Application of AHP for Lean Implementation Analysis in 6 MSMEs

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Abstract---- An attempt made to create an awareness about the benefits of lean manufacturing in some Micro, Small and Medium scale industries situated in the southern parts of India, and also to find out the extent up to which companies have implemented lean in their premises. The basic need for lean manufacturing is to help customers, by providing them quality products at the lowest cost and contribute to the better enhancement of the environment. In order to enforce the concept, AHP techniques have been selected. The AHP model was applied to find the best one in lean implementation from a group of six MSMEs. FUZZY AHP has been used to reduce uncertainty of the obtained results. From this the company which implemented lean best is ranked and suggestions were provided to improve in lean implementation.

Key words: Analytical hierarchy process (AHP), Fuzzy AHP, Lean Implementation.

I. INTRODUCTION

In order to lift the living standard of the people, which can be done by implementing lean manufacturing. Lean manufacturing is to find the waste in each process and isolate them. Waste can be removed by adequate monitoring of the employees, equipment, material and exact production of the actual work involved. Waste does not improve the value, it only increases the cost, decreasing the satisfaction of the customer. Hence the careful elimination of waste leads to foremost cost reductions. Generally, all the companies aim at give high quality products. . Producing high-quality products are primary important, therefore, first priority must be given by any manufacturing industry. All parts produced in a process must be inspected to make sure that, there are no defects [1]. In today's competitive business world, selection and evaluation of industries are one of the important activities of a company development. Studies show that decision making is a complex process involves various criteria such as cost, product quality, delivery performance, etc. These criteria may vary depending on the type of product considered and are often in conflict with one another. The objective of managing the supply chain is to coordinate the requirements of the customers with the flow of materials to strike a balance between factors seen as a conflict of goals of high customer service, low inventory and low unit cost.

There is a need to select the Industries as it reduces risk and maximizes the overall value of the product. Selection of industry is based on a series of strategic variables. While selecting industries, it should focus on the capabilities, competencies and not the resources. Selecting the best performing industry is important for the customer to pay the right amount for the product.

II. METHODOLOGY

A. Analytical Hierarchy Process:

Analytic Hierarchy Process (AHPs), was first proposed by Saaty (1980) [2]. AHP a popular multiple criteria decision-making technique [3] combining qualitative with quantitative criteria. It ranks the potential industries in a hierarchy system [4] [5]. AHP a decision making technique to find out the best criteria to attain their goal. It thus provides the best technique to reduce qualitative and quantitative complex constrains by formulating a series of one-on-one comparisons. It not only helps decision makers choose the best option, but also provides justifications for the most part.

B. Fuzzy Analytical Hierarchy Process:

In general, the method Analytic Hierarchy Process (AHP) has been used to solve multiple-criteria decision making problems [6]. However, due to inconsistency in the decision maker's solution, a crisp and pairwise comparison with a conventional AHP may be unable to capture the correct decision. Therefore, fuzzy logic is introduced into the pairwise comparison in the AHP to compensate for this in the conventional AHP.

III PROCEDURE

A. *Identification of the Performance Criterion:*

The performance of criteria's was identified by taking opinions from the industry experts. After discussing with the industry expert the factors which are finalized for the study are as follows:

1. Strong management and Leadership (SML).
2. Organizational culture (OC)
3. Determination of Goals and Objective, getting employee trust (GAO)
4. Skills and expertise (SE)
5. Financial capabilities (FC_P)
6. Communication of the transformation process and goals-Effective Communication (EC).
7. Performance measures (PM)
8. Education and training (ET).
9. Plan and strategy. (PS)
10. Thinking development (TD)
11. Customer focus (CF)

IV. ANALYTICAL HIERARCHY PROCESS

Analytical Hierarchy Process (AHP) a mathematical decision making technique that allows consideration of both qualitative and quantitative aspects of decisions. Compared to other techniques AHP uses human judgments to compare alternatives of the designated criteria or sub-criteria. It not only makes the decision makers choose the best alternatives, but also provides justifications for their choice [7].

