# SELECTION OF GREEN USING PROMETHEE – II MCDM METHOD

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OBJECTIVE AND METHODOLOGY

Objective of present study is to set a preference for green suppliers using the PROMETHEE under the usual criterion preference functions. Seven economical and environmental criteria, four suppliers and five decision makers were the main structures in the green supplier selection problem. . The algorithm of PROMETHEE under usual criterion function was implemented, and the results show that supplier A1 is the most preferred alternative.
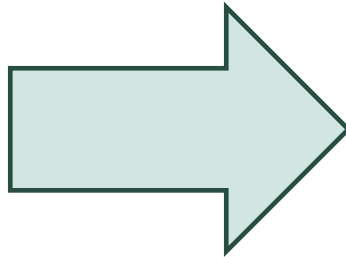
1. **Seven economical and environmental criteria, four suppliers and five decision makers were the main structures in the green supplier selection problem.**
2. **Data were collected via personal communication with decision makers using five-point Likert scale.**
3. **The algorithm of PROMETHEE under usual criterion function was implemented, and comparative analysis has been done to identify most preferred supplier.**

INTRODUCTION

- Multi-criteria decision-making (MCDM) method is referred as a method used for scoring or ranking a finite number of alternatives by considering multiple criteria attached to the alternatives.

- PROMETHEE is one of the MCDM methods. The PROMETHEE is the abbreviation of preference ranking organization method for enrichment evaluation.

- I PROMETHEE is a ranking method which is considered as simple in conception and computation compared to many other MCDM methods.
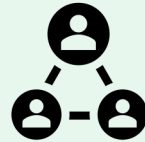
ADVANTAGE OF PROMOTHEE METHOD

It is well adapted to the decision problems where a finite set of alternatives is to be outranked.

PROMETHEE method is based on pairwise comparisons of alternatives with respect to each criterion

It is user-friendly outranking method. It is useful in real-life planning problems.

PROMETHEE I and PROMETHEE II allow partial and complete ranking of alternatives, respectively.

It established inner relationship between the attributes during the decision-making process.

