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Research Paper

ANALYSIS OF ALUMINIUM PROFILE MANUFACTURING INDUSTRIES BY USING TOPSIS METHOD

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This paper deals with the selection of optimum manufacturing firm for the manufacturing of Aluminium profile, with the help of MADM (multi-attribute decision making) technique. Various choices of industries are generally available that are producing the same type of the product. Selection of industry is done based on various alternatives and attributes such as product cost, cycle time, weight of profile, percentage conversion of metal, number of trial run, number of work station, etc. For the research, data from four Aluminium profile manufacturing industries are selected. The product of these industries are same, i.e., Aluminium profile. Considering sixteen different attributes which affects the performance of the industry. Selection is done by using Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method.

Keywords: Aluminium profile, Multi-Attribute Decision Making (MADM), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

INTRODUCTION

Introduction to Decision Making in the Manufacturing 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

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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

The effective optimization of machining process parameters affects dramatically the cost and production time of machined components as well as the quality of the final products. This paper presents optimization aspects of a multi-pass milling operation. The objective considered is minimization of production time (i.e., maximization of production rate) subjected to various constraints of arbor strength, arbor deflection, and cutting power. Various cutting strategies are considered to determine the optimal process parameters like the number of passes, depth of cut for each pass, cutting speed, and feed. The upper and lower bounds of the process parameters are also considered in the study. The optimization is carried out using three non-traditional optimization algorithms namely, Artificial Bee Colony (ABC), Particle Swarm Optimization (PSO), and Simulated Annealing (SA). An application example is presented and solved to illustrate the effectiveness of the presented algorithms. The results of the presented algorithms are compared with the previously published results obtained by using other optimization techniques.

Several kinds of metallic bipolar plates for PEMFCs are currently being developed in order to meet the demands of cost reduction, stack volume, lower weight and enhanced power density. This work shows an application of the Technique of ranking Preferences by Similarity to the Ideal Solution (TOPSIS) Multiple Attribute Decision Making (MADM) method for solving the material selection problem of metallic bipolar plates for Polymer Electrolyte Fuel Cell (PEFC), which often involves multiple and conflicting objectives. The proposed methodological tool can aid the material designer in the modeling and selection of suitable materials according to a set of predefined criteria. After introducing the theoretical background, a case study is presented for the material selection of a bipolar plate in a PEFC. A list of all possible choices, from the best to the worst materials, is obtained by taking into account all the material selection criteria, including the cost of production. A user-defined codein Mathematica has been developed to facilitate the implementation of the method. It was shown that the optimum value of each criterion is independent of other criteria values (i.e., no interaction is allowed). The proposed approach may be applied to other problems of material selection of fuel cell components.

An ever increasing variety of materials is available today, with each having its own characteristics, applications, advantages, and limitations. In choosing the right material, there is not always a single definite attribute of selection and the designers and engineers have to take into account a large number of material selection attributes. This paper presents a logical procedure for material selection for a given engineering application. The procedure is based on an improved compromise ranking method considering the material selection attributes and their relative importance for the application considered. Two examples are included to illustrate the approach.

IDENTIFICATION OF PROBLEM

There are different types of manufacturing industries. Four different Aluminium profile manufacturing industries are selected which are situated around 40 km radius of Nagpur. These are Ama Extrusion, New Era Extrusion, Falcon Extrusion and Pennar Aluminium Pvt. Limited various attributes and alternatives from these industries are selected. 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. TOPSIS is a comprehensive structured frame work. It is used for selecting the best industry by comparing the various alternatives and attributes in it.

METHODOLOGY AND CALCULATION

We have used one methodologies to optimize and selecting of Aluminium profile manufacturing industries. They are Technique for Order Preference by Similarity to Ideal Solution (TOPSIS Method).

