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Implementation of multi-criteria decision-making method for the selection of magnesium alloy to suit the automotive application

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ABSTRACT

In global competitive Environment demand of automotive industry and demand for automotive parts of the vehicle is increasing day by day for the fulfillment of customer need. The selection of suitable material plays an important role in product development for customer satisfaction. Due to wrong selection of material, increase the cost of the product as well as product failure. A better method is more important for selection of material. Due to increasing scenario in the manufacturing of automotive parts, there should be a selection of best material for manufacturing of automotive parts. In this present work, there is a selection of Mg Alloy in the automobile industry. For the proper selection of Mg alloy a TOPSIS, COPRAS, MOORA, ELECTRE and SAW Method is applied and then finally ranked the best magnesium alloy. In this proposed research work, five Method is compromised and select the best Mg alloy.

Keywords: *MG alloy, TOPSIS, Copras, Moora, Electra, Saw, Material selection*

1. INTRODUCTION

In this project mainly focused on the selection of magnesium alloy with various factors considerable with the help of multi-criteria decision-making method (MDMM) such as Topsis, MOORA, SAW, ELECTRE and COPRAS Method, and there are various properties has taken in Mg alloy for the selection of best magnesium alloy. The abundance of Magnesium on the earth is considered to be 4th highest following iron, oxygen and silicon. The density of magnesium is approximately two-thirds of that of aluminum, one-quarter of zinc, and one-fifth of steel. Accordingly, magnesium casting production has experienced an annual growth of between 10 and 20% over the past decades and is expected to continue at this rate [1]. (In India Automobile industry is growing in outstanding rate with its impact globally in India. in the automobile industry with the use of correct resources and correct raw material, it will enhance the profit and productivity and also increase product development. In any automobile industry with the proper selection of materials and proper selection of Mg alloy for construction of various parts of the vehicle, the manufacturing process can lead in the proper way in the global market with good quality, with performance rate and at low cost. One of the primary advantages of magnesium is its density. It is approximately 2/3rd of that of aluminum, 1/4th of zinc, and 1/5th of steel. The abundance of Magnesium on the earth is considered to be 4th highest following iron, oxygen and silicon. But magnesium has disadvantages like corrosion, oxidation and melts at low temperatures. Due to its low mechanical strength, Magnesium was alloyed with Al, Zn, manganese, rare earth, thorium, Zirconium, to make them most important materials for applications, where weight reduction is important [2]. The selection of Magnesium alloy depends upon various factors, functional requirement, the need of customer for customer satisfaction, various alloying parameters, availability of alloying elements, cost of magnesium alloy, types of the production system, the cost involved in the manufacturing of vehicle in the automobile industry. There are various magnesium alloys for making parts in the automobile industry for better quality, due to this various magnesium alloy decision maker facing lots of problem in selection of particular materials in magnesium alloy for performing a various function and for making various manufacturing parts in the automobile industry. Magnesium alloys have always been good-looking to designers due to their low density, only two thirds that of aluminum alloys in the aerospace industry and therefore can be an invention Technology if used for low weight airframe structures. Also, there is recycle process of magnesium alloys for utilization in any automotive industry, which will give the better performance, and with the recycling off magnesium alloy it will reduce the cost of the product, and it will good for the environment and with the recycling of magnesium alloy it improve the quality of automobile industry. With the invention, it has been shown that 99% parts of magnesium alloy can recycle , with this achievement it reduce the transportation cost, and improve the quality of automobile industry.

