Application of AHP in the Analysis of Flexible Manufacturing System

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Abstract—In recent years, the area of manufacturing has become more intensive and competitive. Now-a-days all the service fields are attempting to find ways to improve their flexibility by changing their manufacturing strategy. The main aim of Flexible Manufacturing is to adopt effective and efficient strategies to fulfill the demands of consumers. In this highly competitive global market the industries are forced to focus more on increasing productivity and quality coupled with decreasing cost by right selection of efficient manufacturing system. Present study highlights a logical procedure to select the effective flexible manufacturing process in terms of various aspects as quality improvement, faster delivery, profitability, etc. by using Analytical Hierarchy Process (AHP) method. The AHP is used in flexible manufacturing as a potential decision making tool. The primary requirement of AHP is to make a matrix of the variables for their paired comparison. There are a lot of AHP processes, but here only the two of them i.e. Additive Normalization Method and Geometric Mean Method are being used by analyzing the flexible manufacturing with respect to micro and macro variables.

Index Terms—flexible manufacturing systems (FMS), AHP, multi-criteria decision making, additive normalization process, geometric mean process, advanced manufacturing technologies.

I. INTRODUCTION

Flexible manufacturing is considered as a cost effective process that can be used to perform repetitious, difficult and unsafe manufacturing tasks with high degree of accuracy. Selection of proper manufacturing process is one of the critical issues for achieving high competitiveness in the global market. The main advantages of analysis of a proper manufacturing process lie not only in increased production and delivery, but also in improved product quality, increased product flexibility and enhanced overall productivity. In this paper authors analyze the flexible manufacturing for applying the concept of AHP method [1]. According to the flexible manufacturing processes, customer’s utmost satisfaction has become the main objective of various industries & organizations that have to adopt effective and efficient strategies to fulfill the demands of the customers. Flexible manufacturing is considered as a strategic approach to achieve the ultimate objective i.e. customer satisfaction.

It is essential for an organization to carry out various manufacturing processes in a smooth and efficient manner, to fulfill customer demands timely and accurately [2]. Advanced information technology and improved information infrastructures have made it possible for smooth and result centric implementation of flexible manufacturing systems. Decision-making techniques are very useful for study of flexible manufacturing. In order to maintain a competitive position in the national & global markets, organizations have to follow strategies to achieve shorter lead times, reduced costs and higher quality. Therefore flexible manufacturing analysis plays a key role in achieving corporate competitiveness and as a result of this the consideration of the right manufacturing process that constitutes critical component of these new strategies is possible. In these new strategies, authors are using the AHP method. The AHP is a decision- aiding method developed by Saaty (1980) and is often referred to eponymously as the Saaty method [3]-[6]. It focuses on quantifying relative Eigen values for a given set of alternatives on a ratio scale. The analytical hierarchy process as a potential decision making method is used in flexible manufacturing. The AHP is decided with the behavior of decision-maker. The strength of this approach lies in consideration of tangible and intangible factors in a systematic way and provides a structured yet relatively simple solution to the decision making problem [7] for any industry. The objective of this paper is to integrate application of AHP in the flexible manufacturing analysis. The paper briefly reviews the concepts and application of the multiple criterion decision analysis. This paper also presents a logical and systematic procedure to evaluate the basic concepts of flexible manufacturing processes in terms of system specifications and cost by using the techniques for order preference in similarity to ideal AHP method. The primary need of AHP is to construct a matrix of the variables for their pair-wise comparison, and then the priority weights for different criteria are determined using AHP method which is subsequently used for arriving at the best decision regarding analysis of the proper flexible manufacturing processes using AHP method [8].