CRITERION AND ALTERNATIVES

Group of Managers evaluating suppliers

m1 m2 m3 m4 m5

Suppliers

A1

A2

A3

A4

C1 • Cost of Products

C2 • Quality of Products

C3 • Services

C4 • Delivery on Time

C5 • Technology Level

C6 • Environmental management systems

C7 • Green Packaging
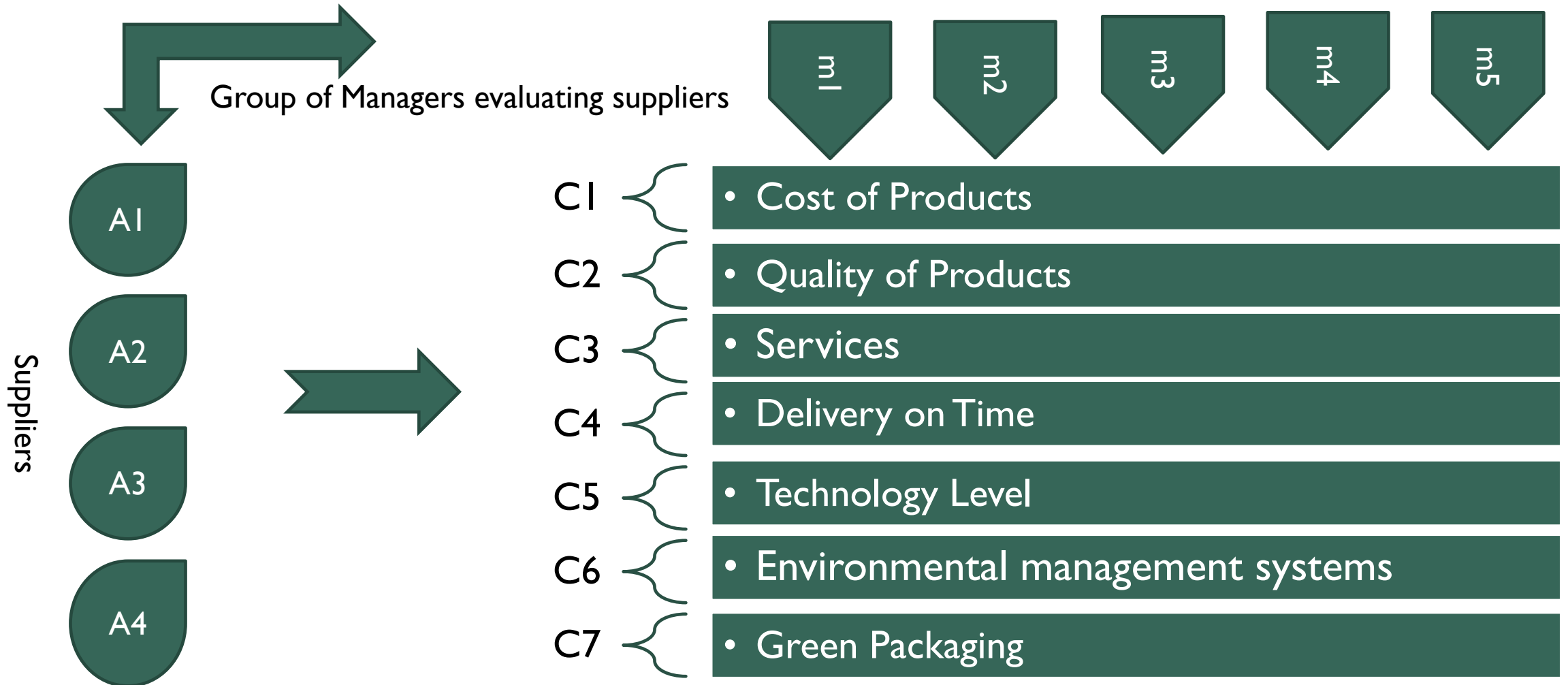
STEPS TO FINALIZE BEST SUPPLIER

- Determine the criteria (j =1,…, k) and the set of possible alternatives in a decision problem.

Five point Likert Scale and Description.

Scale	Weight of importance
1	Unimportant
2	Less important
3	Moderately important
4	Important
5	5 Very important

- Determine the weight wj of the criteria. It shows the relative importance of each of the criteria and notes that

$$\sum_{j=1}^{k} W_J = 1$$

STEPS TO FINALIZE BEST SUPPLIER – COMPUTE CRITERION WEIGHT

- Normalize the decision matrix to range 0–1 by using,

$$R_{ij} = \frac{[X_{ij} - min(X_{ij})]}{[max(X_{ij}) - min(X_{ij})]} \qquad i= 1,2,\ldots,n, \; j= 1,2,\ldots,m$$

where X_{ij} is evaluation values provided by decision makers.

Evaluations provided by the decision makers need to be normalized in the range 0–1 and compute the fraction based on each criterion using above equation -

Criteria	D_1	D_2	D_3	D_4	D_5	Average Weight
C_1	0.1667	0.1905	0.1818	0.1905	0.2000	0.1859
C_2	0.2222	0.1905	0.1818	0.1905	0.1500	0.1870
C_3	0.1111	0.1429	0.1818	0.0952	0.1000	0.1262
C_4	0.1667	0.1429	0.1818	0.1429	0.2000	0.1669
C_5	0.1111	0.0952	0.0909	0.0952	0.1500	0.1085
C_6	0.1111	0.0952	0.0909	0.1429	0.1000	0.1080
C_7	0.1111	0.1429	0.0909	0.1429	0.1000	0.1176

STEPS TO FINALIZE BEST SUPPLIER – NORMALIZE AND AGGREGATE THE RATE OF SUPPLIER

- The ratings of suppliers are averaged to aggregate and normalize them to 0–1 scale. The evaluations of four suppliers corresponding to all the criteria are displayed in

