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Application of Analytical HIERARACHY Process in Industries

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ABSTRACT: *Analytic Hierarchy Process (AHP) is a multiple criteria decision-making(MCMD) tool that has been used in almost all the applications related with decision-making. It is used to derive ratio scales from both discrete and continuous comparison in pair wise. These comparisons may be taken from actual measurements or from a fundamental scale which reflects the relative strength of preferences and feelings. AHP being a powerful tool to make decisions which are accurate and fast in the engineering applications. In many situations, an accurate and correct decision need to be taken.*

Keywords: *AHP Analytic Hierarchy Process, Predictive Maintenance, Corrective Maintenance, Expert Choice.*

I. Introduction

With AHP technique, several aspects, which characterise each of the maintenance strategies, are arranged in a hierarchic structure and evaluated using only a series of pairwise judgements. To improve the effectiveness of the methodology AHP is coupled with a sensitivity analysis[1]. For example robot selection for a particular application in a given environment and also a robot performance in different work environment, although the method has been applied in the past new attributes and more demanding situations can be analyzed with AHP more effectively. Similarly vendor selection, selection of a person most suited for a job, resource allocation, conflict resolution, evaluation of technology, investment decision on any project, whether to apply flexible manufacturing system, layout design, automobile assembly line design, employee performance evaluation and best method of doing a job from among various alternatives can be effectively done with the help of software (Expert choice). The unique features of AHP is its flexibility to be integrated with useful and effective techniques like Linear Programming, Quality Function Deployment, Fuzzy Logic, etc.

II. Objective

The objective of present work is to make use of AHP to find easy and effective solution to what appears to be a complex set of problems. As maintenance management is taking on an important strategic role, numerous companies are expecting their maintenance to be performed effectively in order to leverage and transform the maintenance into competitive advantages. More importantly, the successful maintenance management starts with a proper maintenance system strategy produced through a robust evaluation method. However, the maintenance strategy selection is a kind of MCDM problem[2], which requires considering a large number of complex factors as multiple evaluation criteria.

III. Methodology

With the help of case studies and data survey the methodology along with software will be developed to solve the complex decision making problems in maintenance of the machine shop of steel plant to involve a number of options and constraints.

To carry out the proposed research work through data collection, maintenance history of the machines, interviews, group discussions, questionnaires, databases, seminars, conferences etc. to maintenance wing of steel plant and the analysis of data.

Take some case studies and validate them.

IV. Case Study

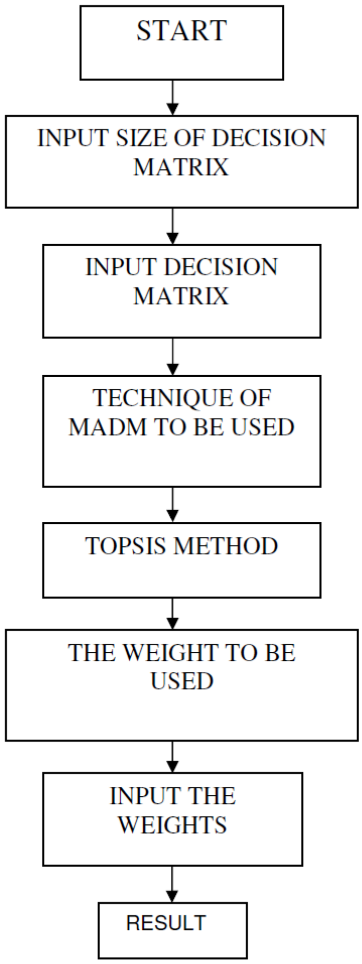
SELECTION OF ROBOT FOR WELDING OPERATION BY MULTIPLE ATTRIBUTE DECISION MAKING (MADM) APPROACH

