Review Paper: Optimization (MCDM) Tools Used in Selection Process

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Abstract: -Optimization is the Field of applied mathematics whose principles and methods are used to solve quantitative problems in disciplines including physics, biology, engineering, and economics. Questions of maximizing or minimizing functions arising in the various disciplines can be solved using the same mathematical tools (see maximum; minimum).In this paper the Review of Literature is done for Selection process in various fields. The various MCDM Tools used for selection process are AHP, GENETIC Algorithm, Fuzzy Logic and Fuzzy AHP and FEA. After reviewing the different papers it is found that AHP is a Simple and most effective tool for selection process. Among the various optimization methods most of the researchers used the Analytical Hierarchy Process for optimization. Also Author suggested that the AHP Tool can be used in future in any field for Optimization & selection process.

Key Words: Optimization, MCDM, AHP, FUZZY logic, Genetic Algorithm, FEA.

I. INTRODUCTION

Optimization is nothing but maximization and minimization technique. Optimization techniques are widely used in various selection processes for various applications. Optimization is the Field of applied mathematics whose principles and methods are used to solve quantitative problems in disciplines including physics, biology, engineering, and economics. Questions of maximizing or minimizing functions arising in the various disciplines can be solved using the same mathematical tools. MCDM is a Multi Criteria Decision Making tool used for various selection processes by various researchers such as Material Selection, Cricket player selection, Selection of Blends for an I.C. engine, Welding process selection and Maintenance strategy selection etc. by considering different criteria's and finally score is obtained for each alternatives and accordingly they are ranked.

Literature Review is divided in next part as Material selection, Cricket player selection, selection of Blends for an I. C. engine, Welding process selection, Maintenance strategy selection and Maintainability Evaluation. Now a day Material selection and Maintenance strategy selection are important in every field of industries due to this reason the review is done by most papers based on these two purposes.

Material selection is the process by which an optimum martial is selected considering different criteria's and attributes. Maintainability considerations and Maintenance strategy selection are important while designing a plant or system because an incorrectly maintained system or plant will leads to the failure of parts as well as increase in overall cost of the plant. Only few researchers have attempted in the field of maintenance and human error considerations of boilers.

The relevant theory and Literature review regarding Material selection, Cricket player selection, selection of Blends for an I. C. engine, Welding process selection, Maintenance strategy selection and Maintainability Evaluation are reported in next session.

II. LITERATURE REVIEW

After reviewing papers on Optimization methods the various approaches of researcher can be classified in major four parts i.e. 1) papers on material selection 2) paper on Cricket player selection 3) Paper on selection of Blends for an I. C. engine 4) optimization papers 5) paper on welding process selection 6) papers on Maintenance strategy selection and 7) paper on maintainability evaluation 8) few other paper. This is explained in the next session.

- Material selection plays an important role in Design stage because an incorrectly chosen material leads to the failure of parts and also increases the overall cost of the plant or equipment. Material selection in design is generally done by multi criteria decision making. Most of the Authors have done the work on Material selection. Most of the Authors have used AHP tool for material selection and other selection processes. An AHP is a simple decision making tool to deal with complex, unstructured and multi-attribute problems.

- Ashby [1] chart is very useful in material selection. Author first pointed out that wide range of material Properties could be collected and plotted on

same curve where two individual material variables appears on abscissa an co-ordinate.

- Sanjay. D. Yadav et.Al [2] used FUZZY logic and FEA approach to find the best Material for biogas storage cylinder. During cylinder design more focus has been given on points like low weight, low cost and material for storage cylinder. Software Analysis of designed biogas storage cylinder has also been carried out by considering different materials.

- Somnath Chattopadhyay [3] suggested the different material for the pressure vessel. Selection of materials and manufacturing processes are important activities from structural design point of view. This author has given method for the selection of material and focused on leak before burst (LBB) which is considered as significant design feature for pressure vessel and also discussed fatigue crack initiation.

- Hambali et.al [4] suggested the that there is an increased study for considering the precise decisions on the design concept (DC) and material concurrently at the early stage of development of product. Six different types of composite materials of automotive bumper beam have been considered. Both of these decisions were then verified by using analytical hierarchy process through utilizing Expert Choice software. Different criteria which can be considered are explained in this paper.

