSIS, AHP, Fuzzy, Fuzzy TOPSIS, Fuzzy AHP, VIKOR, VIKOR AHP, ANP to solve facility location problem. Researchers mentioned seven criteria and six alternative project and used MCDM method Simple Additive Weighting Method and also used Integrated VIKOR and AHP Method (Wu *et al.* 2006). Researchers also mentioned nine location factors and described the AHP model

to solve the facility location problem (Zhang et al. 2016). Researcher recommended Geoff ion's model to solve the facility location problem and their proposed model was obtained by using the software ND from SAP/APO (2001). Also used C-Plex, Xpress or GLPK (Pourkhabbaz et al.2014). For finding out the best location researcher mentioned four criteria and four decision and used Fuzzy TOPSIS method (Yang e Lee. 1997). Researchers used to find the best location to use VIKOR and AHP method to solve the optimization solution of facility location problem. Also used FLD method. Compared between FLD and VIKOR method. Researchers observed that FLD method was very flexible, logical, efficient and convenient ranking technique in conception and application as compared to other method (Conceição et al. 2011). For finding out the optimal solution of the facility location researchers used to VIKOR method applies AHP weights as input weights. Researchers also used ten alternative and ten criteria to solve the facility location. Analytic network process (ANP) may be used to structure network and identify dependence among criteria. The proposed methodology can be used in any other selection problem involving multiple and conflicting criteria (Alimoradi et al. 2011). Researchers applied an integrated VIKOR and AHP method. In first step nine criteria were taken. The researchers suggest that the wind energy is the best renewable energy. Secondly used seven criteria. The methodology applied for both decision problem .In the future research similar studies can be conducted based on different MCDM techniques such as fuzzy PROMETHEE, Fuzzy ELECTRE or Fizzy TOPSIS for comparative purposes (Shokri et al. 2013). For finding optimum hospital location researchers used Fuzzy VIKOR method. And used five alternative and ten criteria to solve the hospital facility location problem. The proposed methodology used for the other MCDM problem of health science. To improve the result and methodology it can be used other Fuzzy MCDM method (Alimoradi et al. 2011). Researchers finding out the best site for the hospital, the AHP method was also used and showed that the cost of land, population density, and proximity to public transport evolved as the three most significant sub factors. With the consideration of the relevant factors it could apply for the power plants location selection (Kaya e Kahraman. 2010). Finding reported on the motivations of firms in seeking to manufacture across national borders and the key steps that should be followed in making international location decisions. Further studies using other methodologies such as structured interviews and detailed case studies are advocated to take the subject forward (Çelikbilek e Karar Verme. 2018). Researchers comparing some methods which is used in MCDM method and find the best ,simple and easiest solution is VIKOR method (Çelikbilek e Karar Verme. 2018). Researchers observed ordaining optimal locations for enlarging a higher education system by treating population and social criteria and the best results were gained with the p-median model (Xavier et al., 2020). Researcher analyzed the raised modeling framework with two exoteric multi-objective met heuristics, MOEA/D and NNIA (Shi et al., 2019). Researcher reviewed the hierarchical facility location model and also first classified the hierarchical facility problems similar to the peculiarity of systems studied, which are based on flow pattern, service availability at each level of the hierarchy, and spatial configuration of services in collation to the purposes to locate facilities (Şahin e Süral, 2007). Researcher described the appeal of four Multi Criteria Decision Making methods for solving pipes material selection problem in sugar industry (Anojkumar et al. 2014).

3. Methods

The methodology for solving the problem is given below:

Step 1: First of all, we have to vindicate a matrix of criteria and different alternatives. Mainly VIKOR method works for identifying the best alternative among all alternatives. So making a matrix between criteria and alternatives is the first step.

Step 2: Normalize the decision matrix. The matrix that we made, now we find the best (F_i^+) and worst value (F_i^-) of every criteria column. For these values we make two more rows on that matrix.

Step 3: Calculate the weight (W_j) of the normalized decision matrix. Using F_i^+ and F_i^- value we create another matrix which is named as weight matrix.

Step 4: Determine the ideal solutions and nadir solutions (Negative ideal solutions). By using weight matrix we identify the ideal or positive value and negative value, here which is called nadir solution.

Step 5: Compare the distance for each alternative.

Step 6: Calculate the relative closeness to the ideal solution. In step 5 here we identify the Q_j the value. And using that value we are very close to find our best alternative. In this stage we find some value respect to all alternatives. And all these values are in a range of 0 to 1 most of the case in VIKOR method.

