

## **SELECTION OF CHAIN-MATERIAL IN AUTOMOBILE SECTOR USING MULTI ATTRIBUTE DECISION MAKING APPROACH**

Harwinder Singh  
Department of Mechanical Engineering  
Guru Nanak Dev Engineering College  
Ludhiana, Punjab-141006, India  
E-mail: harwin75@rediffmail.com

Raman Kumar  
Department of Mechanical Engineering  
Chandigarh University,  
Gharuan, Punjab-140413, India  
E-mail: ramankakkar@gmail.com

### **ABSTRACT**

The selection of material is a multi-attribute decision problem. In this research work, Analytical Hierarchy Process (AHP) has been implemented to compute subjective weight of criteria and MATLAB programming has been used to compute objective weight of criteria. An attempt has been made to rank out materials on their performance index by using subjective weights as well as objective weights. The use of MATLAB avoids lengthy mathematical calculations and it minimizes the possibility of error in statistical calculation. An example has been demonstrated to show the effectiveness of proposed methodology in selection of material. The alternatives have also been ranked and the 2nd alternate (AISI 1075) has been termed as best chain material.

Keywords: material selection, AHP, objective weight, preference index

### **1. Introduction**

In this globalization competitive scenario, two wheeler manufacturers are making lot of efforts to manufacture better mileage vehicles at low cost. The Indian two wheeler industry share in automobile industry has increased from 15% in 2001 to 25% in 2013. They are facing lot of competition from especially Chinese market. The Chinese market is dominating India market in terms of production volumes and number of manufacturers. To compete in this highly globalized world, India has to take care of designer's parameters such as functional requirements, process ability, cost reliability, resistance to service conditions give emphasis while selection of material in manufacturing industries. The wrong choice of materials may result in loss of productivity and profitability and hence reputation of a manufacturing organization. The rest of the articles are organized as follows: - Section 2 narrates the literature review. Section 3 defines the hypothesis. Section 4 describes the research methodology. Section 5 concludes the research and provides suggestions for further research.

## 2. Literature Review

Literature review reveals that various methodologies have already been used by the past researchers to provide a direction for proper material selection. The performance index of material has been computed by using objective weights. The effort was made for the evaluation of material for bicycle chain. It was suggested to use MATLAB to avoid healthy mathematical calculation [1]. A novel hybrid approach consists of induced ordered weighted averaging standardized distance and VIKOR (IOWA-VIKOR) has been purposed for material selection A case example has been discussed to validate the purposed methodology and compare the result with other methods [2]. An integrated fuzzy based frame model was developed for material handling equipment selection problem. The purposed methodology consists of two different approaches such as Fuzzy Analytic Network Process (FANP) and Fuzzy Preference Ranking Organization Method for Enrichment Evaluations (FPROMETHEE). A real industries problem of a manufacturing company was solved and a sensitivity analysis was so performed to check the sensitivity in ranking of alternates due to changes of the weights [3]. An attempt has been made to bridge the gap in material selection of Pipe material in Sugar Industry. The F-AHP was used to compute weights of attributed and TOPSIS, VIKOR, ELECTRE, PROMETHEE were used to provide ranking of alternates. A comparative analysis was done based on the result obtained from different multi attributes decision making (MADM) approach [4]. A novel MADM approach consists of both objective weights and subjective weight was introduced for material selection for design problem. The fuzzy theory was used to convert qualitative data in to crisp value. Three different examples from literature were discussed with purposed methodology and results were compared with rest of MADM approaches [5].

## 3. Hypotheses

Hypothesis 1- Selection of material for Cycle chain

Hypothesis 2- Develop a program to compute objective weights for criteria

## 4. Research Methodology

### 4.1 Implement of AHP

The AHP methodology as invented by Saaty in 1980 [6].

#### *Step 1:- Data Collection*

Five different medium carbon materials such as AISI 1050, AISI 1074, CS 1045, EN 47 and C 50 from material database have been selected for the selection of material for motorcycle chain. The six properties such as Tensile strength (TS) in MPa, Yield strength in MPa (YS), Hardness (BH) in HB, Density (D) in kg/m<sup>3</sup>, Elongation in % (E) and Young's Modulus of elasticity (YM) in GPa has been considered in the present research work. The secondary data of above mentioned parameters was collected from different sources, brainstorming etc. as shown in Table 1.

Table 1. Data of material selection

	TS	YS	BH	D	E	YM
AISI 1050	690	580	197	7850	23	208
AISI 1074	650	505	192	7800	10	202
CS 1045	91	77	163	7870	12	184
EN 47	710	415	175	7700	25	200

C 50	610	320	241	7850	14	205
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*Step 2:- Draw hierarchy diagram*

Three level hierarchy diagram (shown in figure 2) has been used to evaluate the best material. Figure 2 show that level 1 refers to the goal; level 2 composes of the six objectives.

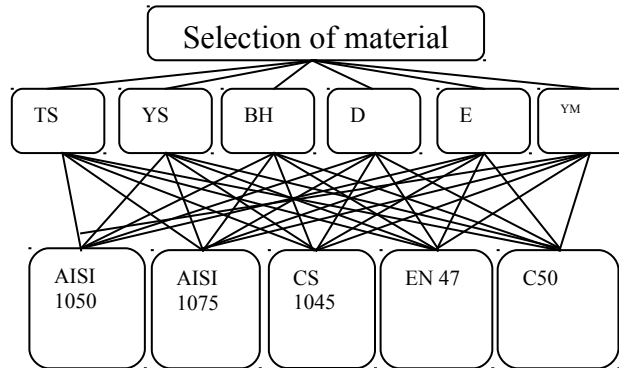


Fig. 1 Hierarchy Diagram

*Step 3:- Pair-wise comparison matrix and subjective weight (W<sup>s</sup>) of criteria*

The degree of preference or intensity of the decision maker in the choice of each pair-wise comparison used in this model is quantified on a scale of 1-9. The Pair-wise comparison matrix and priority weights are shown in Table 2.