Nowadays new materials and new alloys are typically costly than the magnesium alloy, and in global market, there is need of product in low cost with good quality for large scale of production of parts in the automobile industry. The global effort in magnesium materials development has diversified in recent years, targeting new automotive, aerospace. Magnesium alloys are vulnerable to galvanic erosion. Therefore, it is often necessary to apply coatings to magnesium components for separation purposes. Therefore, a widespread corrosion screening study was performed to evaluate pre-treatment and coating systems currently available for use within the automotive industry. There should be a proper selection of material, which plays an important role in automobile industry construction for the achievement of a better product at good rate with the improvement of better productivity with proper cost optimization. In this proposed research work, there are a multi-criteria decision making method such as TOPSIS, SAW, COPRAS, MOORA, and ELECTRE Method is applied for selection of magnesium alloy in an automobile application. In this study, a different method is applied for different properties for efficient production rate in the automotive industry. If there is not the correct selection of magnesium alloy with the not proper method, it leads towards ultimately drive the industry in failure mode, and leads in the cost of production, and finally, customer get the product in bad quality with a higher rate. So, the decision maker need to identify and select proper magnesium alloy with the help of various decision making method or multi-criteria decision making system with specific functionalities in order to get the desired output with minimum cost involvement. In this case i.e. selection of materials and selection of Mg alloy with correct method selection, it is not simple task for selection of magnesium alloy for engineering application in automobile industry , there is no single definite selection criteria and no single definite alternative for decision maker .but decision maker needs a lots of number of attributes and huge number of alternatives for proper selection of Mg alloys, so there is systematic approach for selection of magnesium alloys for engineering application in automobile manufacturing industry. In this proposed research work it focuses on the application of multi-criteria decision making methods for solving magnesium alloy, selection related problem in given manufacturing environment for the construction of automobile parts. A complete list of various properties regarding like density, thermal conductivity, impact, hardness etc. properties has to be considered and ranked according to selected method for proper selection of Mg alloy for increasing production value in better quality and to fulfillment of customer need and do the customer satisfied after selection of proper method and material.

2. PROBLEM FORMULATION

Magnesium alloys are mixtures of magnesium with other metals (called an Alloy), often aluminum, zinc, magnesium, silicon, rare earth. Magnesium is the lightest auxiliary metal. Magnesium combinations have a hexagonal cross-section structure, which influences the basic properties of these amalgams. Plastic twisting of the hexagonal cross section is more convoluted than in cubic latticed metals like Aluminum, copper, and Steel; along these lines, magnesium composites are regularly utilized as thrown compounds, yet research of fashioned amalgams has been more broad since 2003. Cast magnesium combinations are utilized for some parts of present-day cars have been utilized as a part of some elite vehicles; kick the bucket cast magnesium is additionally utilized for camera bodies and segments in focal points [3]. Practically, all the commercial magnesium alloys manufactured in the United States contain aluminum (3 to 13 percent) and manganese (0.1 to 0.4 percent). Many also contain zinc (0.5 to 3 percent) and some are hardenable by heat treatment. All the alloys may be used for more than one product form, but alloys AZ63 and AZ92 are most used for sand castings, AZ91 for die castings, and AZ92 generally employed for permanent mold castings (while AZ63 and A10 are sometimes also used in the latter application as well). For forgings, AZ61 is most used, and here alloy M1 is employed where low strength is required and AZ80 for highest strength. For extrusions, a wide range of shapes, bars, and tubes are made from M1 alloy where low strength suffices or where welding to M1 castings is planned. Alloys AZ31, AZ61 and AZ80 are employed for extrusions in the order named, where an increase in strength justifies their increased relative costs [4].

A survey has been made on different Mg alloys in automotive industries [5, 6, 7, 8, 9] and its properties among which eight Magnesium alloys with ten important properties (Density – Physical Property, UTS, YTS, FS, Impact, Hardness, % Elongation – Mechanical Properties, Thermal Conductivity, Specific heat, CTE – Thermal Properties are considered and tabulated below[10,11].

Table 1: Magnesium alloy Materials and its properties

S.No.	Material	Density (g/cm)	Thermal conductivity (W/mK)	UTS (Mpa)	YTS (Mpa)	Fatigue strength (Mpa)	Impact (j)	Hardness (BHN)	%elongation in 50mm	Specific heat (j/gc)	Coeff . of Thermal Expansion (µm/m-C)
1	AZ91	1.81	72.7	230	150	97	2.7	63	3	0.8	26
2	AM60	1.79	62	241	131	80	2.8	65	13	1	26
3	AM50	1.77	65	228	124	75	2.5	60	15	1.02	26
4	AZ31	1.771	96	260	200	90	4.3	49	15	1	26
5	ZE41	1.84	113	205	140	63	1.4	62	3.5	1	26
6	EZ33	1.8	99.5	200	140	40	0.68	50	3.1	1.04	26.4
7	ZE63	1.87	109	295	190	79	2.3	75	7	0.96	27
8	ZC63	1.87	122	240	125	93	1.25	60	4.5	1	26