II. FLEXIBLE MANUFACTURING SYSTEMS (FMS)

In around 1920’s many product oriented department produced the standard product in many machine
manufacturing companies to reduce the transportation time and efforts. Thus it can be observed as the beginning of the group technology/ flexible manufacturing age [9]. Group technology / flexible manufacturing are a theory of management that is based on the principles and the things in flexible manufacturing may be done according to these principles. In the present discussion of group technology the context “things” include design of product, planning, process, fabrication, assembly, and control of production. Generally the group technology/ flexible manufacturing should be applied to all activities inclusive of the administrative functions. The group technology/ flexible manufacturing term in flexible manufacturing may be done according to these factors. Flow line of flexible manufacturing has a mixed configuration of group are taken as most appropriate group of machines or any commodity (normally not more than five). In flexible manufacturing, medium variety, medium volume, flexible environments and functional configuration of group are taken as most appropriate factors. Flow line of flexible manufacturing has a mixed product assembly line system. Flexible manufacturing has the basic idea about the manufacturing technique as clustering the products that are made with the same processes/ the same equipment and parts are assembled into a part family zone. These products can be grouped into a cell and hence the material handling requirements are minimized.

III. THE ANALYTICAL HIERARCHY PROCESS (AHP)

The Analytic Hierarchy Process (AHP) was evolved by Saaty and is often referred to eponymously, as the Saaty method. In the past research [10] compared AHP and a simple multi- attribute value (MAV), as two of the multiple-criteria approaches. A number of criticisms have erupted at AHP over the years. The approach in order to elicit the weights of the criteria by means of a ratio scale. Saaty developed the following steps for applying the AHP.

**Step 1:** Specify the problem and evaluate its goal.

**Step 2:** Lay down the hierarchy from the top (the objective from a decision- makers view point) through the mid levels (criteria on which subsequent levels depend) to the lowest level which usually accommodate the set of options.

**Step 3:** Evolve a set of paired comparison of matrices (size ‘n x n’) for each of the bottom levels with one matrix for every constituent in the level promptly above by adopting the comparative scale measurement shown in Table I. The paired comparisons are done in terms of which constituent influences the other.

**Step 4:** There are ‘m / (m-1)” judgment needed to construct the set of matrix in step 3. Complementary are automatically allocate in every paired comparison.

**Step 5:** Hierarchical incorporate is now utilized to weigh the Eigen vectors by the weights of the standard and the summation is taken overall weighted Eigen vector ingress correlating to those in the next bottom level of the hierarchy.

The weightages of the features are obtained by calculating the Eigen vectors weights for the judgment matrix. The yields normalization matrix Aw. Eigen vector ‘c’ is initiate out by splitting the summation of all the ingresses in rows ‘i’ with ‘m’ no. of constituents of normalization matrix. After computing Aw and c, then calculate the AC as given below in the following forms.

Here, C = Eigen vector, J=column, Aw= Yield normalized matrix, I =Row = Number of elements of normalized matrix

\[
Aw = \begin{bmatrix}
\sum a_{i1} & \sum a_{i2} & \cdots & \sum a_{im} \\
\vdots & \vdots & \ddots & \vdots \\
\sum a_{m1} & \sum a_{m2} & \cdots & \sum a_{mm}
\end{bmatrix}
\]

(1)

**TABLE I: PAIRED COMPARISON OF SCALE FOR AHP PREFERENCE**

<table>
<thead>
<tr>
<th>Intensity of importance</th>
<th>Definition</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Especially preferred</td>
<td>The conformation advising one over the other is of excessive possible validity</td>
</tr>
<tr>
<td>8</td>
<td>Very strongly to especially</td>
<td>When agreement is needed</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly preferred</td>
<td>Experience and judgment very strongly favor one over the other. Its importance is demonstrated in practice</td>
</tr>
<tr>
<td>6</td>
<td>Very strongly</td>
<td>When agreement is needed</td>
</tr>
<tr>
<td>5</td>
<td>Strongly preferred</td>
<td>Experience and judgment strongly favor one over the other</td>
</tr>
<tr>
<td>4</td>
<td>Moderately to strongly</td>
<td>When agreement is needed</td>
</tr>
<tr>
<td>3</td>
<td>Moderately preferred</td>
<td>Experience and judgment slightly favor one over the other</td>
</tr>
<tr>
<td>2</td>
<td>Equally to moderately</td>
<td>When agreement is needed</td>
</tr>
<tr>
<td>1</td>
<td>Equally preferred</td>
<td>Two factors contribute equally to the objective</td>
</tr>
</tbody>
</table>