TOPSIS METHOD

The TOPSIS method was developed by Hwang and Yoon (1981). This method is based on the concept that the chosen alternative should have the shortest Euclidean distance from the ideal solution, and the farthest from the negative ideal solution. The ideal solution is a hypothetical solution for which all attribute values correspond to the maximum attribute values in the database comprising the satisfying solutions. The negative ideal solution is the hypothetical solution for which all attribute values correspond to the minimum attribute values in the database. TOPSIS thus gives a solution that is not only closest to the hypothetically best, that is also the farthest from the hypothetically worst.

PROCEDURE

The main procedure of TOPSIS METHOD is as follows:

Step 1: The first step is to determine the objective, and to identify the pertinent evaluation attributes.

Step 2: This step represents a matrix based on all the information available on attributes.

This matrix is nothing but the decision table. Each row of this matrix is allocated to one alternative, and each column to one attribute. Therefore, an element m_{ij} of the decision table '*D*' gives the value of the j^{th} attribute in original real values, that is, non-normalized form and units, for the i^{th} alternative. In the case of a subjective attribute (i.e., objective value is not available), a ranked value judgment on a scale is adopted. Once a subjective attribute is represented on a scale, then the normalized values of the attribute assigned for different alternatives are calculated in the same manner as that for objective attributes.

Step 3: Obtain the normalized decision matrix,

$$R_{ij} = m_{ij} \Big/ \left[\sum_{i=1}^{M} m_{ij}^2 \right]^{1/2}$$

Step 4: Decide on the relative importance (i.e., weights) of different attributes with respect to the objective. A set of weights *w* =1 may be decided upon.

Step 5: Obtain the weighted normalized matrix V_j (for $j = 1, 2, \ldots, M$) such that *w*. This is done by the multiplication of each element of the column of the matrix R_{ij} with its associated weight w_j. Hence, the elements of the weighted normalized matrix *V* are expressed as:

$$V_{ij} = w_j \times R_{ij}$$

Step 6: Obtain the ideal (best) and negative ideal (worst) solutions in this step. The ideal (best) and negative ideal (worst) solutions can be expressed as:

$$V^+ = \left\{ \left(\sum_i^{\max} V_{ij} / j \in J \right), \left(\sum_i^{\min} V_{ij} / j \in J' \right) / i = 1, 2, \ldots, N \right\}$$

$$V^- = \left\{ \left(\sum_i^{\min} V_{ij} / j \in J \right), \left(\sum_i^{\max} V_{ij} / j \in J' \right) / i = 1, 2, \ldots, N \right\}$$

$$= \{V_1^-, V_2^-, V_3^-, \ldots, V_M^-\}$$

where

$J = (j = 1, 2, 3, \ldots, M)/j$ is associated with beneficial attributes, and

$J' = (j = 1, 2, 3, \ldots, M)/j$ is associated with non beneficial attributes.

Step 7: Obtain the separation measures. The separation of each alternative from the ideal one is given by the Euclidean distance in the following equations:

$$S_i^+ = \left\{ \sum_{J=1}^{M} \left(V_{ij} - V_j^+ \right)^2 \right\}^{0.5} \quad i = 1, 2, \ldots, N$$

$$S_i^- = \left\{ \sum_{J=1}^{M} \left(V_{ij} - V_j^- \right)^2 \right\}^{0.5} \quad i = 1, 2, \ldots, N$$

Step 8: The relative closeness of a particular alternative to the ideal solution P_{ij}, can be expressed in this step as follows:

$$P_i = S_i^- \Big/ \left(S_i^+ + S_i^- \right)$$

Step 9: A set of alternatives is generated in the descending order in this step, according to the value of *P* indicating the most preferred and least preferred feasible solutions. P_{ij} may also be called the overall or composite performance score of alternative A

List of Attributes

1. Cycle time.
2. Dead cycle time.
3. Product cost
4. Working temperature.
5. Pre heating temperature.
6. Socking time.xc
7. Weight of profile

Sr. No.	List of Attributes	Abbreviat-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.,

