OPEN ACCESS

International
Journal
Of Modern Engineering Research (IJMER)

AHP as A Tool for Analyse And Decide the Maintenance Strategy of Machines of Machine Shop

Shashikant Tamrakar[1], Dr. Ajay Tiwari[2], Praveen Tandon[3]
[1](*Mechanical Engineering Department, /Dr. C.V. Raman University, INDIA)*
[2](*Principal, Rungta Engineering College / Dr. C.V. Raman University, INDIA)*
[3](*Mechanical Engineering Department, / Dr. C.V. Raman University, INDIA)*

ABSTRACT:- This paper explain the reason for selecting the right strategy of maintenance of various machines in a machine shop without much effecting the production and maximum utilization of available resources. In a machine shop of capacity 110 machines there are various types of works are assigned periodically and there is a big task to make the strategy of preventive maintenance of various types of machines such as Lathe machines, shaper machine, planner machine, drilling machines, power hacksaw machines etc., with the minimum shut down time and without much effecting the production of the house. This is purely decision making situation to fix and follow the schedule of preventive maintenance and AHP method becoming increasingly important tool in various industries in different decision making situations. To maintain the appropriate tolerances in products or machines of machine shop are periodically tested and efficiency and accuracy has to be maintained. AHP is one of the best ways for deciding the complex machine maintenance schedule.

Keywords:- Machine Shop, Strategy of Maintenance, AHP Analytic Hierarchy process, periodically test, Preventive Maintenance.

I. INTRODUCTION

AHP Analytic Hierarchy process is known that the best way to understand it is to work through an example. The example below shows how a broad range of considerations can be managed through use of the Analytic Hierarchy Process. The decision at hand requires a reasonably complex hierarchy to describe. It involves factors from the tangible and precisely measurable (purchase price, passenger capacity, cargo capacity), through the tangible but difficult to measure (maintenance costs, fuel costs, resale value) to the intangible and totally subjective (style). In the end, there is a clear decision whose development can be seen, traced, and understood by all concerned. In an AHP hierarchy for a family buying a vehicle, the goal might be to choose the best car for the Jones family. The family might decide to consider cost, safety, style, and capacity as the criteria for making their decision. They might subdivide the cost criterion into purchase price, fuel costs, maintenance costs, and resale value. To incorporate their judgments about the various elements in the hierarchy, decision makers compare the elements two by two. How they are compared will be shown later on. Right now, let's see which items are compared. Our example will begin with the four Criteria in the second row of the hierarchy, though we could begin elsewhere if we wanted to. The Criteria will be compared as to how important they are to the decision makers, with respect to the Goal.

II. OBJECTIVE

Companies and other organizations are often confronted with the decision to select the right projects for their business. The decision on selecting and implementing projects must be carefully considered. Organizations deal with many different problems and opportunities that surround them. We have to recognize the right opportunities and select the right projects. But how, what are the best criteria for selecting projects, it is not an easy decision and wrong decisions can have long-term damaging consequences. We spend a lot of money on projects that do not fulfill customers' needs and demands. The use of AHP for evaluating and selecting projects was studied earlier. Some of the approaches slightly differ, but they are all useful. AHP is based on pair wise comparisons using a ratio scale to indicate strength of preference

III. CASE STUDY

THE USE OF AHP FOR EVALUATING AND SELECTING PROJECTS

Practical use of AHP steps will be demonstrated later on a specific project. But first we will look at the specific steps of the AHP process. Each project has its purpose and its goals. They are representing customers needs and wants. There are usually several possibilities to fulfill these needs and wants. Therefore, we prepare several scenarios in the form of projects.

To evaluate and select projects we need criteria. The project customer together with project team decides what the best criteria to evaluate projects are. We have already presented potential criteria in the second chapter. The first step of the method is to develop criteria hierarchy. The highest level is the decision making goal or project purpose. Structuring project criteria means constructing hierarchy of criteria and its sub criteria. Structuring criteria into sub criteria helps manager to set priorities among projects. Criteria hierarchy reflects the structure of organizational strategy and key performance indicators and at the same time provides a possibility to select project in regard to its alignment with business goals. The first challenge when we select among may strategically important projects for our organization is to set appropriate and clear criteria. This is also the task of functional managers from marketing, finance, ICT, sales and others. When we choose criteria it is almost immediately clear that they are not equally important and that they are interrelated.

How do we assign weights to criteria is, we usually compare two criteria simultaneously and use the points between 1 and 9. The limitation of the scale is the consequence of realization that human mind can correctly sense and consider only a few elements at once. The most accurate guidelines for assessing the pairs can be found in Table I. In every pair we assign the degree of dominance of one element over another. The exceptional supremacy of one criterion over another can be assessed at 9, equality at 1. If the second criterion is more important than the first one, record the reciprocal value. Thus we obtain the values in the region from 1/9 to 9.