Eigen vector can be calculated as per the procedure shown in the given matrix

\[
c = \begin{bmatrix}
c_1 \\
c_2 \\
\vdots \\
c_m
\end{bmatrix}
\]

(2)

\[
a = \begin{bmatrix}
a_{11} & a_{12} & \cdots & a_{1m} \\
a_{21} & a_{22} & \cdots & a_{2m} \\
\vdots & \vdots & \ddots & \vdots \\
a_{m1} & a_{m2} & \cdots & a_{mm}
\end{bmatrix}
\]

Step 6: In this step authors assemble the pair-wise comparisons and then the consistency is resolved by applying the Eigen value \( \lambda_{max} \).

\[
Ac = \begin{bmatrix}
a_{11} & a_{12} & \cdots & a_{1m} \\
a_{21} & a_{22} & \cdots & a_{2m} \\
\vdots & \vdots & \ddots & \vdots \\
a_{m1} & a_{m2} & \cdots & a_{mm}
\end{bmatrix}
\begin{bmatrix}
c_1 \\
c_2 \\
\vdots \\
c_m
\end{bmatrix} = \lambda_{max}
\]

(3)
Now, consistency index (CI) is determined as follows

\[
CI = \left( \frac{\lambda_{\text{max}} - m}{m - 1} \right)
\]  

(4)

where \( m \) = Size of matrix

\[
\lambda_{\text{max}} = \frac{1}{m} \sum_{i=1}^{m} AC_{i}
\]

(5)

\[
\lambda_{\text{max}} = \frac{1}{m} \sum_{i=1}^{m} X_i
\]

Consistency of Judgment can be evaluated by processing the consistency ratio (CR) of consistency index (CI) with the proper value as given in Table II.

By determining proper value of random consistency index (RCI), for a matrix size using Table II, author finds RCI and computes the consistency ratio, CR, as shown.

\[
CR = \frac{CI}{RCI}
\]

(6)

The CR is adequate, if the value of consistency ratio is more than 10% or 0.10, the given judgment matrix is unacceptable and inconsistent and if it is less, then judgment matrix is consistent and acceptable.

**Step 7:** Steps 3-6 are accomplish for each of elevation in the hierarchy.

### TABLE II: RANDOM CONSISTENCY INDEX (RCI)

<table>
<thead>
<tr>
<th>Size of Matrix</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random consistency index</td>
<td>0</td>
<td>0</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
</tr>
</tbody>
</table>

### IV. MULTI-CRITERIA DECISION ANALYSIS (MCDA)

The elements of the problems are numerous and the interrelationships among the elements are extremely complicated. Relationship between elements of a problem may be highly nonlinear and changes in the elements may not be related by simple proportionality. Therefore the human value and judgment system are integral elements of flexible manufacturing problems [11]. Therefore the ability to make sound decisions is very important to the success of a process for manufacturing analysis. Multiple-criteria decision making (MCDM) approaches are major parts of decision theory and analysis. Author seeks to take explicit account of more than one criterion in supporting the decision process. The aim of MCDM methods is to help decision-makers to learn about the problems that they face, to learn about their own and other parties personal value systems, to learn about organizational values & objectives and exploring these in the context of the problem to guide them in identifying a preferred course of action[12]-[16].

### V. RESULT AND DISCUSSION

**Case study:** Here the analysis is done to evaluate the best flexible manufacturing process in terms of specifications and cost at the operational level. Selecting and analyzing the best flexible manufacturing processes on the basis of performance and efficiency, we select the most appropriate manufacturing process as per the author’s expectations. The evaluation of effective flexible manufacturing processes is based on the AHP method. It aims in identifying a homogenous set of good systems by critically analyzing each manufacturing process. The use of AHP method is to discriminate between the various flexible manufacturing processes. These good systems can be further evaluated for the selection of the best manufacturing processes amongst them in the decision-making process. The main input and output measures for assessing the manufacturing process that is considered to be effective and have better technical specifications. The technical features (output) on which the performance of a manufacturing system depends are Quality Improvement, Faster Delivery, Satisfaction of customer, Product Variety, Labor Cost, Production Time, Machine Utilization, Profitability, and therefore to simplify calculations, these factors are used in flexible manufacturing processes analysis. On the basis of goal, criteria, and manufacturing, authors are arranged manufacturing processes according to the criteria that are taking in the manufacturing processes analysis. The hierarchies of manufacturing processes are doing by selecting and analyzing the best manufacturing processes on the basis of their manufacturing performance. The arrangement that is discussed in this case study is discussed below.