Industries	CT	DT	PC	WT	PHT	ST	WP	MC
Pennar AL	18	20	190	420	300	6	0.75	2
Falcon Ex.	22	35	180	400	280	4	0.7	2.5
Ama Ex.	22	30	185	400	300	5	0.72	2.3
New Era Ex.	28	45	175	440	300	3	0.68	1.5
Industries	**PCM**	**NTR**	**FIT**	**NWS**	**MHT**	**APC**	**TCY**	**TP**
Pennar AL	82	3	30	3	30	0.1	4	0.895
Falcon Ex.	78	4	45	5	45	0.12	5.5	0.495
Ama Ex.	75	6	60	5	60	0.13	5	0.495
New Era Ex.	65	7	120	7	120	0.09	8	0.115

Industries	CT	DT	PC	WT	PHT	ST	WP	MC
Pennar AL	324	400	36100	176400	90000	36	0.5625	4
Falcon Ex.	484	1225	32400	160000	78400	24	0.49	6.25
Ama Ex.	484	900	34225	160000	90000	25	0.5184	5.29
New Era Ex.	784	2025	30625	193600	90000	9	0.4624	2.25
Sum of square	2076	4550	133350	690000	348400	94	2.0333	17.79
Square root	45.563143	67.453688	365.1712	830.66239	590.2542	9.69536	1.4259383	4.2178193
Industries	**PCM**	**NTR**	**FIT**	**NWS**	**MHT**	**APC**	**TCY**	**TP**
Pennar AL	6724	9	900	9	900	0.01	16	0.80103
Falcon Ex.	6084	16	2025	25	2025	0.0144	30.25	0.24503
Ama Ex.	5625	36	3600	25	3600	0.0169	25	0.24503
New Era Ex.	4225	49	14400	49	14400	0.0081	64	0.01323
Sum of square	22658	110	20925	108	20925	0.0494	135.25	1.3043
Square root	150.5257	10.48809	144.6548	10.3923	144.655	0.22226	11.6297	1.14206

Industries	CT	DT	PC	WT	PHT	ST	WP	MC
1	0.39505615	0.29649973	0.5203039	0.505621	0.5082556	0.618853	0.52597	0.4742
2	0.48284641	0.51887452	0.4929195	0.481543	0.4743719	0.412568	0.4909	0.5927
3	0.48284641	0.44474959	0.5066117	0.481543	0.5082556	0.515711	0.50493	0.5453
4	0.61453179	0.66712438	0.4792273	0.529698	0.5082556	0.309426	0.47688	0.3556
Industries	**PCM**	**NTR**	**FIT**	**NWS**	**MHT**	**APC**	**TCY**	**TP**
1	0.5447573	0.286039	0.20739	0.288675	0.20739	0.44992	0.34395	0.783672
2	0.5181838	0.381385	0.311086	0.481125	0.31109	0.53991	0.47293	0.433427
3	0.4982536	0.572078	0.414781	0.481125	0.41478	0.5849	0.42993	0.433427
4	0.4318198	0.667424	0.829561	0.673575	0.82956	0.40493	0.68789	0.100695

CT	DT	PC	WT	PHT	ST	WP	MC
0.155193	0.031039	0.155193	0.02217	0.02217	0.051731	0.155193	0.031039
PCM	**NTR**	**FIT**	**NWS**	**MHT**	**APC**	**TCY**	**TP**
0.155193	0.02217	0.01724	0.02992	0.017244	0.05173	0.051731	0.031039