AHP calculations can be done in three stages:

(i) Construction of the hierarchy,

(ii) Evaluation of pairwise comparison matrices,

(iii) Calculation of the relative priority weights of pairwise comparison tables.

A. *Steps for AHP*

1. Identify the goal of the problem and the criteria's that help in achieving their goal.
2. Identify the alternative solutions suggested to accomplish the goal- all levels following the criteria levels.
3. Find out the related weights for each comparison table: for instance a scale from 1 to 5 is used to compare how important a given criterion compared to another.
4. Make comparisons between each possible pair of alternatives with their rankings under each criterion-result in several square matrices for each criterion
5. Calculate the composite relative priority for each alternative and the steps were illustrated in the table mentioned below

TABLE I

Rating Scale to Compare One Criterion Over Another

Response	**Grade**
Excellent	5
Good	4
Normal	3
Satisfied	2
Unsatisfied	1

TABLE II

Linguistic Variable Weights for 6 industries for the Performance Factors Obtained from the Industry

Industries	SML	Resistance to change/ Organisational Culture	GAO	Skills and Expertise	Financial capabilities	Effective communication	Performance measure	Education and Training	Customer focus	Planning and Strategy	Thinking development
A	5	4	1	3	3	3	1	2	2	1	2
B	5	4	1	2	1	4	1	2	2	2	1
C	5	4	1	3	1	3	1	1	1	2	1
D	5	4	1	3	2	3	1	1	2	1	2
E	5	4	2	2	3	3	1	2	1	2	1
F	5	3	1	2	2	4	1	2	1	1	2

Finally the priority weights of each supplier can be calculated by weights per supplier multiplied by weights of the corresponding criterion as shown in the equation 3. The highest (best) score of the supplier gives the best global supplier for the mentioned parts.

Alternative Priority Weights Calculation,

$$P_i = \sum_{i=1}^{n} (w_i a_{ij}) for\ j = 1,2,3, \ldots, n \quad (1)$$

$$\sum P_i = 1$$

TABLE III

Priority Weights with the Ranking of each industries

Industries	Alternative Priority Weights	Rank
A	0.192	1
B	0.171	5
C	0.184	2
D	0.174	4
E	0.181	3
F	0.147	6

V. FUZZY ANALYTICAL HIERARCHY PROCESS

A. Steps for Solving Fuzzy AHP:

At First the assessment of the success factors is converted into triangular fuzzy numbers. Then the triangular fuzzy numbers are used to build the comparison matrices of AHP based on pairwise comparison technique. The important weights of the success factors and industries can be calculated by applying fuzzy AHP. Triangular fuzzy numbers (0 to 9) are used to represent subjective pairwise comparisons of success factors in order to capture unclearness (fuzziness).

1) Compare the performance score

2) Construct the importance weights of success factors

3) Construct the fuzzy comparison matrix

4) Set the fuzzy numbers of factors depending on the rankings.

5) Calculate crisp weight

6) After crisp weight calculate the normalized weight

7) Based on normalized weight will do the ranking

TABLE IV

Normalized Weights to the Performance Criteria of 6 industries

Industries	Strong management and leadership	Resistance to change /organization's culture	GAO	Skills and Expertise	Financial capabilities	Effective communication	Performance measure	Education and Training	Customer focus	Planning and Strategy	Thinking Development
A	0.1666	0.1739	0.142	0.3125	0.2500	0.1500	0.1660	0.2000	0.2222	0.1111	0.2222
B	0.1666	0.1739	0.142	0.2080	0.0833	0.2000	0.1666	0.2000	0.2222	0.2222	0.1111
C	0.1666	0.1739	0.142	0.3125	0.0833	0.1500	0.1666	0.1000	0.1111	0.2222	0.2222
D	0.1666	0.1739	0.142	0.3125	0.1666	0.1500	0.1666	0.1000	0.2222	0.1111	0.2222
E	0.1666	0.1739	0.285	0.2080	0.2500	0.1500	0.1666	0.2000	0.1111	0.2222	0.1111
F	0.1666	0.1304	0.142	0.2080	0.1666	0.2000	0.1666	0.2000	0.1111	0.1111	0.1111

