Hazardous Facility Location: A Supply Chain Perspective

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Abstract:- **The selection of location of hazardous industries is a considerable risk procedure. However, not much research has been conducted on Hazardous facility location. It is a multi-criteria decision making process. The conventional methods for this process are inadequate for dealing with imprecise or vague nature of linguistic assessment. To overcome this difficulty & motivated by the lack of research on Hazardous facility location and the fact that there is an increasing demand for it, we have listed out various factors influencing the hazardous facility location decision and a Fluffy Fuzzy TOPSIS approach for selecting plant location under linguistic environments is presented, where the ratings of various alternative locations under various criteria, and the weights of various criteria are assessed in linguistic terms represented by fuzzy numbers. A numerical application is provided to illustrate the approach.**

Key words: Fuzzy logic, multi-criteria decision making,(TOPSIS), facility location selection

NOMENCLATURE

A^+	fuzzy Positive ideal solution
A^-	fuzzy Negative ideal solution
CC_i	Closeness coefficient
µa(x)	Membership function of x
w_{ij}	Aggregated Fuzzy Weights
r_{ij}	Normalised Fuzzy weights

I. INTRODUCTION

Facility location selection is the determination The facility location problem has been around for a long time. In general, it concerns the geographical positioning of facilities for a specific organizational entity, such as a company. As competition increases and the complexity of the environment in which companies operate is increasing, setting up and operating a hazardous industry has become very challenging. Traditionally, the objective has been to derive a cost-optimal distribution of facilities with respect to the location of markets (customers) and raw materials (suppliers). More recently, access to skills and knowledge has been added as a major strategic factor that affects location decisions. But, when the decision has to be made about hazardous facilities, more concern arises. Facilities such as garbage dump sites, landfills, chemical plants, nuclear reactors, military installations and polluting (noise/gas)plants that turn out to be undesirable (repulsive) for the surrounding population, that avoids them and tries to stay away from them. In this sense, Erkut and Neuman(1989) distinguish between noxious (hazardous) and obnoxious (nuisance) facilities, although both can be simply regarded as undesirable. Despite these undesirable facilities being necessary in general to the community, for instance, garbage dump sites, gas stations, electrical plants, etc., the location of such facilities might cause a certain disagreement among the population. Such a disagreement may result in a true opposition of people to the installation of undesirable facilities in their neighbourhood. For this reason location of such hazardous facilities is of vital importance.

In this paper we have taken a case of locating oil tanking & depot. Various criterions which affect its location decision are listed out & assessed against location alternatives. Along these lines in this paper, fuzzy TOPSIS strategy is proposed for office area determination, where the appraisals of different option areas under different subjective criteria and the weights of all criteria are spoken to by fuzzy numbers.

The rest of this paper is organized as follows. Section 2 briefs about Fuzzy TOPSIS method. Section 3 presents the case study conducted Section 4 describes results & discussion. Finally, conclusions are presented in Section 6.

II. PROBLEM ON HAND

The location decision is based on factors which are very vague, imprecise and linguistic in nature. Methods like gravity location technique have a tendency to be less viable in managing the loose or unclear nature of such data. Consequently in this paper, fluffy TOPSIS strategy is proposed for location of petroleum terminal, where the appraisals of different option areas under different subjective criteria and the weights of all criteria are spoken to by fuzzy numbers. Fuzzy hypothesis was acquainted by Zadeh [1] with manage vulnerability and unclearness in choice making. Thus in this paper, fuzzy TOPSIS method is proposed for facility location selection for petroleum terminal (hazardous plant) in Karnataka and/or Maharashtra, where the ratings of various alternative locations under various subjective criteria and the weights of all criteria are represented by fuzzy numbers. Fuzzy theory was introduced by Zadeh [1] to deal with uncertainty and vagueness in decision making.

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III. METHODOLOGY

A. TOPSIS method for calculating the weights of alternatives

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) is very simple and easy to implement. We use this method to calculate the weights of alternatives and make the decision of the best alternative [2]. The corresponding data for each alternative are collected by reviewing the government publications and actual investigations.

Table I. Linguistic terms for alternative ratings.

Linguistic term	**Membership function**
Very Poor(VP)	(1,1,3)
Poor(P)	(1,3,5)
Fair(F)	(3,5,7)
Good(G)	(5,7,9)
Very Good(VG)	(7,9,9)

TABLE II. Linguistic terms for Criteria ratings.

Linguistic term	**Membership function**
Very low	(1,1,3)
Low	(1,3,5)
Medium	(3,5,7)
High	(5,7,9)
Very high	(7,9,9)

B. Locations evaluation using fuzzy TOPSIS

The third step involves evaluation of potential locations against the selected criteria using the technique called fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Situation). The TOPSIS approach chooses the alternative that is closest to the positive ideal solution and farthest from the negative ideal solution [2]. A positive ideal solution is composed of the best performance values for each attribute whereas the negative ideal solution consists of the worst performance values. Fuzzy TOPSIS has been applied to facility location problems by researchers. Reference [2] represents The various steps of fuzzy TOPSIS.