- R.Venkata Rao, [16] has used the Analytical Hierarchy Process for selection of cricket players in Indian team. The Objective is related to selection of right player among the available players. The various attributes are taken into account are Batsman, Bowler, All Rounder and Wicket keeper for the purpose of selection of different variables i.e. cricket players. They have considered six players as a alternatives and the players are ranked according to scores obtained by considering four attributes.

- KambleA.G [17] has used the AHP tool for selection of cutting fluid in case of machining operation. The objective is to select optimum cutting fluid among the available cutting fluids. The different attributes used are wheel wear, Tangential force, Grinding temperature and surface roughness. The cutting fluids are ranked according to final scores obtained for each cutting fluid by considering the four attributes.

- A.G. Kamble, et. alhas used the Analytical Hierarchy Process for for the selection of welding mechanisms in case of ship building industry.

- M. JavedHyder, M. Asif [12] has optimized the location and size of opening in a pressure vessel cylinder using ANSYS. Optimization of hole size is carried out by making holes having different diameter. Von Misses stress is observed for different diameters. Location and size of the hole depends upon the size of cylinder.

- R. C. Carbonari [13] discussed shape optimization of axisymmetric pressure vessels. Author considered an integrated approach in which the entire pressure vessel model is used in conjunction with a multi-objective function that aims to minimize the Von-Mises mechanical stress from nozzle to head.

- M. Walker, P.Y. Tabakov[14] suggested the design by considering the manufacturing uncertainty accounted while manufacturing. Author proposed and demonstrated in-depth analysis of the problem and then a new technique for determining the optimal design of engineering structure by considering the manufacturing tolerances. Author uses genetic algorithm and implemented in the technique.

- Yasin Kisioglu [15] studied the effect of weld zone properties on the bursting. Influence of weld zone property is very important from burst pressure and burst location point of view

III. LITERATURE ANALYSIS

For selection of a maintenance strategy selection there are many methodology to be used are AHP, FUZZY Logic, Genetic algorithm, FUZZY-AHP and FEA approach. Many of the researchers used different methodologies; few of them are described in next session.

- Ling Wang, Jian Chu, Jun Wu [5] have used the FUZZY Analytical Hierarchy Process for the evaluation of maintenance strategies such as Preventive maintenance, time based Preventive maintenance, Predictive maintenance and condition based maintenance. According to research of authors an optimum maintenance strategy mix can improve the availability reliability levels of plant equipment & unnecessary cost involved in the maintenance.

- M. Bevilacquaa, M. Bragliab [6] have used the AHP tool for maintenance strategy selection in case of Italian oil refinery plant. The five alternatives considered for maintenance strategy selection are preventive maintenance, predictive maintenance, condition based, corrective maintenance and opportunistic maintenance. According to the authors conclusion this plant will have about 200 facilities (pumps, compressors, air-coolers, etc.) and the management must decide on the maintenance approach for the different machines.

- Massimo Bertolini, Maurizio Bevilacqua [7] have presented the 'Lexicographic' Goal Programming (LGP) approach in order to define the best strategies for the maintenance of critical centrifugal pumps in an oil refinery. This paper represents a new contribution in the field of Decision Support System (DSS) tool for maintenance policies selection problem. Authors have used the AHP method for the evaluation of the classic parameters occurrence (O), severity (S) and detect ability (D).

- B S Gandhare and MM Akarte [8] have reviewed various maintenance strategies and work by

different researcher in the field of maintenance strategy selection.

A. Coulibaly et al [9] explored for maintainability and safety prediction at early stage of design. Author consider maintenance and safety as functional aspect and not as contrain. The assessment procedure uses the product CAD 3D model and an associated semantic matrix gathering information on the product components criticality and reliability and used movement transfer mechanism as case study. Author has suggested to use MCDM as future work.

