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ADAPTING CONCURRENT ENGINEERING APPROACH FOR DESIGN AND DEVELOPMENT OF A NEW ROTARY HYDRAULIC MOTOR FOR MARINE APPLICATION

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ABSTRACT

Nowadays industries are aiming to reduce lead time of the new product development. In this regard, they are using to adapt a lot of manufacturing methodologies like concurrent engineering, lean manufacturing and agile manufacturing in their design process. In order to select a suitable manufacturing method, in this paper an attempt has been made by using Analytical Hierarch Process (AHP) a multi criteria decision making model. The result of AHP shows that concurrent Engineering is most suitable for developing a new concept hydraulic motor for marine application. Among the various approaches of concurrent engineering, CAD based approach is used to design, develop, redesign and analyze the new hydraulic motor.

Keywords: hydraulic motor, analytical hierarch process, multi criteria decision making, concurrent Engineering, cad based approach.

1. INTRODUCTION

Analytical Hierarchy Process (AHP) is a methodology which involves a multi- criteria analysis that enables a decision maker to represent the interaction of multiple factors in complex situations. It was developed based on mathematics and human psychology by Prof. L. Saaty. It is a structured technique for helping people to deal with complex decisions. Saaty (2008) described the Analytical Hierarchy Process (AHP) as a theory of measurement through pair wise comparisons in which AHP is used to take decisions to estimate the dominance of the consumption of drinks in the USA.

Pun *et al* (2010) worked towards the development of generic self-assessment models for small and medium sized enterprises to know their performance in new product development practices. Venkataraman *et al.* 2014 made a comparative analysis using Analytical hierarchy process (AHP) and Analytical network process (ANP) for selecting lean manufacturing system. Ravanshadnia *et al.* 2010 made an attempt to develop a step by step decision making model for engineering partner selection process and also described a fuzzy analytical hierarchy process (FAHP) model which constitutes a quantitative estimation methodology which was used to select engineering partner for construction companies. Vijaya Ramnath *et al.* (2010,2011) made an attempt to select suitable assembly system for an automotive industry in India using AHP and concluded that lean kitting assembly is most suitable as compared to other systems and also suggested that kanban system can be used to implement lean manufacturing. Tseng et al [8], analysed and found that every aspect of engineering design and manufacturing capability has not been linked with customers and suppliers and proactively throughout the product development process, also found lot of lack of collaborations among them.

2. SELECTION OF SUITABLE MANUFACTURING METHOD USING AHP

According to theoretical works, a lot of benefits are associated with concurrent engineering. Some of them are intangible in nature and hence are not usually measured in the same units. Hence, in this work, a multi criteria decision making (MCDM) model AHP was used as a decision making tool to select suitable manufacturing method among concurrent engineering, lean manufacturing and agile manufacturing.

The hierarchical tree of the AHP is shown in Figure-1. The level 1 is the goal to be attained while level 2 is the criteria considered for achieving the goal and level 3 sub-criteria considered under criteria 3. Level 4 shows the alternatives A, B and C available for achieving the goal.

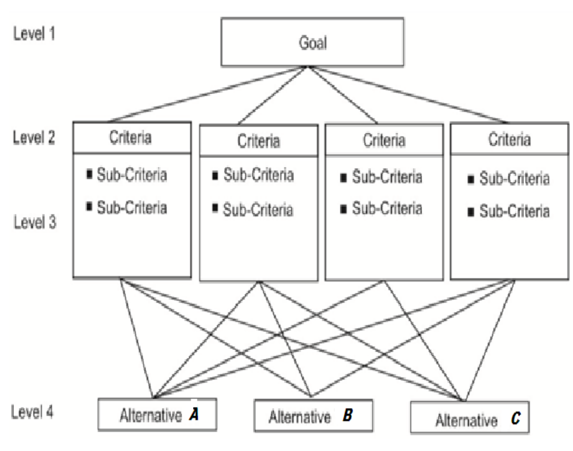

Figure-1. Hierarchical tree of the AHP.

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3. PROCEDURE OF AHP

Step-1: Setting up hierarchy
Step-2: Comparison of characteristics
Step-3: Establish priority vector
Step-4: Comparison of alternatives
Step-5: Calculate priority vector for alternatives
Step-6: Obtain the overall priority vector

a) AHP for selecting suitable manufacturing method

AHP calculation for Forging Line is shown in the following tables (Table-1 to 5).

Table-1. Factor considered: Product development time.

Reciprocal Matrix					
Choice	**Concurrent Engineering**	**Lean Manufacturing**	**Agile Manufacturing**		
Concurrent Engineering	1	4	8		
Lean Manufacturing	0.2	1	3		
Agile Manufacturing	0.14	0.33	1		
Sum	1.34	5.33	12.00		
Normalized Matrix					
				SUM	Priority Vector
Concurrent Engineering	0.746	0.750	0.667	2.163	72.11%
Lean Manufacturing	0.149	0.188	0.250	0.587	19.56%
Agile Manufacturing	0.104	0.062	0.083	0.250	8.32%
Sum	1.000	1.000	1.000	3.000	100.0%
λ_{max}			3.008		
Consistency Index (CI)			0.39%	n = 3	
Consistency Ratio (CR)			0.68%		

Table-2. Factor considered: man power skill.