4.1 Introduction

There has been rapid increase in the number of robot systems and robot manufacturers. Robots with vastly different capabilities and specifications are available for a wide range of applications. The selection of the robot to suit a particular application and production environment, from the large number of robots available in the market today has become a difficult task. Various considerations such as availability, management policies, production systems compatibility, and economics need to be considered before a suitable robot can be selected. The complexity of problem can be better appreciated when one realizes that there are over 75 attributes that have to be considered in the selection of robot for particular application. Moreover, many of them are conflicting in nature and have different units, which cannot be unified and compared as they are. The quantification and monitoring of the attribute magnitudes will help the manufacturer to control them closely so that he can fulfil the demand of the user precisely. Moreover, he can find out the market trend by observing the attributes magnitudes. This will help the manufacturer to modify his product to suit the future needs of the robot user. He can use the database to produce optimum robots in the minimum possible time. The robot manufacturer can also use these attributes for the SWOT (Strength–Weakness–Opportunity–Threat) analysis of his product. This identification of the attributes will help the user for the database storage and its retrieval. This will generate the computerized database, which can be used in different formats for different purposes by different people in the organization. It also will help the user to select the best possible robot for the particular application whenever it is required. The user will know exactly what are the physical characteristics and performance parameters of the robot. This will keep the user well informed about the capabilities of the robot while putting it to use.

4.2 PROCEDURE - TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) Method

Selection of ROBOT using Multiple Attribute Decision Making -We take the example of robot selection for welding operation using MADM approach. Flow chart for Multiple attribute decision making is given below-



The minimum requirement for this application is as follows Table 1:

1. Load capacity	minimum 2 kg
2. Repeatability	0.5 mm
3. Maximum tip speed	at least 255 mm/s
4. Type of drives (actuators)	electrical only
5. Memory capacity	At least 250 points/steps
6. Manipulator reach	500 mm
7. Degree of freedom	at least 5

From the database generated, after 'elimination search' we can find out manageable number of candidate robots and their pertinent attributes.

Candidate robots are listed below in Table 2: -

No.	Name of Robot
A1	ABB–IRA1400M97
A2	Kawasaki F 545 N
A3	Mitshubishi Melfa CR
A4	Yaskawa Electric Motoman
A5	Fanuc Arcmate100 I
A6	Panasonic VR 006

Pertinent attributes are listed below Table 3: -

Attribute	No.
- Reach (mm)	X1
- Max. Tip Speed (mm/sec)	X2
- Memory Capacity (Points or Steps)	X3
- Load Capacity (kg)	X4
- Repeatability (mm)	X5
- Price (Rs.)	X6

Table shows the Attributes for the short-listed candidate robots is show in table 4:-

Attribute Alternate	X1	X2	X3	X4	X5	X6
A1	1.40	1200	500	6	0.30	375000
A2	1.97	1450	3000	20	0.25	425000
A3	1.00	1000	800	5	0.08	100000
A4	0.92	850	1000	3	0.15	150000
A5	1.36	1600	2000	5	0.16	225000
A6	1.36	1740	1400	6	0.12	250000