The hierarchy is sequenced manually or automatically by the AHP software, and as per the expert choice.

**Step-1:** Arranging the pair-wise comparison and then computing the Eigen vector for a criterion such as Quality Improvement.

**Step-2:** Calculating the Consistency ratio (CR), \( \lambda_{\text{max}} \) and Consistency index (CI).

**Step-3:** choosing proper value of the random consistency index (RCI).

**Step-4:** Scanning the consistency of the paired comparison matrix to evaluate the decision-makers comparisons were consistent or not.

**A. Additive Normalization Method (ANM)**

Additive normalization method is very popular because of the simple procedure of this method and also it is very easy to understand. This method is also widely used due to its simplicity. Each constituents of matrix is normalized by dividing every element in a column by the summation of the constituents lie in the same column to create the normalized paired comparison matrix. The Eigen vector ‘C’ is obtained by dividing the total summation of the constituents in each row of matrix by the number of the matrix size. The additive normalization method has three basic steps of procedure in order to obtain the priorities or the Eigen vector. The steps for this method are as given below:

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Step 1: Add the values of each constituent in each column of the matrix.

Step 2: Split or divide every constituent in a column of matrix paired comparison matrix by the total summation of the given column (values obtained in step 1). The obtained normalized matrix is generated at the end of this step.

Step 3: Calculate the average of all the constituents in every row of the matrix to attain the Eigen vector C.

B. Geometric Mean Method (GM)

This method is one of the methods implement in deriving estimates of ratio-scales from positive reciprocal matrix and this also evaluated by Saaty. This method is also known by another name as logarithmic least squares method or approximate Eigen vector method. The Eigen vector is the normalized vector obtained after process is completed. The steps for this given method are as follow:

Step 1: Multiply every constituent in each row and then power of 1/n.

Step 2: Summation of all the values obtained in i.

Step 3: Divide the value of every row obtained by the total summation of the values in order to obtain the Eigen vector c.

Now, the step first is considered for carrying out the work is to decide the determinants on the basis of the considered layout that has to be analyzed with the help of findings through the research conducted. The determinants that are considered during the deciding the effective and efficient layout are:


Firstly authors determine the matrix that should be made for paired comparison with the given appropriate variables and then values should be entered on the basis of findings for flexible manufacturing layout as follows in Table III:

<table>
<thead>
<tr>
<th>Variable</th>
<th>QI</th>
<th>FD</th>
<th>SOC</th>
<th>PV</th>
<th>LC</th>
<th>PT</th>
<th>MU</th>
<th>PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>QI</td>
<td>1</td>
<td>1/3</td>
<td>1/5</td>
<td>1/2</td>
<td>1/3</td>
<td>2</td>
<td>1/3</td>
<td>1/3</td>
</tr>
<tr>
<td>FD</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1/2</td>
<td>1/3</td>
<td>3</td>
<td>1</td>
<td>1/3</td>
</tr>
<tr>
<td>SOC</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PV</td>
<td>2</td>
<td>1/2</td>
<td>1/3</td>
<td>1</td>
<td>1/3</td>
<td>2</td>
<td>1/3</td>
<td>1/3</td>
</tr>
<tr>
<td>LC</td>
<td>3</td>
<td>3</td>
<td>1/2</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>PT</td>
<td>1/2</td>
<td>1/3</td>
<td>1/3</td>
<td>1/2</td>
<td>1/3</td>
<td>1</td>
<td>1/3</td>
<td>1/2</td>
</tr>
<tr>
<td>MU</td>
<td>3</td>
<td>1/3</td>
<td>1</td>
<td>1/4</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PA</td>
<td>3</td>
<td>1/3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>1/3</td>
<td>1</td>
</tr>
</tbody>
</table>

After preparing the matrix authors will convert this matrix into standard matrix, therefore the calculation required by the additive normalization method implement in AHP can be done in very simple and easy manner. Therefore the standard matrix find for the flexible manufacturing layout as shown in Table IV.