Criteria	Supplier A1	Supplier A2	Supplier A3	Supplier A4
C_1	0.8000	0.4000	0.5000	0.5000
C_2	0.6000	0.4000	0.4000	0.4500
C_3	0.8500	0.7500	0.6000	0.6500
C_4	0.7000	0.5000	0.5500	0.6000
C_5	0.8000	0.5000	0.6000	0.6500
C_6	0.6500	0.5000	0.5500	0.5000
C_7	0.6000	0.5000	0.7000	0.5500

- This step involves the calculation of the differences in criteria values of A1 with respect to other suppliers. The deviations are obtained using

$$d_j(a,b) = g_j(a) - g_j(b)$$

	A1A2	A1A3	A1A4	A2A1	A2A3	A2A4	A3A1	A3A2	A3A4	A4A1	A4A2	A4A3
C_1	1	1	1	0	0	0	0	1	0	0	C1	0
C_2	1	1	1	0	0	0	0	0	0	0	C1	1
C_3	1	1	1	0	1	1	0	0	0	0	C0	1
C_4	1	1	1	0	0	0	0	1	0	0	C1	1
C_5	1	1	1	0	0	0	0	1	0	0	C1	1
C_6	1	1	1	0	0	0	0	1	1	0	C0	0
C_7	1	0	1	0	0	0	1	1	1	0	C1	0

STEPS TO FINALIZE BEST SUPPLIER –CALCULATE THE PREFERENCE INDE

- Calculation of the preference index of each supplier takes into account the criteria weight. It is also a value to show the degree of preference of a supplier over another supplier. The index is calculated using equation -

$$\pi(a, b) = \sum_{j=1}^{k} P(a, b)w_j$$

where $w_j > 0$ are the weights associated with each criterion. The symbol $\pi(a, b)$ shows that the degree of a is preferred to b over all the criteria.

	Supplier A1	Supplier A2	Supplier A3	Supplier A4
Supplier A1		1.0001	0.8825	1.0001
Supplier A2	0		0.1262	0.1262
Supplier A3	0.1176	0.6869		0.2256
Supplier A4	0	0.7659	0.5886	

STEPS TO FINALIZE BEST SUPPLIER –DETERMINE THE POSITIVE AND NEGATIVE OUTRANKING FLOWS OF EACH SUPPLIER (PROMETHEE I PARTIAL RANKING)

- Positive outranking flow (leaving flow) shows the degree of the supplier dominated other suppliers. In contrast, negative outranking flow (entering flow) shows the degree of the supplier dominated by other suppliers. Equation given below is used to calculate these two

$$\varnothing^+(a) = \frac{1}{n-1} \sum_{x \in A} \pi(a, x)$$

Supplier	$\varnothing^+(a)$	$\varnothing^-(a)$
Supplier A1	0.9609	0.0392
Supplier A2	0.084133	0.817633
Supplier A3	0.343367	0.532433
Supplier A4	0.4515	0.450633

STEPS TO FINALIZE BEST SUPPLIER – NET FLOW VALUE OF SUPPLIER

- Net flow values are calculated to avoid incomparability. Below equation has been used to calculate Net Flow Value -

$$\varnothing(a) = \varnothing^+(a) + \varnothing^-(a)$$

where $\varnothing(a)$ denotes the net outranking flow for each alternative.

Suppliers	Net Flow $\varnothing(a)$
Supplier A1	0.9217
Supplier A2	-0.7335
Supplier A3	-0.189067
Supplier A4	0.000867

- The best supplier is the one having the highest net flow value, $\varnothing(a)$. By using PROMETHEE II (complete ranking) method, supplier A1 is selected as the best alternative.

CONCLUSION

- This study has proposed the preference in selecting the suppliers that deal with green organic products. Different types of preference functions have been used in the implementation. The first net outflows and preference order are obtained using the usual criterion preference function, which is considered as the simplest function. The second net outflows and preference order are obtained using the combination of linear preference function and level preference functions. Both of these functions are chosen based on the nature of criteria. The final preference order of suppliers is summarized in below table-

Suppliers	PROMETHEE (usual criterion function)	PROMETHEE (linear and level functions)
Supplier A1	1	1
Supplier A2	4	4
Supplier A3	3	2
Supplier A4	2	3

THANK YOU