Reciprocal Matrix					
Choice	**Concurrent Engineering**	**Lean Manufacturing**	**Agile Manufacturing**		
Concurrent Engineering	1	3	4		
Lean Manufacturing	0.14	1	5		
Agile Manufacturing	0.14	0.5	1		
Sum	1.28	4.50	10.00		
Normalized Matrix					
				SUM	Priority Vector
Concurrent Engineering	0.781	0.667	0.400	1.848	61.60%
Lean Manufacturing	0.109	0.222	0.500	0.832	27.72%
Agile Manufacturing	0.109	0.111	0.100	0.320	10.68%
Sum	1.000	1.000	1.000	3.000	100.0%
λ_{max}			3.104		
Consistency Index (CI)			5.21%	n = 3	
Consistency Ratio (CR)			8.98%		

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Table-3. Factor considered: Product development cost.

Reciprocal Matrix					
Choice	**Concurrent Engineering**	**Lean Manufacturing**	**Agile Manufacturing**		
Concurrent Engineering	1	3	3		
Lean Manufacturing	0.5	1	3		
Agile Manufacturing	0.17	0.5	1		
Sum	1.67	4.50	7.00		
Normalized Matrix					
				SUM	Priority Vector
Concurrent Engineering	0.599	0.667	0.429	1.694	56.47%
Lean Manufacturing	0.299	0.222	0.429	0.950	31.67%
Agile Manufacturing	0.102	0.111	0.143	0.356	11.86%
Sum	1.000	1.000	1.000	3.000	100.0%
λ_{max}			3.198		
Consistency Index (CI)			9.92%	n = 3	
Consistency Ratio (CR)			17.11%		

Table-4. Factor considered: infrastructure required.

Reciprocal Matrix					
Choice	**Concurrent Engineering**	**Lean Manufacturing**	**AGILE Manufacturing**		
Concurrent Engineering	1	4	5		
Lean Manufacturing	0.17	1	3		
Agile Manufacturing	0.14	0.5	1		
Sum	1.31	5.50	9.00		
Normalized Matrix					
				SUM	**Priority Vector**
Concurrent Engineering	0.763	0.727	0.556	2.046	68.21%
Lean Manufacturing	0.130	0.182	0.333	0.645	21.50%
Agile Manufacturing	0.107	0.091	0.111	0.309	10.30%
Sum	1.000	1.000	1.000	3.000	100.0%
λ_{max}			3.003		
Consistency Index (CI)			0.13%	n = 3	
Consistency Ratio (CR)			0.22%		

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Table-5. Priority vector of factors.

Reciprocal Matrix					
Criteria	**Product development time**	**man power skill**	**Product development cost**	**infrastructure required**	
Product development time	1	2	4	3	
man power skill	0.5	1	5	4	
Product development cost	0.2	0.2	1	2	
infrastructure required	0.33	0.25	0.5	1	
Sum	2.03	3.45	10.50	10.00	
Normalized Matrix					
					Priority Vector
Product development time	0.493	0.580	0.381	0.300	1.753
man power skill	0.246	0.290	0.476	0.400	1.412
Product development cost	0.099	0.058	0.095	0.200	0.452
infrastructure required	0.163	0.072	0.048	0.100	0.383
Sum	1.000	1.000	1.000	1.000	4.000
λ_{max}			4.2503		
Consistency Index (CI)			8.34%	n=4	
Consistency Ratio (CR)			9.27%		

Table-6. Overall priority vector (Combined output of Tables 1 to 5).

	P_a				X_f	P_o
	Product development time	**man power skill**	**Product development cost**	**infrastructure required**	**Priority Vectors of factors**	**Overall Priority vector**
Concurrent Engineering	72.11%	61.60%	56.47%	68.21%	1.753	0.66
Lean Manufacturing	19.56%	27.72%	31.67%	21.50%	1.412	0.24
Agile Manufacturing	8.32%	10.68%	11.86%	10.30%	0.452	0.10
					0.383	1.0000

Table-6 shows that the 'overall priority vector for concurrent engineering is higher' than other two methods. So, concurrent engineering is selected for doing this project.

4. RESULT AND DISCUSSION

Since the priority vector of concurrent engineering is higher with respect to all the factors from table 1 to 5, it is suggested that concurrent engineering may be selected for the design and development of a new rotary hydraulic motor for marine application.

5. CONCLUSIONS

The result of AHP shows that concurrent engineering is most suitable for developing a new concept hydraulic motor in comparison with lean and agile manufacturing.

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