Now, after finding the standard matrix, the three steps are to be obtained and then the Eigen vectors according to the additive normalization method and then authors also provide the rank to all variables considered according to the flexible manufacturing layout. The performed steps are as follows:

Step-1: Add the values of each constituent in each column of the matrix.

### Table IV: Standard Matrix for Flexible Manufacturing Layout

<table>
<thead>
<tr>
<th>Variables</th>
<th>QI</th>
<th>FD</th>
<th>SOC</th>
<th>PV</th>
<th>LC</th>
<th>PT</th>
<th>MU</th>
<th>PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>QI</td>
<td>0.3334</td>
<td>0.2</td>
<td>0.5</td>
<td>0.334</td>
<td>2</td>
<td>0.334</td>
<td>0.334</td>
<td></td>
</tr>
<tr>
<td>FD</td>
<td>3</td>
<td>1</td>
<td>0.334</td>
<td>2</td>
<td>0.334</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>SOC</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>PV</td>
<td>2</td>
<td>0.5</td>
<td>0.334</td>
<td>1</td>
<td>0.334</td>
<td>3</td>
<td>0.334</td>
<td>0.334</td>
</tr>
<tr>
<td>LC</td>
<td>3</td>
<td>3</td>
<td>0.334</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>PT</td>
<td>0.5</td>
<td>0.334</td>
<td>0.334</td>
<td>0.5</td>
<td>0.334</td>
<td>1</td>
<td>0.334</td>
<td>0.5</td>
</tr>
<tr>
<td>MU</td>
<td>3</td>
<td>0.5</td>
<td>0.334</td>
<td>3</td>
<td>0.25</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>PA</td>
<td>3</td>
<td>0.334</td>
<td>0.334</td>
<td>3</td>
<td>0.334</td>
<td>2</td>
<td>0.5</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table V: Obtained Values after the Step 2

<table>
<thead>
<tr>
<th>Variables</th>
<th>QI</th>
<th>FD</th>
<th>SOC</th>
<th>PV</th>
<th>LC</th>
<th>PT</th>
<th>MU</th>
<th>PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>QI</td>
<td>0.04879</td>
<td>0.03704</td>
<td>0.06250</td>
<td>0.03126</td>
<td>0.05971</td>
<td>0.10527</td>
<td>0.02899</td>
<td>0.02532</td>
</tr>
<tr>
<td>FD</td>
<td>0.14635</td>
<td>0.1111</td>
<td>0.10416</td>
<td>0.1260</td>
<td>0.05971</td>
<td>0.15789</td>
<td>0.17392</td>
<td>0.22785</td>
</tr>
<tr>
<td>SOC</td>
<td>0.2438</td>
<td>0.3334</td>
<td>0.31251</td>
<td>0.1876</td>
<td>0.53731</td>
<td>0.15789</td>
<td>0.26087</td>
<td>0.22785</td>
</tr>
<tr>
<td>PV</td>
<td>0.09757</td>
<td>0.05556</td>
<td>0.10417</td>
<td>0.0626</td>
<td>0.05971</td>
<td>0.10527</td>
<td>0.02899</td>
<td>0.02532</td>
</tr>
<tr>
<td>LC</td>
<td>0.14635</td>
<td>0.3334</td>
<td>0.10417</td>
<td>0.1876</td>
<td>0.17910</td>
<td>0.15789</td>
<td>0.34781</td>
<td>0.22785</td>
</tr>
<tr>
<td>PT</td>
<td>0.02438</td>
<td>0.03703</td>
<td>0.10417</td>
<td>0.03126</td>
<td>0.05971</td>
<td>0.05264</td>
<td>0.02899</td>
<td>0.03798</td>
</tr>
<tr>
<td>MU</td>
<td>0.14635</td>
<td>0.05556</td>
<td>0.10417</td>
<td>0.1876</td>
<td>0.04478</td>
<td>0.15789</td>
<td>0.08696</td>
<td>0.15189</td>
</tr>
<tr>
<td>PA</td>
<td>0.14635</td>
<td>0.03703</td>
<td>0.10417</td>
<td>0.1876</td>
<td>0.05971</td>
<td>0.10527</td>
<td>0.04348</td>
<td>0.07595</td>
</tr>
</tbody>
</table>