3. CONCEPT of TOPSIS

TOPSIS is a multi-criteria decision-making method for selection of magnesium alloy in the automotive industry with different criteria and attributes for better implementation and getting a better result. The full form of TOPSIS is Technique of order by similarity to the ideal solution. This method considers three type of attributes or criteria such as,

1-Qualitative benefits attributes/criteria.
2-quantitative benefits attributes/criteria.
3-cost attribute or criteria.

Step1.construct the decision matrix and determine the weights of the criteria.
Let, $X=(x_{ij})$be a decision matrix and ,$W=[w_1,w_2,\ldots w_n]$ a weight vector, where $w_1+w_2+w_3+w_4+\ldots+w_n=1$ Criteria of the functions can be benefit functions (more is better) or cost functions (less is better).

Step 2. Calculate the normalized decision matrix. The normalized value *NIJ* is calculated as.

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \quad \text{For } i=1,2,..m;\ j=1,2,...n$$

Step 3. Calculate the weighted normalized decision matrix. The weighted normalized value V_{ij} is calculated as, G.R.Jahanshahloo (2006) [12].
The weighted normalized value V_{ij} is calculated in the following way:

$$v_{ij}=w_j n_{ij},\ i=1,2,3,\ldots\ldots m;\ j=1,2,3,\ldots n$$

Where JW is the weight of j^{th} criterion $\sum_{j=1}^{n} w_j = 1$.

Step 4: Determine the positive ideal and negative ideal solutions.
Identify the positive ideal solution (extreme performance on each criterion) and identify the negative ideal solution (reverse extreme performance on each criterion). The perfect positive arrangement is the arrangement that boosts the advantage criteria and limits the cost criteria though the negative perfect arrangement amplifies the cost criteria and limits the advantage criteria.

The positive ideal solution A^+ has the form:

$$A^+ = \left(v_1^+, v_2^+ \ldots v_n^+\right) = \left(\left(\max_i v_{ij} \middle| j \in I\right), \left(\min_i v_{ij} \middle| j \in J\right)\right)$$

The negative ideal solution A^- has the form:

$$A^- = \left(v_1^-, v_2^- \ldots v_n^-\right) = \left(\left(\min_i v_{ij} \middle| j \in I\right), \left(\max_i v_{ij} \middle| j \in J\right)\right)$$

Where *I* am associated with benefit criteria, and *J* is associated with the cost criteria,
Step 5. Calculate the separation measures from the positive ideal solution and the negative ideal solution.
The separation of each alternative from the positive ideal solution is given as

$$d_i^+ = \left(\sum_{j=i}^{n} \left(v_{ij} - v_j^+\right)^p\right)^{1/p}, i=1,2,\ldots m.$$

The separation of each alternative from the negative ideal solution is given as

$$d_i^- = \left(\sum_{j=i}^{n} \left(v_{ij} - v_j^-\right)^p\right)^{1/p}, i=1,2,\ldots m.$$

Where $p \geq 1.$ for $p=2$ we have the most used traditional n-dimensional Euclidian metric.

$$d_i^+ = \sqrt{\sum_{j=i}^{n} \left(v_{ij} - v_j^+\right)^2}, i=1,2,3\ldots, m.$$

$$d_i^- = \sqrt{\sum_{j=i}^{n} \left(v_{ij} - v_j^-\right)^2}, i=1,2,3\ldots, m.$$

Step 6-Calculate the relative closeness to the positive ideal solution.
The relative closeness of the *six*th alternative A_j with respect to A^+ is defined as

$$R_i = \frac{d_i^-}{d_i^- + d_i^+},$$

Where $0 \leq R_i \leq 1, i=1,2,\ldots m$

Step.7- Rank the preference order. For ranking alternatives using this index, we can rank alternatives in decreasing.

