Analytical Hierarchical Process: Fundamentals and its Application

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Abstract- This article reveals fundamentals of the Analytical hierarchical Process (AHP) and its applications in various industries including construction, telecommunication, information technology , manufacturing industries, consumer electronics engineering companies, preventive maintenance and supply chain sectors.AHP has been dealing as a multi criterion decision making tool for the decision makers who are facing much difficulties while solving complex problems quantitatively and sorting in order of various undetermined factors or sub factors concerned.

Keywords – AHP, CSFs, criterion, factors, SWOT.

I. INTRODUCTION

Decision making is the important part for any managers in a firm. An inappropriate decision by the decision makers can result in total collapse of the structure in any industries. However all the information gathered cannot be used to come to the appropriate judgment so there the need to use a decision making tool becomes very important. If the problem comprises of various factors and under each factors there are some sub-factors or sub-criterion then to solve such a complex problem Analytical hierarchical Process (AHP) has been deployed by the decision makers very often.

AHP method in its basic form as described by Saaty is described in the following steps:
Step no: 1 Define judgment criteria C_i to be used to evaluate and rank alternatives.
Step no: 2 Define the set of alternatives to be ranked.
Step no: 3 Define a pair-wise comparison of relative importance between the n criteria. This results in an n x n matrix **A** (a_{ij}) with (i,j = 1,2, …, n)

$$A = \begin{matrix} a_{11}\ a_{12}\ \ldots.\ A_{1n} \\ a_{21}\ a_{22}\ \ldots.\ A_{2n} \\ \ldots\ \ \ldots.\ \ldots.\ \ldots. \\ a_{n1}\ a_{n2}\ \ldots.\ A_{1nn} \end{matrix}$$

where aij > 0, $a_{ij} = 1/a_{ij}$, $a_{ij} = 1$ and a_{ij} is the user-defined rating of relative importance of criterion i respect criterion j. In case criteria i and j are of equal relative importance then $a_{ij} = a_{ij} = 1$.

Values of relative rankings a_{ij} can be assumed as follows:
Criteria i and j are of equal importance: 1
Criterion i is slightly more importance than criterion j: 3
Criterion i is significantly more importance than criterion j: 5

Criterion i is strongly more importance than criterion j: 7
Criterion i is extremely more importance than criterion j: 9
Obviously it is possible to utilize intermediate numerical values to give more graduality to the expressed judgments.

Step no: 4 Compute the resulting numerical weights to be assigned to the rating criteria C_1, C_2, ….. ,C_n on the basis of pair-wise comparison matrix **A.** This results in weight vector
W = $[w_1, w_2, \ldots\ldots , w_n,]^{\gamma}$
which is normalized principal eigenvector of matrix **A**. For simplicity the elements of weight vectors are computed as the average values of the rows in the normalized pair-wise comparison matrix **A**. i.e. by dividing the elements of each column in **A** by the sum of that column to normalize the column values. Then the elements in each resulting rows are added and the sum is divided by the number of the elements in the row
$w_i = 1/n \, \Sigma_j \, (a_{ij}/ \Sigma_j \, a_{ij})$
Step no: 5 The consistency of the pair-wise comparison matrix **A** is checked by computing the Consistency Index CI
$CI = (\lambda_{max} - n)/ (n-1)$
Where λ_{max} is the maximum eigenvalue
$\lambda_{max} = 1/n \times \Sigma^{n}_{1=1} \, (Aw)_I \, /w_i$
Then obtained CI value is compared to a Random Coincidence Index RI through the Consistency ratio CR = CI / RI. RI is the average value of CI one would obtain were the entities in **A** chosen at random, subject that all the diagonal entries must be equal to 1.
For instance, in case n = 2 then RI = 0, for n=6 then RI = 1.25, for n=10 then RI = 1.49, for n=15 then RI = 1.58. In case CR < 0.1 the degree of consistency is satisfactory. [1]

II. SEGMENTING CSF FOR ERP IMPLEMENTATION

CSFs were developed to resolve the risk associated with management, right software selection, failure of ERP implementation, producing improvement, changing customers demand and competitive benefit. It is very necessary to indentify which CSFs are important during implementation because preference to certain wrong CSFs will led to huge problems to the companies like over budget, long tenure as well as decrease as promised benefit during implementation stage. So there has been a need to use some multi criterion decision making techniques to evaluate, analyze or rank CSFs for ERP implementation like fuzzy AHP to determine the rank of each CSFs in order to analyze them and evaluate and selecting appropriate one during implementation phase. [2]