Table I: Details of pair wise comparison.

The Fundamental Scale for Pair wise Comparisons		
Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective.
3	Moderate importance	Experience and judgment slightly favor one element over another.
5	Strong importance	Experience and judgment strongly favor one element over another.
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice.
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation.
Intensities of 2,4,6 and 8 can be used to express intermediate values, Intensities 1.1, 1.2, 1.3 etc. can be used for elements that are very close to importance.		

We are going to evaluate four projects (based on Pinto [1]). They are all strategically important projects for organization X. They are supposed to contribute to increase organization's competitiveness on different levels. The project customers (organization's top management) had to select three criteria to evaluate project alternatives:

- A – financial benefits,
- B – contribution to organization strategy,
- C – contribution to IT infrastructure.

Financial benefits criteria focus on tangible benefits of the project and is further subdivided into long-term and short-term benefits. Contribution to strategy is an intangible factor, subdivided into three subcriteria: increasing market share for product A, retaining existing customers for product B and improving cost management.

Table II: Hierarchy of selection criteria choices.

Sr. No.	First Level	Second Level
1.	financial benefits (A)	A1: short-term A2: long-term
2.	contribution to organization strategy (B)	B1: increasing market share for product A B2: retaining existing customers for product B B3: improving cost management
3.	contribution to IT infrastructure (C)	C1

First we have to compare criteria on the first level.

Table III: Criteria weights on the first level.

	A	B	C		
A	1	3	5	1.9000	63.33%
B	1/5	1	3	0.7815	26.05%
C	1/3	1/3	1	0.3185	10.62%
	1.5333	4.3333	9.0000	3.0000	100.00%

If we look at our example, we can see that the financial benefits criterion is slightly more important than the contribution to organization strategy criterion. At the same time financial benefits criteria is much more important than contribution to IT infrastructure criterion. Contribution to organization strategy criterion is slightly more important than contribution to IT infrastructure criterion. The last column in the table presents the importance of the criteria .

Two criteria have additional sub criteria. Financial benefits criterion has two sub criteria. To assign weights to criteria in this case we do not use the AHP process. We just compare both criteria and determine their interdependence. For example, we believe that long-term financial benefits are more important than short-term financial benefits. We assign value 25 % to short-term financial benefits and 75 % to long-term financial benefits (together, of course, 100 %). Both values have to be translated on the first level with the following simple procedure:

A1 = 0.6333 (0.25) = 0.1583 = 15.83 %
A2 = 0.6333 (0.75) = 0.4749 = 47.49 %

Contribution to organization strategy criteria has three sub criteria that we have to compare. Our analysis provided the following values for all of them: increasing market share for product A – 35 %, retaining existing customers for product B – 47,78 % and improving cost management – 17,22 %. These values have to be transformed on the first level:

B1 = 0.2605 (0.35) = 0.0912 = 9.12 %
B2 = 0.2605 (0.4749) = 0.1237 = 12.37 %
B3 = 0.2605(0.1722) = 0.0448 = 4.48 %

Now we have basically six criteria to evaluate our four projects. By far is the most important criteria long-term financial benefits (47.49 %). The next step is to select qualitative dimensions and to assign numerical values to them on the scoring scale. We have decided for the following:

- poor – value 0,0;
- fair – value 0,15;
- good – value 0,35;
- very good – value 0,7;
- excellent – value 1,0.

In the last step we evaluate all four projects. We must analyze each project individually and decide what the level of fulfillment of each selected criteria is. Value “excellent” means that this project completely fulfils a specific criterion. Value “good” means that this project fulfils the criterion much less than it should.

Table IV: Evaluation of project in regard to criteria fulfillment.

		Total	**Finance**		**Strategy**			**IC**
			Short term	Long term	Market share	Customers	Costs	
			0.1583	0.4749	0.0912	0.1237	0.0448	0.1062
1	Project 1		Excellent	Excellent	V.Good	Excellent	V.Good	Excellent
2	Project 2		Good	Excellent	Good	Excellent	Good	Excellent
3	Project 3		Excellent	Good	Excellent	Good	Excellent	Good
4	Project 4		V.Good	V.Good	V.Good	V.Good	V.Good	V.Good

We must transform qualitative values from Table IV into numerical ones.

Table V: Calculation of the project total grade.

