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Analysis of Aluminium Profile Manufacturing Industries by using PROMETHEE II Method

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Abstract

This paper deals with the analysis of Aluminium profile manufacturing industries by extrusion process .The Analysis of Aluminium profile manufacturing industries will be done by selecting various alternatives and attributes .The Aluminium profile manufacturing industries are selected and they are ranked according to the priority using PROMETHEE method. Using AHP method certain results have been sorted out, and PROMETHEE method brings out the best results than AHP.

Keywords: PROMETHEE II Method.

Introduction

Introduction to Decision Making in theManufacturing Environment Manufacturing is the backbone of any industrialized nation. Its importance is emphasized by the fact that, as an economic activity, it comprises approximately 20 to 30% of the value of all goods and services produced. A country's level of manufacturing activity is directly related to its economic health. In general the higher the level of manufacturing activity in a country, the higher the standard of living of its people.

Manufacturing can be defined as the application of mechanical, physical, and chemical processes to modify the geometry, properties and/or appearance of a given starting material in the making of new, finished parts or products. This effort includes all intermediate processes required for the production and integration of a product's components. The ability to produce this conversion efficiently determines the success of the company. The type of manufacturing performed by a company depends on the kinds of products it makes. Manufacturing is an important commercial activity carried out by companies that sell products to customers. In the modern sense, manufacturing involves interrelated activities that include product design and documentation, material selection, process planning, production, quality assurance, management, and marketing of products. These activities should be integrated to yield viable and competitive products . The selection decisions are complex, as decision making is more challenging today. Necessary conditions for achieving efficient decision making consist in understanding the current and upcoming events and factors influencing the whole manufacturing environment, in exploring the nature of decision-making processes and the reach of different typologies of methods and techniques, and finally in structuring appropriately the decision-making approach based on a wide range of issues related to manufacturing systems design, planning, and management.

Literature Review

1. Selection of an optimal facility layout design is an iterative process as it relates to the interrelationship between various departments of the organization. So the decision maker must be creative and comprehensive while selecting the optimal layout and the industrialists or decision makers always face the difficulties in selecting an optimal facility layout design. Recently, Maniya and Bhatt (2011) proposed an alternative

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decision making method named as 'Preference Selection, Index (PSI) method' and they had considered two facility layout design selection problems for demonstration.

2. The location selection decision may be required due to various reasons, like change in production capacity , addition or deletion of product line, change in distribution cost or change in customer demand. Wrong selection of location may result in inadequate qualified work force, unavailability of raw materials, insufficient transportation facility, increased operating expenses or even disastrous effect on the organization due to political and societal interference. Thus, the decision maker must select the location for a facility that will not only perform well, but also it will be perform well, but also it will be flexible enough to accommodate the necessary future changes.
3. Harmonosky and Tothero (1992) proposed a heuristic based mathematical model for multi-objective facility layout problem. This model allowed solving the facility layout problem for more than two factors handling qualitative and quantitative factors simultaneously by combining into one factor known as composite factor and then the layout resulted from the heuristic is then used in pair wise exchange routine for further improvement. Tretheway and Foote (1994) developed a fast heuristic for the facilities layout problem including aisle location. In their approach, the location of aisles is considered during the layout development procedure.
4. The PROMETHEE I (partial ranking) and PROMETHEE II (complete ranking) were developed by J.P. Brans and presented for the first time in 1982 at a conference organised by R. Nadeau and M. Landry at the Université Laval, Québec, Canada (L'Ingéniérie de la Décision. Elaboration d'instruments d'Aide à la Décision). The same year several applications using this methodology were already treated by G. Davignon in the field of Heath care.
5. After the successful launch of the WMS system, many businesses will find that the resources required to operate the system is greater than prior to the implementation. This is primarily due to the data intensive nature of the software and the fact that warehouses are in a state of flux; racks are moved, placement and removal strategies changed, new items added, new processes developed. Warehouse accuracy is paramount for the software to operate and to do this data will need to be entered accurately and in a timely fashion. Although most WMS implementations will reduce labor costs in the placement and removal of materials, there is often an added warehouse management function required just to operate the software.
6. In multi-attribute decision making, the decision problem is decomposed into a number of smaller , less complex subproblems (Keeney and Raiffa 1976, Chankong and Haimes 1983, French 1986) Alternatives are decomposed onto different di- mensions, usually called attributes, criteria, goals, etc. These are evaluated independently. The total utility of an alternative is finally obtained by some ag-gregation procedure. Alternatives are ranked according to utility values, where a higher value means a better alternative.