4. RESULT and DISCUSSION of TOPSIS METHOD

Table 2: Normalized the decision Matrix (*NIJ*)

	C1	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	*C8*	*C9*	*C10*
A1	0.3525	0.2709	0.3401	0.3478	0.4338	0.3851	0.3652	0.1119	0.2886	0.3512
A2	0.3486	0.2311	0.3564	0.3038	0.3578	0.3994	0.3768	0.4848	0.3608	0.3512
A3	0.3447	0.2422	0.3372	0.2875	0.3354	0.3566	0.3478	0.5594	0.3680	0.3512
A4	0.3449	0.3578	0.3845	0.4638	0.4025	0.6134	0.2840	0.5594	0.3608	0.3512
A5	0.3583	0.4211	0.3032	0.3247	0.2818	0.1997	0.3594	0.1305	0.3608	0.3512
A6	0.3505	0.3708	0.2958	0.3247	0.1789	0.0970	0.2898	0.1156	0.3752	0.3566
A7	0.3642	0.4062	0.4363	0.4406	0.3533	0.3281	0.4347	0.2610	0.3463	0.3647
A8	0.3642	0.4547	0.3549	0.2899	0.4159	0.1783	0.3478	0.1678	0.3608	0.3512

Attributes with equal importance (Equal weighting factors) - Mean Weight Method This section discusses, consideration of all the properties with equal importance, so that the decision maker will look on each individual property with the same importance. There are ten attributes such that the weighting factor for each attribute is 1/10 = 0.1 and is given in Table 3.

Table-3 Attributes with equal importance (Equal weightage factors) - Mean Weight Method

Attribute	Attribute	Attribute	Attribute	Attribute	Attribute	Attribute	Attribute	Attribute	Attribute
1	2	3	4	5	6	7	8	9	10
0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Using the above weights, apply the TOPSIS method of compromise ranking to each alternate as explained in Section 3. Then the corresponding performance scores obtained are tabulated below in Table 4.

Table-4: Distance from ideal and non-ideal solution and R_i

S. No.	d_i^+	d_i^-	R_i
1	0.0567	0.0402	0.4149
2	0.0378	0.0529	0.5832
3	0.0412	0.0552	0.5724
4	0.0191	0.0759	0.7989
5	0.0650	0.0263	0.2883
6	0.0772	0.0167	0.1780
7	0.0425	0.0454	0.5163
8	0.0623	0.0358	0.3650

On arranging the values from Table 4 in ascending order, the selection of the best alternate can be easily identified. The ranking selection can be chosen based on R_i values. From the Table 5, it can be clearly identified that the alternate 4 is the best choice among the other. Hence AZ31 is the best material choice with equal weight of properties

Table 5-Performance score and ranking by TOPSIS Method

S. No.	Materials	Score	Rank of selected material
1	AZ91	0.4149	5
2	AM60	0.5832	2
3	AM50	0.5724	3
4	AZ31	0.7989	1
5	ZE41	0.2883	7
6	EZ33	0.1780	8
7	ZE63	0.5163	4
8	ZC63	0.3650	6

5. CONCEPT of MOORA METHOD

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

Step 2: The next step is to signify all the information available for the attributes in the form of an assessment matrix. The data given are represented as matrix X_{mxn}. Where x_{ij} is the performance measure of i^{th} alternative on the j^{th} attribute, *m* is the number of alternatives, and *n* is the number of attributes. Then a ratio structure is developed in which each performance of an alternative on an attribute is compared to a denominator which is a representative for all the alternatives regarding that attribute.

$$F(n) = \begin{bmatrix} x_{11} & x_{12} & . & x_{1n} \\ x_{21} & x_{22} & . & x_{2n} \\ . & . & . & . \\ x_{m1} & x_{m2} & . & x_{mn} \end{bmatrix}$$

Step 3: Brauers et al. (2008)[13], concluded that for this denominator, the best choice is the square root of the sum of squares of each alternative per attribute. This ratio can be expressed as below:-

$$x^*_{ij} = x_{ij} \Big/ \sqrt{\sum_{i=1}^{m} x^2_{ij}} \qquad \text{where } (j = 1, 2, ..., n)$$

Where x_{ij} is a dimensionless number which belongs to the interval [0, 1] representing the normalized performance of ith alternative on the jth attribute.