IV. ANALYSIS

TABLE IV. Linguistic assessments for the three alternatives

C1	Location	**D1**	**D2**	**D3**
	Bellari	VG	G	G
	Udapi	F	F	G
	kolhapur	VP	VP	VP
C2	Bellari	VP	P	P
	Udapi	F	F	F
	kolhapur	P	P	F
C3	Bellari	F	F	F
	Udapi	G	G	G
	kolhapur	VG	G	G
C4	Bellari	VP	VP	VP
	Udapi	VG	VG	VG
	kolhapur	VP	G	VG
C5	Bellari	G	G	VG
	Udapi	F	G	F
	kolhapur	VP	P	VP
C6	Bellari	P	P	P
	Udapi	F	F	F
	kolhapur	F	G	F
C7	Bellari	P	F	F
	Udapi	G	F	G
	kolhapur	VG	VG	VG
C8	Bellari	F	F	F
	Udapi	G	G	F
	kolhapur	G	VG	G
C9	Bellari	P	F	F
	Udapi	G	G	F
	kolhapur	VG	G	VG
C10	Bellari	G	F	G
	Udapi	G	F	G
	kolhapur	G	G	G
C11	Bellari	F	F	P
	Udapi	F	F	F
	kolhapur	F	F	F

Indian Oil Tanking Company is expected to expand in near future its terminal facilities to serve the remote areas of Karnataka & Maharashtra. A committee of three decision makers D1, D2 and D3 is formed to select the best location. The decision makers are Mr Nimbalkar, (Location In charge, BPCL, Goa Region), Mr. Valencio D'Souza (Safety In charge, ZIOL, Goa.), Mr. Shri Prasad (Terminal Manager, ZIOL, Goa).

The alternatives available for location selection are Bellary & Udapi Districts of Karnataka and Kolhapur District of Maharashtra.

The criteria used for evaluation of locations are distance of the facility from the human locality (C1), Availability of water(C2), Good roads and transport network(C3), Close to harbour(C4), Vast land area(C5), Hospital in close vicinity(C6), Near to market or dealers(C7), Government policies and norms(C8), Human resource availability(C9), Region or area served(C10), Reaction of Native residents towards the facility setup(C11). The committee provided linguistic assessments for the eleven criteria using rating scales given in TABLE I. and TABLE II.. TABLES III. and IV. present the linguistic assessments for the criteria and the three alternatives (locations) for each of the 11 location criteria using rating scal

TABLE III. .Linguistic assessments for the 11 criteria

	Decision Makers		
CRITERION	D1	D2	D3
C1	VH	VH	VH
C2	M	H	H
C3	H	H	M
C4	VH	H	H
C5	VH	H	H
C6	L	M	VL
C7	H	H	H
C8	H	VH	H
C9	M	L	M
C10	H	H	VH
C11	H	VH	VH

Table V.Normalized fuzzy decision matrix for alternatives

Criterion	a_{j-}	c_{j+}	**NORMALIZED RATINGS**		
			BELLARI	**UDPI**	**KOLHAPUR**
C1	1	9	0.55,0.85,1	0.33,0.62,1	0.11,0.11,0.33
C2	1	7	0.14,0.33,0.71	0.43,0.71,1	0.14,0.43,0.71
C3	3	9	0.33,0.55,0.77	0.55,0.77,1	0.55,0.85,1
C4	1	9	0.11,0.11,0.33	0.77,0.77,1	0.11,0.11,0.33
C5	1	9	0.55,0.85,1	0.33,0.62,1	0.11,0.11,0.33
C6	1	9	0.11,0.33,0.55	0.33,0.55,0.77	0.33,0.62,1

C7	1	9	0.11,0.40,0.77	0.33,0.70,1	0.77,1,1
C8	3	9	0.33,0.55,0.77	0.33,0.70,1	055,0.85,1
C9	1	9	0.11,0.40,0.77	0.33,0.70,1	055,0.85,1
C10	3	9	0.33,0.70,1	0.33,0.70,1	0.55,0.77,1
C11	1	7	0.14,0.62,1	0.43,0.71,1	0.43,0.71,1