Step7: Finally, rank the preference order. Those values we find from Q_j matrix that we organized in order minimum value to maximum value

Step 8: After finding the rank value then we checked the value by using VIKOR method acceptance rank choice process. If the value accepts the condition that's values respect alternative selected the best alternative.

3.1 VIKOR Method:

VIKOR method is known as a technique of MCDM method. This method basically works with some alternatives and to choose an alternative from those alternatives, some criteria have to be chosen according to the type of work (Chu, 2002). The improvement of VIKOR method is started with the following form of LP-metric (Bhattacharya et al. 2020).

$$L_{pi} = \left\{ \sum_{j=1}^n [(f_j^* - f_{ij}) / (f_j^* - f_j^-)]^p \right\}^{1/p} \quad 1 \leq p \leq \infty; i = 1, 2, \dots, m$$

In this method L_j (as S_j) and $L_{\infty, i}$ (as R_j) are used to formulate ranking measure.

The compromise ranking algorithm of the VIKOR method has the following steps:

1. Determine best value f_i^* and worth value f_j^- for all criteria that we take.
2. Compute the value of S_j and R_j (here S_j means utility measure and R_j means regret measure.) $i = 1, 2, \dots, m$, by these relations:

$$S_j = \sum \left[\frac{W_i(F_i^+ - F_{ij})}{F_i^+ - F_i^-} \right], \quad R_j = \text{Max} \left[\frac{W_i(F_i^+ - F_{ij})}{F_i^+ - F_i^-} \right]$$

Where S_j = utility measure

R_j = regret measure

W_i = weights of criteria, expressing their relative importance

3. Compute the values Q_i ; $i = 1, 2, \dots, m$, by the following relation:

$$Q_j = \frac{v(S_j - S^+)}{(S_j - S^-)} + (1-v) \left(\frac{R_j - R^+}{R^- - R^+} \right)$$

Where $S^+ = \min S_j$, $S^- = \max S_j$

$R^+ = \min R_i$, $R^- = \max R_i$

v is introduced as weight of the strategy of “the majority of criteria” (or “the maximum group utility”), here suppose that $v = 0.5$.

4. Now we have to rank the alternatives and spotting the value S , R , and Q in decreasing order.
5. Here mainly used a formula which is a characteristic of VIKOR method for denoting the best alternative.

Acceptance of rank choice.

Case 1 : $Q(a(2)) - Q(a(1)) \geq D_Q$

Case 2 : Choice of random acceptance stability, where Q_j is best choice from S

The best alternative, ranked by Q , is the one with the minimum value of Q . VIKOR is an very useful tool in multi-criteria decision making (MCDM), especially in a situation where the decision maker is not able, or does not know to express his/her preference at the beginning of system design.

Mathematical Equation for VIKOR method:

Step 1: Determination of Best and Worst value

$$F_i^+ = \text{Max} (F_{ij})$$

$$F_i^- = \text{Min} (F_{ij})$$

Step 2 : Normalization of S_j and R_j

$$S_j = \sum \left[\frac{W_i(F_i^+ - F_{ij})}{F_i^+ - F_i^-} \right], \quad R_j = \text{Max} \left[\frac{W_i(F_i^+ - F_{ij})}{F_i^+ - F_i^-} \right]$$

Step 3 : Computation of Q_j for group utility function

$$Q_j = \frac{v(S_j - S^+)}{(S_j - S^-)} + (1-v) \left(\frac{R_j - R^+}{R^- - R^+} \right)$$

Step 4: Ranking the alternative

Shorting of R_j , S_j and Q_j are made from their minimum value. Hence three Ranking list is obtained.

Step 5: Acceptance of rank choice.

Case 1 : $Q(a(2)) - Q(a(1)) \geq D_Q$

Case 2: Choice of random acceptance stability, where Q_j is best choice from S and or R with $V \geq 0.5$

Criteria to be considered for VIKOR Method:

- Health Service
- Social Welfare
- Population

- Literacy Rate
- Transportation Cost
- Skilled labor cost

4. Data Collection

We have surveyed and collected data from different Upazila's of Thakurgaon district. We took their valuable opinions from AC land and UNO of Thakurgaon district while doing the survey and based on that opinion we determined the criteria of our VIKOR method. They have provided many key information which help our study to go on.