Step 4: For multi-criteria objective, these normalized values are added in the case of maximization (for beneficial attributes) and subtracted in case of minimization (for non-beneficial attributes). Then the optimization problem becomes:

$$y_i = \sum_{j=1}^{g} x^*_{ij} - \sum_{j=g+1}^{n} x^*_{ij}$$

Where g is the number of attributes to be maximized, (n−g) is the number of attributes to be minimized, and y_i is the normalized assessment value of i^{th} alternative with respect to all the attributes. In some cases, it is often observed that some attributes are more important than the others. In order to give more importance to an attribute, it could be multiplied with its corresponding weight (significance coefficient) (Brauers et al. 2009)[14], When these attribute weights are taken into consideration, the equation becomes as follows:-

$$y_i = \sum_{j=1}^{g} w_j x^*_{ij} - \sum_{j=g+1}^{n} w_j x^*_{ij} \qquad \text{Where } (j = 1, 2, ..., n)$$

Where w_j is the weight of jth attribute.

Step 5: The y_i value can be positive or negative depending of the totals of its maxima (beneficial attributes) and minima (non-beneficial attributes) in the decision matrix. An ordinal ranking of y_i shows the final preference. Thus, the best alternative has the highest y_i value, while the worst alternative has the lowest y_i value.

6. Result And Discussion Of Moora Method

Table-6 score of yi

S.no.	material	y_i
1	AZ91	0.324718
2	AM60	0.35705
3	AM50	0.352999
4	AZ31	0.412215
5	ZE41	0.309054
6	EZ33	0.275483
7	ZE63	0.373541
8	ZC63	0.328537

Table 7:- Performance score and ranking by MOORA Method

S.no.	Materials	Score	Rank of selected material
1	AZ91	0.324718	6
2	AM60	0.35705	3
3	AM50	0.352999	4
4	AZ31	0.412215	1
5	ZE41	0.309054	7
6	EZ33	0.275483	8
7	ZE63	0.373541	2
8	ZC63	0.328537	5

Table 7 shows the rank of selected material by MOORA Method, which show the highest value of material i.e.AZ31.

7. CONCEPT of COPRAS

Step 1. Normalized decision-making matrix D is constructed**.**

For normalization in COPRAS method the following formula is used:-

$$\overline{x_{ij}} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}$$

Where x_{ij} is the performance of the i^{th} alternative with respect to the j^{th} criterion $\tilde{x}_{ij}$ is its normalized value and m number of alternatives.

Step2. The sums of weighed normalized criteria describing the i^{th} alternative are calculated.

In COPRAS method, each alternative is described with its sums of maximizing attributes S_{+i}, i.e. optimization path is maximization, and minimizing criteria S_{-i}, i.e. optimization path is minimization. In order to shorten calculation of S_{+i} and S_{-i} in the decision-making matrix columns, first of all, are positioned maximizing criteria and then minimizing criteria. In such cases, S_{+i} and S_{-i} is calculated as follows

$$S_{+i} = \sum_{j=1}^{k} \overline{x_{ij}}.q_{j},$$

$$S_{+i} = \sum_{j=1}^{k} \overline{x_{ij}}.q_{j}.$$

In above formulas and, k is a number of maximizing criteria; n is the total number of criteria, and q_j is the significance of the j^{th} criterion.

Step 3. Calculation of the relative weight of each alternative. The relative weight Q_i of i^{th} alternative is calculated as follows:

$$Q_i = S_{+i} + \frac{\sum_{i=1}^{m} S_{-i}}{S_{-i} \sum_{i=1}^{m} \frac{1}{S_{-i}}}$$

Step4. Determine the priority order of alternatives.