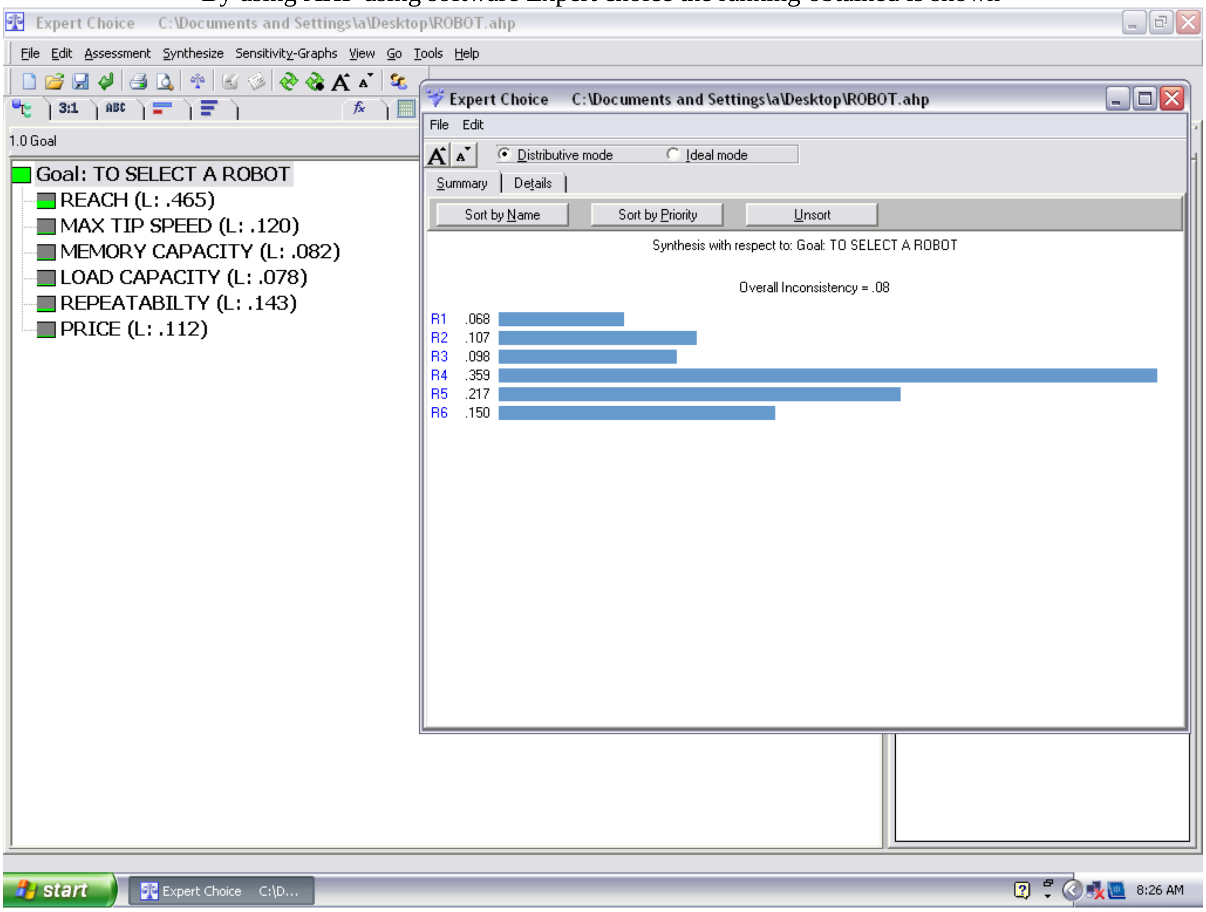
The weighted normalized matrix V is used to obtain the +ve and -ve benchmark robots, where the both benchmark robots are hypothetical robots, which supposed to have best and worst possible attribute magnitudes. Hwang and Yoon developed TOPSIS based upon the concept that the chosen option (optimum) should have the shortest distance from the +ve benchmark robot (best possible robot) and be farthest from the -ve benchmark robot (worst possible robot). The measure ensures that the top ranked robot is closest to +ve benchmark robot and farthest from -ve benchmark robot.

The ranking obtained is shown below in table 5:-

Sl. No.	Alternative Robot	TOPSIS Ranking
1	ABB–IRA1400M97	5
2	Kawasaki F 545 N	4
3	Mitshubishi Melfa CR	6
4	Yaskawa Electric Motoman	1
5	Fanuc Arcmate100 I	2
6	Panasonic VR 006	3

V. Selection of Robots by Using AHP

By using AHP using software Expert choice the ranking obtained is shown



Sl. No.	Alternative Robot	TOPSIS Ranking	Ranking by AHP
1	ABB–IRA1400M97	5	6
2	Kawasaki F 545 N	4	4
3	Mitshubishi Melfa CR	6	5
4	Yaskawa Electric Motoman	1	1
5	Fanuc Arcmate100 I	2	2
6	Panasonic VR 006	3	3

The ranking of Robots obtained is similar to paper referred.

VI. Conclusion

In this case study the raking is similar so this complex decision is solved by Analytical Hierarchy Process and is validated. So I am very much hopeful to apply this technique in making decision in different industrial applications. The AHP is an effective approach in dealing with day – to – day complex decision problems like machine shop maintenance strategy etc.

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