		Total	**Finance**		**Strategy**			**IC**
			Short term	Long term	Market share	Customers	Costs	
			0.1583	0.4749	0.0912	0.1237	0.0448	0.1062
1	Project 1	0.9583	1.00	1.00	0.70	1.00	0.70	1.00
2	Project 2	0.8078	0.35	1.00	0.35	1.00	0.35	1.00
3	Project 3	0.5410	1.00	0.35	1.00	0.35	1.00	0.35
4	Project 4	0.6994	0.70	0.70	0.70	0.70	0.70	0.70

The calculation of the total grade for the first project:
P1 = 0.1583(1.00) + 0.4749(1.00) + 0.09120(0.70) + 0.1237(1.00) + 0.0448(0.70) + 0.1062(1.00)
P1 = 0.9583

Total grades for the other three projects are in the Table VI. We can see that Project 1 got the highest grade. Obviously, it is the best choice for our organization. It is interesting to analyse Project 2 and Project 3. They both got the same number of values “excellent” and “good”. But the difference in the project total grade is extremely different. The reason for that is especially the fact that the Project 2 got an excellent value for the most dominant criteria – long-term financial benefits.

IV. CONCLUSION

The AHP process is now a days used in various decision-making situations. We have decided to present its use for evaluating and selecting projects. AHP have improve the process of developing project proposals. Its biggest strength is systematic approach in several steps and its ability to lower subjectivity of managers who have to decide between project alternatives. It also allows more powerful members of the organization to cheer for their own projects and hinder the open selection process. The process itself can be quite difficult to understand, it also requires some mathematical effort. Therefore, we have developed a simple to use software application that can help managers when evaluating project proposals. This paper explains the reason for selecting the right strategy for the selection of projects and got increase in their value. So AHP can be used in maintenance of various machines in a machine shop without much effecting the production and maximum utilization of available resources.

REFERENCES

[1]. Thomas L. Saaty, Decision making with the analytic hierarchy process , Int. J. Services Science, vol. 1, No. 1(2008), 83-98 , Inderscience Enterprises Ltd.

[2]. J. Pinto, Project Management: achieving competitive advantage, Pearson Education, UK. (2007)

[3]. Jiaqin Yang and Ping Shi, Applying Analytic Hierarchy Process in Firm's Overall Performance Evaluation, International Journal Of Business, 7(1), (2002) Issn:1083-4346

[4]. Maggie C.Y. Tama, V.M. Rao Tummalab, An application of the AHP in vendor selection of a telecommunications system , (2001) Elsevier Science Ltd., International Journal of Management Science Pg. 171-182.

[5]. A. P. Agalgaonkar, S. V. Kulkarni, and S. A. Khaparde, "Multi-attribute Decision Making Approach for Strategic Planning of DGs", publisher IEEE, Year 2005.

[6]. Abhishek Kumar and V.P. Agrawal, "Attribute based specification, comparison and selection of electroplating system using MADM approach", Expert Systems with Applications, Year 2009, Vol.-36, Issue 8, 10815-10827.

[7]. A.S. Milani, A. Shanian, R. Madoliat and J.A. Nemes, "The effect of normalization norms in multiple attribute decision making models: a case study in gear material selection", springer link journal article, Year 2004, vol.- 29, 312-318.

[8]. Al Khalil, M.I. , Selecting the appropriate project delivery method using AHP, International Journal of Project Managemant, Vol. 20, 469-474, Year 2002.

[9]. Melone N. P., Wharton T.J. , Strategies for MIS project selection, Journal of Systematic management, Year - 1984, Pg. 26-33.

[10]. Arbel A, Seidmann A. Selecting a microcomputer for process control and data acquisition. IIE Transactions 1984, Pg. 73-80.

[11]. Beck MP, Lin BW. Selection of automated o_ce systems: a case study. OMEGA 1981;9(2):169-76.

[12]. Zviran MA. Comprehensive methodology for computer family selection. Journal Systems Software 1993;22:17-26.

[13]. Bard JF. Evaluating space station applications of automation and robotics. IEEE Transactions on Engineering Management 1986;EM-33(2):102-11.

[14]. Liberatore MJ. A decision support approach for R& D project selection. In: Golden BL, Wasil EA, Harker PT, editors. The analytic hierarchy process applications and studies. New York: Springer, 1989. p. 13-29.

[15]. Tam CY. An application of the analytic hierarchy process in vendor selection of a telecommunications system. MSc Engineering Management dissertation, Department of Manufacturing Engineering and Engineering Management, City University of Hong Kong, Kowloon, Hong Kong, 1996.

[16]. Tummala VMR, Wan YW. Analytic hierarchy process (AHP) in practice: a survey of applications and recent developments, Journal of Mathematical Modelling and Scientific Computing 1994;3(1):1-38.

[17]. Liberatore MJ. An extension of the analytic hierarchy process for industrial R& D project selection and resource allocation. IEEE Transactions on Engineering Management 1987;EM-34(1):Pg. 12-8.

[18]. Liberatore MJ, Nydick RL, Sanchez PM. The evaluation of research papers (or how to get an academic committee to agree on something). Interfaces 1992;22(2):Pg. 92-100.

[19]. Forman EH, Saaty TL, Selly MY, Waldron R. Expert choice. McLean, VA: Decision Support Software, 1983.

[20]. Expert choice. McLean, VA: Decision Support Software, 1986.