Identification of Problem

There are different types of manufacturing industries. We have chosen four Aluminium profile manufacturing industries situated around 40 km. radius of Nagpur . These are Ama Extrusion, New Era Extrusion, Falcon Extrusion and Pennar Aluminium Pvt. Limited. We select various attributes and alternatives from these industries. The attributes are select with there production line ,location of plant ,cycle time etc.In aluminium profile industry time required for every operation is very important to get quality product and wastage should be minimum. AHP (Analytical Hierarchy Process) is a comprehensive structured frame work. It is used for selecting the best industry by comparing the various alternatives & attributes in it. PROMETHEE is also used to select the best industry

Methodology and Calculation

We have used one methodologies to optimize and selecting of Alluminium profile industries .They are, PROMETHEE METHOD

Promethee Method

PROMETHEE methodology, a Multi Criteria Decision Making (MCDM) technique, was first developed in 1982 by J.P. Brans (Brans and Mareschal, 2005). This methodology includes various types such as PROMETHEE I (partial ranking), PROMETHEE II (complete ranking) and PROMETHEE III (ranking based on intervals) applied in different conditions for different purposes. According to Brans and Marshal (2005), a large number of fields such as Banking, Manpower planning, Industrial Location, Investments, Water resources, Medicine, Chemistry, Health care, Tourism, Ethics in OR and Dynamic management have successfully applied the PROMETHEE methodology. They have emphasized that mathematical properties and friendliness of use are the reasons of success of the methodology. The PROMETHEE II, which ranks alternatives completely, requires very clear information for both the analysts and the decision-makers. These information include decision making matrix that contains decision maker's trade-offs data between alternatives in any criterion, weights (relative importance) of the criteria and preference functions.

The PROMETHEE methodology prefers and prioritizes alternatives based on pair wise comparisons. In other words, the deviation between the evaluations of two alternatives on a particular criterion is specified. Preference functions convert this deviation to a number between 0 and 1 and present the preference of decision maker between alternatives in each criterion .The larger the number, the higher the preference. Brans and Mareschal (2005) have proposed six types of preference functions. Decision maker can employ either these preference functions or his own arbitrary preference function

Procedure

Procedure of PROMETHEE II is constituted by four steps:

Step 1:- Calculating the deviations based compared two alternatives with respect to j^{th} criterion:

$d_j(a,b) = f_j(a) - f_j(b)$ j = 1,2,..., k.

Where j denotes the j^{th} criterion, k stands for the finite number of criteria.

Step 2 :- Applying the preference function:

$$P_j(a,b) = F_j[d_j(a,b)] \quad j = 1,2,..., k.$$

$$0 \le P_j(a,b) \le 1 \qquad j = 1,2,..., k.$$

Where $P_j(a, b)$ expresses the preferencof alternative a with regarding to alternative b on the j^{th} criterion.

Step 3 :- Calculating a global preference index.

The overall preference index of alternative over alternative b is denoted as:

$$\prod(a,b) = \sum_{k=1}^{j} W_j P_j(a,b) \quad j = 1,2,..., k.$$

Where ,w_j represents the weight of the criterion j.

Step 4 :- Calculating the outranking flows. The outgoing flow Φ^+ which expresses the outranking character of alternative a (how a dominates all the other alternatives) and the incoming flow Φ^- which indicates the outranked character of alternative a (how is a dominated by all the other alternatives) can be represented as follows:

$$\emptyset^+(a) = \sum_{x \in A} \pi(x,a)$$

$$\emptyset^-(a) = \sum_{x \in A} \pi(a,x)$$

Where A denotes the alternative set. The net flow $\Phi(a)$ expresses the overall preference degree of alternative a. Higher value of $\Phi(a)$ means a better performance of alternative a.

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

Based on above mentioned results, the final decision can be taken .