Table 2. Pair-wise comparison matrix and priority weight

	TS	YS	BH	D	E	YM	W <sup>s</sup>	Consistency Test
TS	1	1	1	4	3	2	0.230	Maximum Eigen Value =6.37832 C.I.=0.0756643 C.R= C.I/R.I= 0.06102
YS	1	1	2	4	4	3	0.290	
BH	1	1/2	1	5	5	3	0.248	
D	1/4	1/4	1/5	1	1/4	1/2	0.046	
E	1/3	1/4	1/5	4	1	1	0.086	
YM	1/2	1/3	1/3	2	1	1	0.094	

**4.2 Compute the objective weight (W<sup>o</sup>)**

*Step 1:- Normalized Matrix*

The next step is to divide each entry in column by the sum of entries in column to get value of relative weights.

*Step 2:- Calculate the Statistical variance value*

Statistical variance is a measure of the dispersion of a set of data points around their mean value.

*Step 3:- Determine objective weights (W<sup>o</sup>).*

The MATLAB program is shown in Appendix A and simulation results of MATLAB are shown in Appendix B. The objective weights are shown in Table 3.

Table 3. Values of objective weights

Attribute	Objective weights (W <sup>o</sup> )
TS	0.3928
YS	0.3919
BH	0.0350
D	0.0001
E	0.2400
YM	0.0032

*Step 4:- Computation of preference index*

The preference index (Pi) can be calculated using the following equations and preference index value is shown in Table 4.

$$PI^O = \sum_i^n W^O X_{ij}; \quad PI^S = \sum_i^n W^S_j X_{ij}; \quad PI^{(O+S)} = \sum_i^n (W^O+W^S) X_{ij};$$

Table 4. Value of Preference Index value

Attribute	PI <sup>O</sup>		Rank	PI <sup>S</sup>		Rank	PI <sup>(O+S)</sup>		Rank
	W <sup>o</sup> =1	W <sup>s</sup> =0		W <sup>o</sup> =0	W <sup>s</sup> =1		W <sup>o</sup> =0.5	W <sup>s</sup> =0.5	
P <sub>AISI 1050</sub>	0.858		2	0.942		1	0.874		2
P <sub>AISI 1075</sub>	0.923		1	0.931		2	0.902		1
P <sub>CS 1045</sub>	0.322		5	0.444		5	0.378		5
P <sub>EN 47</sub>	0.744		3	0.828		4	0.764		3
P <sub>C50</sub>	0.717		4	0.839		3	0.759		4

## 5. Conclusion

In present study preference index of different materials have been computed to rank out the alternates. In this work, alternative AISI 1075 is placed at first position on basis of ranking of alternates. The results show that ranking order 2-1-5-3-4 obtained by objective weight and ranking order 1-2-5-4-3 is obtained by subjective weight. The obtained result creates conflict in decision making. Thus preference index has been computed by using combination of subjective and objective weights. The purposed simulated work can be implementing to any decision making problem with minor modification. For future works, it is suggested to compact MATLAB program through advanced tools. The sensitivity analysis can be performed to demonstrate the influence of different criteria weight. Further the study could be extended by using different MADM approaches such as TOPSIS, ELECTRE etc.

## References

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## APPENDIX A

```
x= [ Table 1]
s=sum(x);
i= 1:5;
    y1=x(i)/s(1);
z1 = var (y1, 1, 2);
i= 6:10;
    y2=x(i)/s(2);
    z2 = var (y2, 1, 2);
i= 11:15;
    y3=x(i)/s(3);
    z3 = var (y3, 1, 2);
i= 16:20;
    y4=x(i)/s(4);
    z4 = var (y4, 1, 2);
i= 21:25;
    y5=x(i)/s(5);
z5 = var (y5, 1, 2);
    i= 26:30;
    y6=x(i)/s(6);
z6 = var (y6, 1, 2);
z= [z1 z2 z3 z4 z5 z6 z7 z8 z9 z10 z11 z12];
s= sum (z);
o=z/s
```

## APPENDIX B

```

MATLAB 7.11.0 (R2010b)
File Edit Debug Parallel Desktop Window Help
Current Folder: C:\Users\sony
Shortcuts How to Add What's New
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
s=sum(x);
i= 1:5;
    y1=x(i)/s(1);
z1 = var (y1, 1, 2);
i= 6:10;
    y2=x(i)/s(2);
    z2 = var (y2, 1, 2);
i= 11:15;
    y3=x(i)/s(3);
    z3 = var (y3, 1, 2);
i= 16:20;
    y4=x(i)/s(4);
    z4 = var (y4, 1, 2);
i= 21:25;
    y5=x(i)/s(5);
z5 = var (y5, 1, 2);
    i= 26:30;
    y6=x(i)/s(6);
z6 = var (y6, 1, 2);
z= [z1 z2 z3 z4 z5 z6];
s= sum (z);
o=z/s
o =
    0.3298    0.3919    0.0350    0.0001    0.2400    0.0032
  
```