1 column = 1+3+5+2+3+0.5+3+3 = 20.5
2 column = 0.334+ 1+3+0.5+3+0.334+0.5+0.334 = 8.998
3 column=0.2+0.334+1+0.334+0.334+0.334+0.334+0.34 = 3.1998
here authors explain the concept of AHP as by calculating the value of CR. The value of CR is less than 10% or 0.10(CR< 010); therefore the value obtained by authors is correct and efficient. If any firm desires to adopt the given factors in the order find and can implement flexible manufacturing in their firm for effective and efficient outcomes. Now authors provide a ranking order to all the factors considered in the study that are based on author’s calculations as shown in the Table VI.

Geometric mean method of AHP techniques: In this method authors considered Table IV and in this method multiply are done of each constituent in each row and then power of 1/n.

According to the above calculation in the Additive normalization method, Authors do the calculation as in the same procedure and now authors provide a ranking order to all the factors considered in the study that are based on author’s calculations as shown in the Table VII.

<table>
<thead>
<tr>
<th>Determinants considered</th>
<th>Eigen values</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Improvement</td>
<td>0.0472</td>
<td>7</td>
</tr>
<tr>
<td>Faster Delivery</td>
<td>0.1373</td>
<td>3</td>
</tr>
<tr>
<td>Satisfaction of customer</td>
<td>0.2753</td>
<td>1</td>
</tr>
<tr>
<td>Product Variety</td>
<td>0.0652</td>
<td>6</td>
</tr>
<tr>
<td>Labor cost</td>
<td>0.2303</td>
<td>2</td>
</tr>
<tr>
<td>Production Time</td>
<td>0.0454</td>
<td>8</td>
</tr>
<tr>
<td>Machine Utilization</td>
<td>0.1117</td>
<td>4</td>
</tr>
<tr>
<td>Profitability</td>
<td>0.0883</td>
<td>5</td>
</tr>
</tbody>
</table>

From the Table VI and Table VII authors analyze that the implementation of additive normalization method and geometric mean method have the similarity in the result that are obtained from the above calculation. The ranking of these factors are approximately same in both the processes, therefore authors concluded that the factors have same ranking in both the processes, but each factors have their own rank separately, thus authors said that flexible manufacturing process can be improve and making effective and efficient by adopting the these factors according to their rank and utilization. Any firm adopts these factors in orders that are obtained in the above calculation and apply/ implement flexible manufacturing layout in their firm for better outcomes, and improve their flexibility, responsiveness and also fulfill the demands of consumer.

VI. Conclusions

It is crystal clear and understandable that selection and analysis of an appropriate manufacturing technique for a given manufacturing application involves a huge number of considerations and the use of AHP method has been perceived to be entirely competent and also computationally facile to determine and analyze proper manufacturing processes from a given set of alternatives. This work also lays down the measures of the considered criteria with their relative importance in order to arrive at the final ranking of the alternatives of flexible manufacturing. Thus, this more intensive multi criteria decision analysis that are recognized from the AHP method and consist the two effective and efficient
processes as additive normalization method and geometric mean method that can be successfully employed for solving any type of decision – making problems having any number of criteria and alternatives in the manufacturing domain. As a future scope, an AHP methodology may be developed to aid the decision makers. The paper has granted the AHP as an effective decision – making method that permits the deliberation of numerous considerations of multiple criteria. From the results and discussion section the authors analyze that the implementation of additive normalization method and geometric mean method have the similarity in the result that are obtained from the above calculation. The ranking of these factors are approximately same in both the processes, therefore authors concluded that the factors have same ranking in both the processes, but each factor have their own rank separately, thus authors said that flexible manufacturing process can be improved and make it more effective and efficient by adopting these factors according to their rank and utilization. Any firm which adopts these factors in the order that are obtained in the above calculation and apply towards the implementation of flexible manufacturing layout in their firm for better outcomes, and improve their flexibility, responsiveness and also fulfill the demands of consumer.

REFERENCES