List of Attributes With Abbrivation and Values

Table no .1

Sr. No.	List of Attributes	Abbre viat-ion	Pennar Al	Falcon Extrusion	Ama Ertrusion	New Era Extrusion
1	Cycle Time	CT	18 hours	22 hours	22 hours	28 hours
2	Dead Cycle Time	DT	20sec	35 sec	30 sec	45 sec
3	Product Cost	PC	190Rs/kg	180 Rs/kg	185 Rs/kg	175 Rs/ kg
4	Working Temp.	WT	420-450 C	400 -450 C	400-450 C	440-480 C
5	Pre Heating Time	PHT	300 C	280 C	300 C	300 C
6	Socking Time	ST	6 hour	4hour	5 hours	3 hours
7	Weight of Profile	WP	0.75 kg/m	0.07 kg / m	0.72 kg /m	0.68kg/m
8	Type of Procedure	TP	Automatic	Semi- Auto.	Semi- Auto.	Manual
9	Maintenance Cost	MC	2 lak/mon.	2.5 lak/mon.	2.3 lak/mon.	1.5lak/mon.
10	%Conversion of Metal	PCM	82%	78%	75%	65%
11	No. of Trial Run	NTR	3	4	6	7
12	Final Inspection Time	FIT	30 min.	45 min.	60 min.	120 min.
13	No. of Work Station	NWS	3	5	5	7
14	Material Handling Time	MHT	30 min.	45 min.	60 min.	120 min.
15	Average Power Consumption	APC	0.1 Mw/mon.	0.12Mw /mon	0.13 Mw/mon.	0.09 Mw/mon.
16	Tooling Cost Per Year	TCY	4 lak.	5.5 lak	5 lak	8 lak.,

By using satty scale the following calculation are done .

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Normalized Matrix Table of Attributes of Aluminium Profile Industries For Promethe

Industrie	PCM	NTR	FIT	NWS	MHT	APC	TCY	TP
Pennar Al	1	1	1	1	1	0.9	1	1
Falcon Ex	0.95122	0.75	0.666667	0.6	0.666667	0.75	0.727273	0.553073
==-\Ama Ex	0.914634	0.5	0.5	0.6	0.5	0.692308	0.8	0.553073
New Era Ex	0.792683	0.428571	0.25	0.428571	0.25	1	0.5	0.128492

Table no. 2

.Inde	CT	DT	PC	WT	PHT	ST	WP	MC
Pe. Al.	1	1	1	0.954545	1	1	1	0.75
Fa.Ex.	0.818182	0.571429	0.947368	0.909091	0.933333	0.666667	0.933333	0.6
Am. Ex	0.818182	0.666667	0.973684	0.909091	1	0.833333	0.96	0.652174
N.E. Ex.	0.642857	0.444444	0.921053	1	1	0.5	0.906667	1

Pair Wise Comparison Mtrix For Aluminium Profile Industries

Table no.3

	CT	DT	PC	WT	PHT	ST	WP	MC	PCM	NTR	FIT	NWS	MHT	APC	TCY	TP
CT	1	5	1	7	7	3	1	5	1	7	9	5	9	3	3	5
DT	0.2	1	0.2	1.4	1.4	0.6	0.2	1	0.2	1.4	1.8	1	1.8	0.6	0.6	1
PC	1	5	1	7	7	3	1	5	1	7	9	5	9	3	3	5
WT	0.142857	0.714286	0.142857	1	1	0.428571	0.142857	0.714286	0.142857	1	1.285714	0.714286	1.285714	0.428571	0.428571	0.714286
PHT	0.142857	0.714286	0.142857	1	1	0.428571	0.142857	0.714286	0.142857	1	1.285714	0.714286	1.285714	0.428571	0.428571	0.714286
ST	0.333333	1.666667	0.333333	2.333333	2.333333	1	0.333333	1.666667	0.333333	2.333333	3	1.666667	3	1	1	1.666667
WP	1	5	1	7	7	3	1	5	1	7	9	5	9	3	3	5
MC	0.2	1	0.2	1.4	1.4	0.6	0.2	1	0.2	1.4	1.8	1	1.8	0.6	0.6	1
PCM	1	5	1	7	7	3	1	5	1	7	9	5	9	3	3	5
NTR	0.142857	0.714286	0.142857	1	1	0.428571	0.142857	0.714286	0.142857	1	1.285714	0.714286	1.285714	0.428571	0.428571	0.714286
FIT	0.111111	0.555556	0.111111	0.777778	0.777778	0.333333	0.111111	0.555556	0.111111	0.777778	1	0.555556	1	0.333333	0.333333	0.555556
NWS	0.2	1	0.2	1.4	1.4	0.6	0.2	1	0.2	1.4	1.8	1	1	0.6	0.6	1
MHT	0.111111	0.555556	0.111111	0.777778	0.777778	0.333333	0.111111	0.555556	0.111111	0.777778	1	0.555556	1	0.333333	0.333333	0.555556
APC	0.333333	1.666667	0.333333	2.333333	2.333333	1	0.333333	1.666667	0.333333	2.333333	3	1.666667	3	1	1	1.666667
TCY	0.333333	1.666667	0.333333	2.333333	2.333333	1	0.333333	1.666667	0.333333	2.333333	3	1.666667	3	1	1	1.666667
TP	0.2	1	0.2	1.4	1.4	0.6	0.2	1	0.2	1.4	1.8	1	1.8	0.6	0.6	1