- M.F.Wani et al [10] Maintainability of mechanical systems based on tribology is suggested and evaluated, used permanent of the matrix and method useful for enhancing maintainability and useful to compare various design alternatives. This author consider different bearing designs.
- Ranko Vujosevic [11] Maintainability should be considered at early stage of design to reduce total life cycle cost and concurrent approach is used in CAD environment. This author uses rear left suspension assembly of army vehicle as case study. One can reduce maintenance cost, time and human errors considering this approach in design.

After extensive review of papers following classification of paper is done and marked as per their work. These are listed in next table.

TABLE I

Author & Paper No.	Material Selection	Maintenance Strategy Selection	Maintainability Evaluation	Optimization	Cricket Player Selection	Selection of cutting fluid
Ashby (1)	√					
Sanjay.D.Yadav et. Al [2]	√					
S Chattopdhyay [3]	√					
A. Hambali et.al [4]	√					
Ling Wang et. Al [5]		√				
M. Bevilacquaa et. Al [6]		√				
Massimo Bertoliniet.Al [7]		√				
B S Gandhare [8]		√				
A. Coulibaly et al [9]			√			
M.F.Wani et al [10]			√			
RankoVujosevic [11]			√			
M. JavedHyder, M. Asif [12]				√		
R.C. Carbonari [13]				√		
M. Walker, P.Y. Tabakov [14]				√		
YasinKisioglu [15]				√		
R.VenkataRao [16]					√	
A.G. Kamble, et.al [17]						√

IV. OBSERVATIONS AND RECOMMENDATIONS

TABLE II

Author	Method Used (Tool Used)	Area where used	No. of criteria/ Alternatives	Remark
Ashby (2005)	Ashby chart	-	-	Ashby chart is very useful in material selection.
Sanjay.D.Yadav et.Al [2013]	FUZZY logic and FEA approach	Biogas storage cylinder.	1.Low weight 2.Low cost	Software Analysis of designed biogas storage cylinder has been carried out by considering different materials.
Somnath Chattopadhyay [2008]	-	Pressure vessel	leak before burst (LBB)	This author has given method for the selection of material and focused on leak before burst (LBB) which is

				considered as significant design feature for pressure vessel and also discussed fatigue crack initiation.
Hambali et.al [2011]	AHP	Automotive Bumper Beam	Different criteria	Author suggested that there is an increased study for considering the precise decisions on the design concept (DC) and material concurrently at the early stage of development of product.
R. Venkata Rao [2012]	AHP	Cricket Player Selection	Four Criteria	The Objective is related to selection of right player among the available players.
KambleA.G	AHP	Selection of cutting fluid	wheel wear, Tangential force, Grinding temperature and surface roughness	The objective is to select optimum cutting fluid among the available cutting fluids.
Ling Wang, Jian Chu, Jun Wu [2007]	FUZZY Analytical Hierarchy	Selection of optimum maintenance strategies	Four Alternatives	According to research of authors an optimum maintenance strategy mix can improve the availability reliability levels of plant equipment & unnecessary cost involved in the maintenance.
M. Bevilacquaa, M. Bragliab [2000]	AHP	Maintenance strategy selection in case of Italian oil refinery plant.	Five Alternatives	According to the authors conclusion this plant will have about 200 facilities (pumps, compressors, air-coolers, etc.) and the management must decide on the maintenance approach for the different machines.
Massimo Bertolini, Maurizio Bevilacqua [2006]	'Lexicographic' Goal Programming (LGP) approach	Oil Refinery	-	Authors have used the AHP method for the evaluation of the classic parameters occurrence (O), severity (S) and detect ability (D).
B. S. Gandhare and M .M. Akarte [2012]	-	Maintenance strategy selection	-	-

V. CONCLUSION

1. Material Selection can be done by using Multi Criteria Decision Making Tool (MCDM).
2. Now a day's Steel and Steel alloys are used for Boiler Material. In future the alternative Materials such as Composite Materials, Powder Metallurgical net shapes and hot isostatic pressing process can be used.
3. The maintainability can be evaluated for boiler by considering critical components and different criteria's.(According to Coulbaly research).
4. AHP tool can be used in future for selection of optimum Maintenance strategy among the available Maintenance strategies for pressure vessel.
5. Pressure Vessel Design can be explored by using Design for Maintainability.

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