TABLE V

Crisp and Normalized Weights of industries by Fuzzy AHP with their Ranks

Industries	Crisp Weights	Normalized Weights	Rank
A	204.67	1.00	1
B	171.67	0.83	3
C	144.67	0.70	6
D	176.67	0.87	4
E	186.67	0.91	2
F	162.67	0.79	5

TABLE VI

Comparison of Normalized Weights of AHP and Fuzzy AHP

Industries	AHP	FUZZY AHP
A	1.00	1.00
B	0.89	0.83
C	0.96	0.70
D	0.91	0.87
E	0.94	0.91
F	0.77	0.79

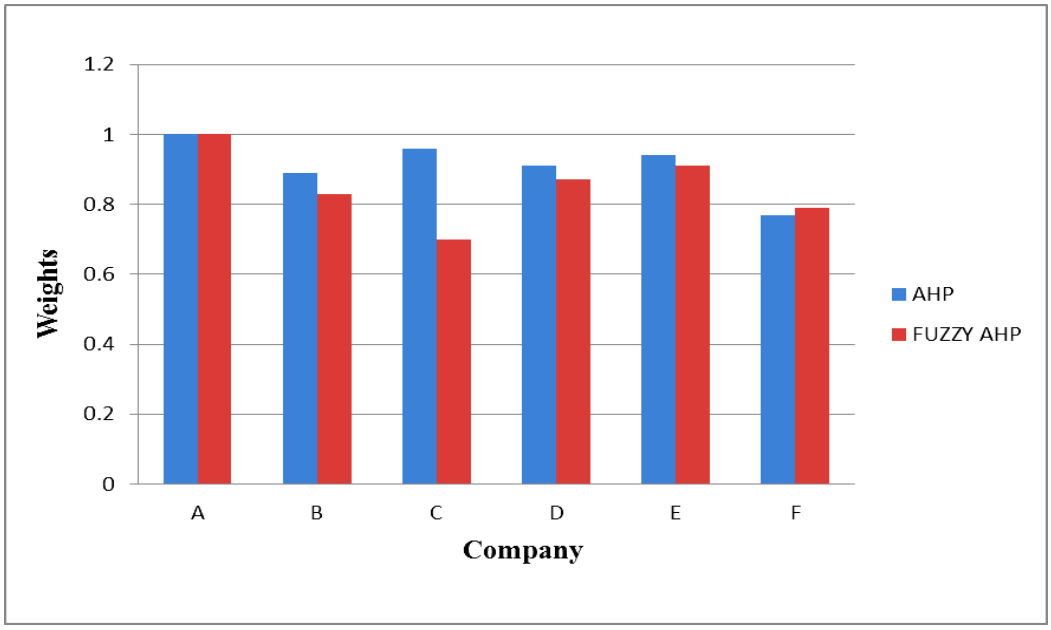

Fig 1: Comparison of weights of AHP and Fuzzy AHP

VI RESULTS AND DISCUSSIONS

The spurs behind Lean Manufacturing to provide superior quality at low cost assuring a better customer satisfaction. The selection of performance factors plays an important role for the customers in many small scale industries. This adaptation needs people to use the best techniques like AHP to contribute. Thus the outcome obtained from these techniques give us to be more practical. This needs the deployment AHP techniques. This is more realistic because of the interaction of criteria with industry experts. AHP proves to be significant with the inclusion of non-quantifiable factors such as social, political factors besides some economic factors. Thus Fuzzy AHP too provides a useful decision making for mitigating environmental, social factors. A comparison is made between AHP and Fuzzy AHP with their weights and rankings to reduce the uncertainty. Some of the results are such as, Company A does not provide any uncertainty, whereas Company C provides a significant change in the weights affecting their rankings. Company A and Company F has the highest and lowest priority weights which are shown in Fig. 1.

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