Weight Calculation

Find the relative normalized weight (w_j) for each criterion by (i) calculating the geometric mean of i^{th} row, and (ii) normalizing the geometric mean of rows in the pair-wise comparison matrix. This can be represented by the following equations

$$GM_j = \left[\prod_{j=1}^{M} b_{ij} \right]^{1/M} \quad \text{and} \quad w_j = GM_j \Big/ \sum_{j=1}^{M} GM_j$$

Tableno.4

Attributes	$\prod_{j=1}^{M} b_{ij}$	$[\prod_{j=1}^{M} b_{ij}]^{1/M}$	$w_j = GM_j \Big/ \sum_{j=1}^{M} GM_j$
CT	468838125	3.482883	0.15519
DT	0.0030726	0.696577	0.03104
PC	468838125	3.482883	0.15519
WT	1.411E-05	0.497555	0.02217
PHT	1.411E-05	0.497555	0.02217
ST	10.891381	1.160961	0.05173
WP	468838125	3.482883	0.15519
MC	0.0030726	0.696577	0.03104
PCM	468838125	3.482883	0.15519
NTR	1.411E-05	0.497555	0.02217
FIT	2.53E-07	0.386987	0.01724
NWS	0.001707	0.671451	0.02992
MHT	2.53E-07	0.386987	0.01724
APC	10.891381	1.160961	0.05173
TCY	10.891381	1.160961	0.05173
TP	0.0030726	0.696577	0.03104

Weights Of Atteributes Alluminium Profile Industry

Table no. 5

CT	0.15519	**PCM**	0.15519
DT	0.03104	**NTR**	0.02217
PC	0.15519	**FIT**	0.01724
WT	0.02217	**NWS**	0.02992
PHT	0.02217	**MHT**	0.01724
ST	0.05173	**APC**	0.05173
WP	0.15519	**TCY**	0.05173
MC	0.03104	**TP**	0.03104

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Aggregate Function Matrix of Alluminium Profile Industries

Table no 5:

	Pennar Aluminium	Falcon Extrusion	Ama Extrusion	New Era Extrusion
Pennar Aluminim	0	0.968958	0.94679	0.841848
Falcon Extrusion	0.03104	0	0.465326	0.634924
Ama Extrusion	0.03104	0.467058	0	0.790117
New Era Extrusion	0.1094	0.10494	0.10494	0

Here addition of all first values is calculated in first box of Aggregated function matrix. Likewise calculations are made for other values. Addition of row elements form positive outranking flow and addition of column elements
form negative outranking flow.

Leaving And Entering Flow And Net Flow Of Different Alluminium Profile Industries

Table no.6

S.no.	Industries	Φ+	Φ-	netΦ
1	Pennar Aluminium	2.757594	0.167018	2.590576
2	Falcon Extrusion	1.119225	1.540956	- 0.421731
3	Ama Extrusion	1.288214	1.50499	- 0.216776
4	New Era Extrusion	031482	2.266889	- 1.952069

Determine the ranking of all the considered alternatives depending on the values of net Φ.Thus ,the best alternative is the one having the highest net Φ value.

Ranking of Alluminium Profile Industries

Table no.7

1	Pennar Aluminium	2.590576
2	Ama Extrusion	- 0.216776
3	Falcon Extrusion	- 0.421731
4	New Era Extrusion	- 1.952069

Conclusion

The selection decision has long-term implications because changing the existing facilities may be quite expensive. It is therefore important to select the most appropriate working process and give sufficient time to obtain quality product industries which will minimize the cost over an extended time period efficiently. The PROMETHEE method which will be applied to other strategic decision-making problems. Using this method, we have sorted out the Pennar Aluminium Profile Industry is having highest value .Thus Pennar Aluminium Profile Industry is the best Choice.

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