Industries	CT	DT	PC	WT	PHT	ST	WP	MC
1	0.06130995	0.00920306	0.0807475	0.01121	0.011268	0.032014	0.08163	0.0147
2	0.07493438	0.01610535	0.0764977	0.010676	0.0105168	0.021343	0.07618	0.0184
3	0.07493438	0.01380458	0.0786226	0.010676	0.011268	0.026678	0.07836	0.0169
4	0.09537103	0.02070687	0.0743727	0.011743	0.011268	0.016007	0.07401	0.011
Industries	**PCM**	**NTR**	**FIT**	**NWS**	**MHT**	**APC**	**TCY**	**TP**
1	0.0845425	0.006341	0.003576	0.008637	0.00358	0.02327	0.01779	0.024324
2	0.0804185	0.008455	0.005364	0.014395	0.00536	0.02793	0.02446	0.013453
3	0.0773255	0.012683	0.007152	0.014395	0.00715	0.03026	0.02224	0.013453
4	0.0670154	0.014797	0.014305	0.020153	0.0143	0.02095	0.03559	0.003125

8. Type of procrdure.
9. Maintenances cost.
10. Percentage conversion of metal.
11. Number of trial run .
12. Final inspection time.
13. Number of work station.
14. Material handling time
15. Average power consumption.
16. Tooling cost per year.

List of Attributes with Abbrivation and Values:

Decision Matrix of Aluminium Profile Manufacturing Industries for Tpopsis, i.e. (m_{ij})

To obtain the normalised matrix = $\left[\sum_{i=1}^{M} m_{ij}^2\right]^{1/2}$

Normalized matrix of aluminium Profile Industries for TOPSIS (R_{ij})

$$R_{ij} = m_{ij} \bigg/ \left[\sum_{i=1}^{M} m_{ij}^2\right]^{1/2}$$

Weights of attributes of aluminium profile industries for TOPSIS W_j

Normalized matrix of aluminium profile industries $V_{ij} = R_{ij} \times W_j$, for TOPSIS

Ideal best (V_j+) and ideal worst (V_j-) of aluminium profile manufacturing industries for TOPSIS

Separation measure of aluminium profile industries for TOPSIS

Ranking of aluminium profile industries using TOPSIS

CONCLUSION

Using MADM models in selection of Aluminium profile manufacturing industry can be considered an efficient and suitable tool. The decision matrix is introduced for selecting the appropriate industry for the manufacturing of

Attributes	Ideal Best (Vj+)	Ideal Worst(Vj-)
CT	0.06131	0.095371
DT	0.0092031	0.0207069
PC	0.080748	0.074373
WT	0.0117434	0.0106758
PHT	0.01126803	0.0105168
ST	0.0320139	0.0160069
WP	0.08163	0.07401
MC	0.01104	0.0184
PCM	0.0845425	0.0670154
NTR	0.0063415	0.0147968
FIT	0.0035762	0.014305
NWS	0.008637	0.020153
MHT	0.003576	0.014305
APC	0.020947	0.030257
TYC	0.017793	0.035585
TP	0.024324	0.003125

S. No.	Industries	Sa^+	Sa^-	Pi
1.	Pennar Aluminium	0.00438542	0.0567277	0.92824096
2.	Falcon Extrusion	0.02689177	0.0335436	0.55503226
3.	Ama Extrusion	0.02572784	0.03391	0.5685984
4.	New Era Extrusion	0.05616863	0.01194	0.17530851

1.	Pennar Aluminium	0.92824096
2.	Ama Extrusion	0.5685984
3.	Falcon Extrusion	0.55503226
4.	New Era Extrusion	0.17530851

Aluminium profile based on design criteria and possible candidate materials. The weighted coefficients are obtained for every attribute by making use of radical root method (also called the geometric mean method). The decision matrix and weighted coefficients are taken as the input for Ordinary TOPSIS and Block TOPSIS. These models list industries, from the best to the worst, taking into account all industry selection criteria including cost. Methods that determine both the score and the rank of each industry may be preferred over methods that provide only the rank of industry. In order to enhance the accuracy of the final decision, using the TOPSIS method can be considered an efficient tool. Using this method, it is we have sorted out the Pennar Aluminium Profile Manufacturing Industry is having highest rank as compare to other three industries. Thus Pennar Aluminium Profile Manufacturing Industry is the best Choice.

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