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IV. EVALUATION OF MOBILE SERVICES AND SUBSTANTIAL ADOPTION FACTORS

Nowadays mobile communication has led to new development into life of people. Smart phones, or tablet are becoming everyday need of the people whether it is email, web browsing, SMs , location, monitoring, voice call and every functions have been led by communications industries, but along with it comes the ever changing attitude of the customer demand. Mobile companies focuses on various factors keeping in view of the customer dynamic needs from particular locations or countries like quality, cost, added values, web services, data services, mobile communication, internet services, etc. It has been found from research that there are various factors which needs to be considered by mobile companies based on user preferences and while service adoption. AHP have been used as a decision making tool to formulate and evaluate the quantitative analysis of the factors /criterion which mobile firms need to consider while developing mobile product or services. AHP was being used to decide most preferred mobile service category and factors influencing it. [3]

V. Selecting Safety Devices of Industrial Machinery

In any industrial sector whether it is textile, pharmaceutical, mining, construction, manufacturing or agriculture site there always have been reports regarding accidents or hazards of the employee working with the machines or equipments. Sometimes the injuries for worker are so severe that it even leads to the death of the workers involved. It has found that accidents are mostly due to the suddenly, caught, stroked, crushed by equipments employed or by the negligence of the manufacturing companies. So there are need to use machines which are safer while safety can be judged with the help of safety devices.

There are many safety devices available or inbuilt with the machinery or equipments deployed. So selection of proper safety devices for machineries is of great challenge on all sellers, users, designers, and even manufacturers. Selection of safety devices also depends upon cost, quality, reliability, environmental friendly and so on. So in keeping view of all the selection problems between various factors AHP has used to select proper safety devices for the equipments used in industries of any sectors. [4]

VI. Supplier Selection based on AHP QFD Methodology

Suppliers are critical to any manufacturing industry because they are the one who shapes the high quality products or services. In reducing lead times, flexibility, cost reducing, thus helps the company's growth, reputation, and lead ahead their competitors since most of the manufacturing companies cannot own all the activities along their supply chain. Now the problem is to how to decide not only flexible but also reliable suppliers. There has been always complexity involved in choosing appropriate suppliers for the decision makers. To solve this problem AHP can be deployed by decision makers to evaluate various factors or criterion depending upon technical as well as customer requirements. [5]

VII. Analysis of IT Outsourcing Provider selection For SMEs in Taiwan

Taiwanese SMEs are in endangering of surviving due to global competitive market. Outsourcing IT/IS provider is used for Large and Medium scale Industries but for SMEs it is very difficult to choose appropriate IT/IS outsourcing provider according to the organization needs. There are various factors like Vendors, Suppliers ability to adopt ERP, quality of Outsourcing provider, reliable with time and so on. AHP have been used to sort this criteria developing evaluation model and giving decision makers right approach for selecting appropriate IT/IS outsourcing service providers for the Small and Medium sized enterprises in Taiwan. [6]

VIII. Analysis of the Turkish Consumer Electronics Firm using SWOT AHP Method

The methods of SWOT (Strength, Weakness, Opportunities and Threats) are extremely used by Turkish Consumer electronics companies. The SWOT has two parts first Strength and Weakness are the infernal factors while second Opportunities and Threats are the external factors. To produce every time innovative products which connects global markets, Turkish electronics companies used the method of SWOT and identify all the sub factors under Strength, weakness, Opportunities and Threats factors and not only evaluating but also ranking them by using AHP methodology.[7]

IX. Analysis of Human factors in Aircraft Icing Accidents

Aircraft icing accident during winter is most common in cold countries. The formation of ice on the Aerofoil body of Aircraft changes its aerodynamic properties which can be fatal for the aircrafts. So it become necessary to turn ON de-icing or anti-icing mechanism installed on the aircrafts. Nevertheless there are many reasons for the formation of icing on the aircraft body including the main reasons of to be human errors. So there is need to employed the Multi Criteria decision making tools like AHP to evaluate complex problems segregated into number of simpler problems and quantitative analysis of it thereby helping the decision makers to act accordingly to control the de-icing mechanism in the aircraft body and achieve the accident prone journey of the aircraft.[8]

X. RISK BASED MAINTENANCE POLICY SELECTION

In any industries whether it may be chemical, pharmaceutical, Textiles, Biomedical or the Manufacturing industries preventive maintenance of the equipments has been generated vigorously. For e.g.in Benzene Extraction Unit there are various factors involved in maintenance which make the t unit accident free. The selection of Maintenance Policy in the companies depends upon various factors including risk associated, costs, time, capability, and so on. The selection and ranking of the proper maintenance policy becomes crucial for the decision makers. AHP can be used to evaluate risk based selection of maintenance policy and rank them giving an optimum decision henceforth. [9]

XI. CONCLUSION

With the ever increasing competitive market, it is good to use AHP as a multi criterion decision making tools by the decision makers to solve complex problems comprising of various factors and sub factors. AHP present the problems into hierarchical way from complex to simpler way. It gives quantitative analysis of the factors giving the preference of each and every factors and sub-factors in a very simple way thereby helping the decision makers to choose proper criteria and give appropriate preferences among the given factors, sub-factors or alternatives. Since real power comes from appropriate decision making so it is important to make use of AHP techniques into various field wherever the complex problems comprising of various factors and sub-factors along with it are involved.

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