There are five Upazila in Thakurgaon district. They are –

- Thakurgaon Sadar
- Haripur
- Pirgonj
- Ranisankail
- Baliadangi

While doing the survey we have collected the following data with the help of 2011 census of Thakurgaon district and from various government and private institutions of Thakurgaon district.

Data Collection:

Based on the type of criteria in Table 1, among the data that we have collected, number of health service, number of social welfare and average transportation cost, these data are collected from Thakurgaon District Commissioner's office We have collected this data from the 2011 census. Average labor cost criteria We have collected these data by talking to some contractor companies in the district.

Table 1. Data collection

Alternative	Criteria						
		Number of Health service	Number of Social welfare	Population (density/sq.-km)	Literacy rate(%)	Average Transportation cost/ stoppage	Average Skilled labor cost
Thakurgaon Sadar		39	106	738	47.4	10	484
Haripur		7	60	638	34.1	10	476
Pirgonj		19	72	611	41.3	12	450
Ranisankail		18	52	682	35.1	9	437
Baliadangi		10	42	598	39.2	11	467

Determination of Best and Worst value:

In the table 2, we mainly calculate the best and worst value in every criterion with respect to all alternatives. For health service maximum value is the best and minimum is the worst. Similarly, Social welfare, literacy rate and skilled labor cost's determined. On the other hand, population and transportation cost's minimum is the best and maximum is the worst.

Table 2. Calculation of best and worst value

Alternative	Criteria						
		Health service	Social welfare	Population	Literacy rate	Transportation cost	Skilled labor cost
Thakurgaon Sadar		39	106	738	47.4	10	484
Haripur		7	60	638	34.1	10	476
Pirgonj		19	72	611	41.3	12	450
Ranisankail		18	52	682	35.1	9	437
Baliadangi		10	42	598	39.2	11	467
Best F_i^+		39	106	598	47.4	9	437
Worst F_i^-		7	42	738	34.1	12	484

Normalization of S_j and R_j

In Table 3 we calculate S_j and R_j value with respect to the formula is

$$S_j = \sum \left[\frac{W_i(F_i^+ - F_{ij})}{F_i^+ - F_i^-} \right], \quad R_j = \text{Max} \left[\frac{W_i(F_i^+ - F_{ij})}{F_i^+ - F_i^-} \right]$$

In this formula

$$F_i^+ = \text{Max} (F_{ij})$$

$$F_i^- = \text{Min} (F_{ij})$$

S_j = utility measure

R_j = regret measure

W_i = weights of criteria, expressing their relative importance

Table 3. Calculation of S_j and R_j

Alternative	Criteria							S_j	R_j
		Health service	Social welfare	Population	Literacy rate	Transportation cost	Skilled labor cost		
Thakurgaon Sadar		0	0	0.1670	0	0.0557	0.1670	0.3897	0.1670
Haripur		0.1670	0.1200	0.0477	0.1670	0.0557	0.1386	0.6960	0.1670
Pirgonj		0.1044	0.0887	0.0155	0.0766	0.1670	0.0462	0.4984	0.1670
Ranisankail		0.1096	0.1409	0.1002	0.1544	0	0	0.5051	0.1544
Baliadangi		0.1513	0.167	0	0.1030	0.1113	0.1066	0.6392	0.1670

Calculation of Q_j :

In Table 4 we calculate the Q_j value by using the formula given below

$$Q_j = \frac{V(S_j - S^+)}{(S_j - S^-)} + (1 - V) \left(\frac{R_j - R^+}{R^- - R^-} \right)$$

Where $S^+ = \min S_j$, $S^- = \max S_j$

$R^+ = \min R_i$, $R^- = \max R_i$

Table 4. Calculation of Q_j

	S_j	R_j	Q_j
	0.3897	0.1670	0.5
	0.6960	0.1670	1
	0.4984	0.1670	0.6775
	0.5051	0.1544	0.1885
	0.6392	0.1670	0.9074
S+,R+	0.3897	0.1544	
S-,R-	0.6960	0.1670	

Calculation of Rank:

In the table 5 we calculate the rank by using Q_i value. Here mainly we calculate the based on the most minimum value in rank 1 and after the second minimum in rank 2 and so on. And the most maximum value rank position is last.