The priority order of compared alternatives is determined on the basis of their relative weight. The alternative with higher relative weight has higher priority (rank), and the alternative with the highest relative weight is the most acceptable alternative.

$$A^{*} = \left\{ A_i \middle| \max_{i} Q_i \right\}$$

8. RESULT and DISCUSSION of COPRAS METHOD

Table 8: Q values of material

S.NO.	Material	Q
1	AZ91	0.772251
2	AM60	0.862565
3	AM50	0.855366
4	AZ31	1
5	ZE41	0.73233
6	EZ33	0.650524
7	ZE63	0.891361
8	ZC63	0.77945

Table 9: Performance score and ranking by COPRAS Method

S.no.	Materi	Score	Rank of selected materia
1	AZ91	0.772251	6
2	AM60	0.862565	3
3	AM50	0.855366	4
4	AZ31	1	1
5	ZE41	0.73233	7
6	EZ33	0.650524	8
7	ZE63	0.891361	2

8	ZC63	0.77945	5

Table 9 shows the rank of selected Mg alloy. From above calculation, the first rank of the selected material is AZ31 with COPRAS Method.

9. CONCEPT of SAW (SIMPLE ADDITIVE WEIGHTED) METHOD

Steps .1- Construct a pair-wise comparison matrix (m× n) for criteria with respect to the objective.

Step .2- Construct a decision matrix (m × n) that includes m personnel and n criteria. Calculate the normalized decision matrix for positive criteria, M.J. Asgharpour (2008)[15]

$$n_{ij}=r_{ij}/r_j^{max} \quad i=1, \dots m, j=1,\dots n$$

And for negative criteria:

$$n_{ij}=r_j^{min}/r_{ij} \quad i=1, \dots m, j=1,\dots n$$

step 3- Evaluate each alternative, A_i by the following formula:

$$A_i=\sum \omega j * xij$$

x_{ij} is the score value of the i^{th} alternative with respect to j^{th} criteria, w_j is the weight criteria

10. RESULT and DISCUSSION of SAW METHOD

Table 10: Value if A_i

S.no.	Material	A_j
1	AZ91	64.701
2	AM60	62.359
3	AM50	59.829
4	AZ31	74.307
5	ZE41	61.674
6	EZ33	56.252
7	ZE63	78.713
8	ZC63	67.462

Table 11-Performance score and ranking by SAW Method

S.no.	Materials	Score	Rank of selected material
1	AZ91	64.701	4
2	AM60	62.359	5
3	AM50	59.829	7
4	AZ31	74.307	2
5	ZE41	61.674	6
6	EZ33	56.252	8
7	ZE63	78.713	1
8	ZC63	67.462	3

11. CONCEPT of ELECTRE METHOD

Step 1: Preparation of Decision Matrix

Step 2: Calculation of the normalized decision matrix. With the help of following formulae.

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \quad \text{For } i = 1,2,..m;\ j = 1,2,...n$$

Step 3: Calculate the weighted normalized decision matrix.

$$v_{ij} = w_j\, n_{ij}$$

For $i = 1,2,3...m;\ j = 1,2,....n$

Step 4: Determine the concordance and discordance sets. If the alternative is better than or equal to another element of the pair it is considered under concordance set and defined by *C*.

$$C(p,q)=\{j, v_{pj} \geq v_{qj}\}$$

If the alternative is worse than the other element of the pair for relevant criteria it is considered under discordance set and defined by *D*.

$$D(p,q)=\{j, v_{pj} < v_{qj}\}$$

Step 5: Calculate the concordance dominance matrix.

Concordance dominance matrix is the matrix generated by adding the values of weights of Concordance set elements.

$$C_{pq}=\sum_{j*} wj *$$

Step 6: Calculate the discordance matrix.

Discordance matrix is prepared by dividing discordance set members values to the total value of the whole set.

$$D_{pq}= \frac{\left(\sum_{j^c}|v_{pj}-v_{qj}|\right)}{\left(\sum_{j^c}|v_{pj}-v_{qj}|\right)}$$

Step 7: Make calculations of advantage.

Averages of concordance and discordance values are taken. In the Concordance matrix any C_{pq} value bigger than or equal to C average it is stated as yes. In the discordance matrix, any value less than or equal to D average is stated as No.

Step 8: Calculate net concordance and discordance matrix.