Table VI. Weighted normalized alternatives, FPIS and FNIS

Criterion	Alternatives			FPIS A+	FPNS A-
	BELLARI	UDPI	KOLHAPUR		
C1	3.85,7.65, 7.65	2.31,5.58, 9	0.77,0.99, 2.97	9,9, 9	0.77,0.77, 0.77
C2	0.42,2.08, 6.39	1.29,4.49, 9	0.42,2.72, 6.39	9,9, 9	0.42,0.42, 0.42
C3	0.99,3.38, 6.93	1.65,4.87, 9	1.65,5.38, 9	9,9, 9	0.99,0.99, 0.99
C4	0.55,0.84, 2.97	3.85,5.89, 9	0.55,0.84, 2.97	9,9, 9	0.55,0.55, 0.55
C5	2.75,6.51, 9	1.65,4.74, 9	0.55,0.84, 2.97	9,9, 9	0.55,0.55, 0.55
C6	0.11,0.99, 3.85	0.33,1.65, 5.39	0.33,1.86, 7	7,7, 7	0.11,0.11, 0.11
C7	0.55,2.8,6. 93	1.65,5.39, 9	3.85,7,9	9,9, 9	0.55,0.55, 0.55
C8	1.65,4.21, 6.93	1.65,5.36, 9	2.75,6.51, 9	9,9, 9	1.65,1.65, 1.65
C9	0.11,1.73, 5.39	0.33,3.03, 7	0.55,3.68, 7	7,7, 7	0.11,0.11, 0.11
C10	1.65,5.36, 9	1.65,5.36, 9	2.75,5.89, 9	9,9, 9	1.65,1.65, 1.65
C11	**0.7,5.16,9**	**2.15,5.91, 9**	**2.15,5.91, 9**	**9,9, 9**	**0.7,0.7,0.7**

Likewise, we compute the fuzzy weights of the three alternatives for the remaining criteria (Table VI)Then, we compute the fuzzy positive ideal solution (A^+) and the fuzzy negative ideal solutions (A^-) using Eqs. (12)–(13) for the three alternatives. Then, we compute the distance dv (.) for each alternative from the fuzzy positive ideal matrix (A^+) and fuzzy negative ideal matrix (A^-) using Eqs. (2), (12) and (13). Likewise, we compute the distances for the remaining criteria for the three alternatives. Then, we compute the distance dv (.) for each alternative from the fuzzy positive ideal matrix (A+) and fuzzy negative idealMatrix (A^-) using Eqs. (2), (12) and (13). Likewise, we compute the distances for the remaining criteria for the three alternatives. The results are shown in Table VIII. Then, we compute the distances di^+ and di^- using Eqs. (14)–(15). Using the distances $di^+$and di^-

We compute the closeness coefficient for the three alternatives using Eq. (16)[1].

TABLE VII. Distances dv (Ai, A^+)and dv (A_i, A^-) for Alternative

Criterion	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
$d_v(B,A^-)$	5.9	3.6	3.7	1.4	6.1	2.2	3.9	3.4	3.2	4.7	5.4
$d_v(U,A^-)$	5.5	5.5	5.1	6	5.5	3.2	5.7	4.7	4.3	4.7	5.7
$d_v(K,A^-)$	1.3	3.7	5.3	1.4	1.4	4.1	6.4	5.1	4.5	4.9	5.7
$d_v(B,A^+)$	3.2	6.5	5.7	7.6	3.9	5.6	6.1	5.2	5.1	4.7	5.3
$d_v(U,A^+)$	4.3	5.1	4.8	3.5	4.9	5	4.7	4.7	4.5	4.7	4.3
$d_v(K,A^+)$	7.5	6.3	4.7	7.6	7.6	4.8	3.2	3.9	4.2	4	4.3

TABLE VIII.Closeness coefficients (CC_i) of the three alternatives.

	Bellari(B)	Udapi(U)	Kolhapur(K)
di^-	48.35	55.89	42.27
di^+	58.70	50.48	57.93
CC_i	0.4247	0.5254	0.4218

V. RESULT AND DISCUSSION

The closeness coefficient CCi represents the distances to the fuzzy positive ideal solution (A+) and the fuzzy negative ideal solution (A−) simultaneously. The closeness coefficient CCi speaks to the separations to the fuzzy positive perfect arrangement (A+) and the fuzzy negative perfect arrangement (A−) at the same time. By looking at the CCi estimations of the three options we find that U > B > K. Accordingly, Udapi is chosen as the best area for Locating Oil Terminal which is having CCi esteem as 0.5254. Bellary & Kolhapur have very close CCi estimate of 0.4247 & 0.4218 respectively. Though it can be said that Bellary would be our 2nd option and Kolhapur stands at 3rd position in case of terminal location decision

VI. CONCLUSION

In this study, we present a multi-criteria decision making framework for location of a hazardous facility i.e. an oil terminal, under a fuzzy environment. The approach used herein comprises four steps. In first step, we identify the criteria for evaluating potential locations oil terminal. The criteria used for evaluation of locations are Distance of the facility from the human locality, Availability of water, Good roads and transport network, Close to harbour, vast land area, Hospital in close vicinity, Near to market or dealers, Government policies and norms, Human resource availability, Region or area served, Reaction of Native residents towards the facility setup.

In step 2, the potential locations are identified. In step 3, the decision makers provide ratings for the criteria and the potential locations. Fuzzy TOPSIS is used to determine aggregate scores for all potential. In our case by comparing the CCi values of the three alternatives we find that B>U>K. Therefore, Udapi is selected as the best location for locating the Oil Terminal with closeness coefficient of 0.5254.

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