Table 5. Finding rank using Q_j value

	S_j	R_j	Q_i	Rank
	0.3897	0.1670	0.5	2
	0.6960	0.1670	1	5
	0.4984	0.1670	0.6775	3
	0.5051	0.1544	0.1885	1
	0.6392	0.1670	0.9074	4
S+,R+	0.3897	0.1544		
S-,R-	0.6960	0.1670		

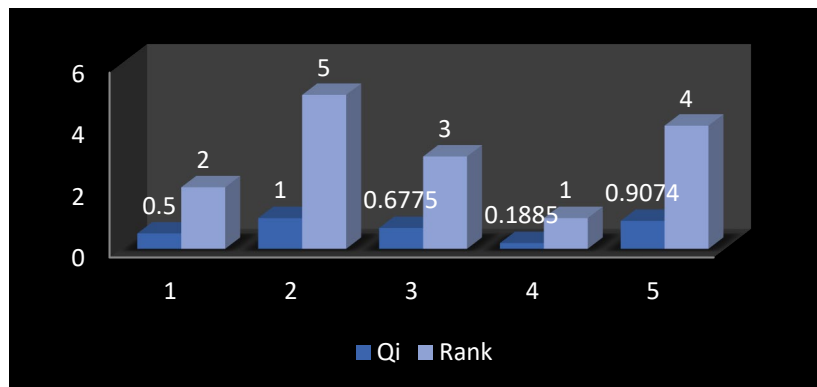


Figure 1: Rank Choose

4.1 Acceptance of rank choice

For Case 1 : $Q(a(2)) - Q(a(1)) \geq D_Q$

$$\begin{aligned} D_Q &= \frac{1}{j-1} \quad [j = \text{Number of alternatives}] \\ &= \frac{1}{5-1} \\ &= 0.25 \end{aligned}$$

Here,

$$Q(a(2)) - Q(a(1)) \geq D_Q$$

$$0.311509 \geq 0.25$$

Here we see that, the first condition is fulfilled. That's means there is no necessity for including the inconsequence of ranked alternative in the collection of compromise solutions. There is no necessity for checking of this condition for the minor ranked alternatives as well because it rather does not apply.

5. Result and Discussion

From the above Calculation using VIKOR method it has been found that Ranisangkail was the maximal expected location for University of Thakurgoan in Thakurgoan district. In this case study five alternatives that's means five Upozila were used to select the location in this district. Moreover, six criteria were selected to find the best alternative. After all calculations, it was concluded that Ranisangkail was the most suitable place for setting up Thakurgoan University.

The study has been accomplished with the mentioned methodology with one outcome. In this study to get the location, five potential locations have been considered from all the location around the Thakurgoan district. For analytical purpose some relevant criteria such as health service, social welfare, population, literacy rate, transportation cost and skilled labor cost in those specific area was considered related to the five locations. All the location has been compared using these qualitative factors. For comparison VIKOR method was conducted as the most suitable method. In Thakurgoan Sadar and other three upazila's population density and the transportation cost was high but in Ranisangkail the population density was low, the transportation cost was low, skilled labor cost was low and the others factors like health service, social welfare, literacy rate was sufficient comparing with the density of the population. Ranisangkail was chosen as the best location as per VIKOR method analysis. Most common factor such as transportation cost, skilled labor cost, population density per square kilometers, social welfare and government and non-government health service etc. Were kept in the study and all these factors were calculated using a tool VIKOR on Excel. By comparing both analysis the ranking came out as Ranisangkail> Thakurgoan Sadar> Pirganj> Baliadangi> Haripur. Though the problem does not always remain the same or not different, but it identify has associated with the existing ones and by re- considering the factors the inconvenience can be solved. The methodology used in the study was formed the knowledge gained from previous studies on the location problem. VIKOR method is one of the basic tools that can be used to analyze any problem with qualitative factors. The results were also considerable in the method.

6. Conclusion

Educational institution like school, college, university plays an important role in the country and nation over the worldwide. If we look at the progress of every developed country in the world today, we see that education plays a major role behind their progress. To build up a new university the study has been accomplished considering the present situation of decision making in location selection. In this study the problem were identified in the beginning and thoroughly all the criterion working on this sector were considered. The methodology was based on VIKOR method. The outcomes were very efficient. As the study was conducted in university location, the outcomes may be applied in the same kind of related sector like plant, industry, school, selecting location. 6.2 Future Work college etc. for We have done the result of our case study basically by using VIKOR method. Facility location can be done with many methods. But if we have a lot of data then we can solve this task with machine learning. So, if we have enough data then we can apply other methods if we want but machine learning is best for all but the problem is that many criteria and alternatives are required in that case.

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Biography

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