Net concordance and discordance values are calculated to make the ranking amongst alternatives. Not always C and D ranks give the same in this case, you may have more than one best alternative and should prepare the final rank based on this data.

$$Cp= \sum_{\substack{k=1\\k\neq p}}^{m} Cpk - \sum_{\substack{k=1\\k\neq p}}^{m} Ckp$$

$$Dp= \sum_{\substack{k=1\\k\neq p}}^{m} Dpk - \sum_{\substack{k=1\\k\neq p}}^{m} Dkp$$

12. RESULT and DISCUSSION of ELECTRE METHOD

Table 12: Aggregation of concordance and discordance matrix

	A1	A2	A3	A4	A5	A6	A7	A8
A1	0	0	1	0	1	0	0	0
A2	0	0	1	0	0	0	0	0
A3	0	0	0	0	0	0	0	0
A4	0	0	0	0	0	0	0	0
A5	0	0	0	0	0	0	0	0
A6	0	0	0	0	0	0	0	0
A7	0	1	1	1	0	0	0	0
A8	1	0	1	0	0	0	0	0

A8>A1>A7>A2>A3>A4>A5>A6

Table 13: Rank of selected material by ELECTRE Method

s.no.	Materials	Rank of selected
1	AZ91	2
2	AM60	4
3	AM50	5
4	AZ31	6
5	ZE41	7
6	EZ33	8
7	ZE63	3
8	ZC63	1

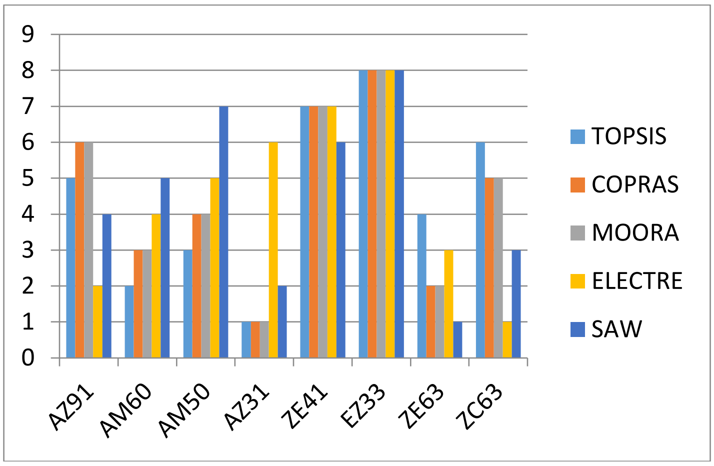
After above calculation the result is shown in Table no.13, which tell the rank of the selected material, and show the rank of the selected material, from both the discussion it is shown that, A8>A1>A7>A2>A3>A4>A5>A6. The rank of A8 is Greatest than another alternative.

13. CONCLUSION

Selection preference of each alternate based ON MCMD for Mg alloy in the automotive industry

Table 14: Ranking Structure

S.no.	Material	TOPSIS	COPRAS	MOORA	ELECTRE	SAW
1	AZ91	5	6	6	2	4
2	AM60	2	3	3	4	5
3	AM50	3	4	4	5	7
4	AZ31	1	1	1	6	2
5	ZE41	7	7	7	7	6
6	EZ33	8	8	8	8	8
7	ZE63	4	2	2	3	1
8	ZC63	6	5	5	1	3



Graph 1: Ranking structure of MCDM of a different alloy of Mg.

As per above calculation, there are Ranking of the different alloy by a different method for the selection of Mg alloy in the automotive industry. From the Table .14, it has been seen that ranking structure of various alloy by a different method is not same. But in this research work, there is a weight for all criteria and for all method is same. So contribute different ranking structure for all criteria. But in some method such as TOPSIS, COPRAS, MOORA, there is the same ranking and in this method first ranking is AZ31 which is superior and it is the best material for construction of automobile parts

This research work proposes the application of few methods for selection of Mg alloy in the automotive industry to construct the vehicle parts. After implementation of these methods give the satisfactory result and improve the productivity of automotive industry and solve the Material selection problem. And finally, it is the choice of the decision maker to go with AZ31, which is the superior and good choice of Mg alloy material for the solution of given problem.

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