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Application of Analytic Network Process in Lean Production System Justification

Vinoth Selva Bruce L[1*],. K. Venkataraman[2] , B.Vijaya Ramnath [3]
[1] P.G Student CAD-CAM, Department of Mechanical Engineering, Sri Sairam Engineering college.
[2]Research scholar, Department of Mechanical Engineering, Vels University.
[3]Professor, Department of Mechanical Engineering, Sri Sairam Engineering college.
Corresponding Email:vinothselvabruce@gmail.com

Abstract— **Now a day's companies are in great pressure to reduce costs, increase flexibility, improve quality and cut down on lead times. Companies are thus turning their attention to implement lean. This has created urgency to apply new tools and techniques to reduce various wastes. This paper deals with applying analytic network process (ANP) to select the best manufacturing process in an industry. Lean manufacturing (LM) is one of the techniques which is used in the manufacturing industries especially in large and reputed industries. Most of the medium and small scale industries are not aware of lean manufacturing. This paper aims to show the advantages of lean manufacturing over computer integrated manufacturing system and traditional manufacturing system by comparing among the alternative. For that we have chosen seven criteria's to compare these manufacturing systems with lean manufacturing system. ANP is a mathematical tool which is used to make decisions when the situations are in critical. The decision is made among the three manufacturing system and it shows that the lean manufacturing is best among the alternative. This result is done by using super decision software.**
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.Keywords— Analytic Network Process, Lean manufacturing system, Super matrix, Multi Attribute Decision making, super decision software.

I. Introduction

LM has attracted the attention of industries all over the world. Many operation managers have implemented or will be implementing LM because of the benefits reported by other companies or because their customers have demanded it**.** For this purpose we propose an approach based on Analytic Network Process (ANP) to make the best selection of manufacturing processes. By utilizing this technique, we manage to accelerate the selection process. A multi attribute decision making (MADM) model, namely, the analytic network process (ANP) has been used for this purpose, which structures the problem related to selection of alternative manufacturing systems in a hierarchical network form. According to EDDIE W. L. CHENG and HENG LI AHP can only be employed in hierarchical decision models. For complicated decision problems, the analytic network process (ANP) is highly recommended since ANP allows interdependent influences specified in the model.

The Analytic Network Process (ANP) is a generalization of the Analytic Hierarchy Process (AHP), by considering the dependence between the elements of the hierarchy. Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher-level elements in a hierarchy on lower level elements.

The success of an organization depends on the functions of cost, quality, flexibility, production, morale, competitive advantage and innovation. In this paper these seven criteria's are taken as a input to the analytic network process. For that each criteria we have chosen three sub criteria respectively which is shown in the fig. According to Laura M. Meade and Adrien Presley, [5] The ANP strategic decision- making tool assisted the company in reaching the decision to upgrade their current system versus investing in the development of a new system.

Lean manufacturing system (LMS) is a better alternative, as it would result in overall improvement in the performance of an organisation in comparison with the alternatives. This paper demonstrated a step-by-step approach of the ANP model using a case study of a small- and medium-sized enterprise, which makes it more suitable for managers to learn and adopt such MADM models to support their decisions.

Fawaz A. Abdulmalek et al. (2007) [9] Studied that ''lean'' approach has been applied more frequently in discrete manufacturing than in the continuous/process sector, mainly because of several perceived barriers in the latter environment that have caused managers to be reluctant to make the required commitment.
(Hines and Taylor 2000) [4] described that lean Production, a concept based on the Toyota Production System, has emerged recently as a global approach that integrates different tools to focus on waste elimination and to manufacture products that meet a customer's needs and expectations in a better way.
According to Rozann Whitaker, [10] The AHP/ANP is fundamentally a way to measure intangible factors by using pairwise comparisons with judgments that represent the dominance of one element over another with respect to a property that they share.

According to Laura M. Meade and Adrien Presley, [5] The ANP strategic decision- making tool assisted the company in reaching the decision to upgrade their current system versus investing in the development of a new system.

Anand gurumurthy et al. (2008) used a Multi-Criteria Decision-Making (MADM) model, namely, the Performance Value Analysis (PVA) for a case situation in which a decision has to be made by the managers in choosing between the following two alternatives: LMS and CIMS.

According to Detcharat Sumrit , and Pongpun Anuntavoranich,[9] Analytic Network Process (ANP) method for solving the complicate decision-making and assessing the interrelationship among various evaluation factors, whereas the relative important weight data were provided by industrial experts based on pair-wise comparison.

According to Zhen Chen [7] The ANP approach allows decision makers to set up their decision-making models based on entire considerations about complex inter-relation among all indicators and their clusters, and reliable collection and reuse of experts' knowledge in related domains.

According to Ali Kamil TASLICALI and Sami ERCAN, [8] Decision making models are helping tools for the managers or decision makers to make future plans by using qualitative or quantitative data.

According to Kai-Ying Chen and Wan-Ting Wu, [12] analytical network process method to deal with dependent problems and evaluate the interdependence between criteria in quantitative approach.

According to EDDIE W. L. CHENG and HENG LI, [13] AHP can only be employed in hierarchical decision models. For complicated decision problems, the analytic network process (ANP) is highly recommended since ANP allows interdependent influences specified in the model.

According to Ali GÖRENER, [11] Successful strategic decisions provide the appropriate operational actions for the right markets at the correct time. AHP, ANP technique is a general form that allows interdependencies, outerdependencies and feedbacks among decision elements in the hierarchical or non hierarchical structures.

II. ANALYTIC NETWORK PROCESS

The ANP is a new and an essential phase in decision making, neglected so far because of the linear structures used in traditional approaches and their inability to deal with feedback in order to choose alternatives not simply according to attributes and criteria, but also according to their consequences both positive and negative. The ANP provides a general framework to deal with decisions without making assumptions about the independence of higher level elements from lower level elements and about the independence of the elements within a level. In fact the ANP uses a network without the need to specify levels as in a hierarchy. Influence is a central concept in the ANP.

Steps in ANP

ANP model process comprises five major steps as follow (Saaty, 1996):

(1) Conducting pairwise comparisons on the elements.

(2) Placing the resulting relative importance weights in pairwise comparison matrices within the supermatrix (unweighted supermatrix).

(3) Conducting pair wise comparisons on the clusters.

(4) Weighting the partitions of the unweighted supermatrix by the corresponding priorities of the clusters.

(5) Raising the weighted supermatrix to limiting powers until the weights convergence remain stable (limit supermatrix).

Super decision

A Super Decision model consists of clusters of elements (or nodes), rather than elements (or nodes) arranged in levels. The simplest hierarchical model has a goal cluster containing the goal element, a criteria cluster containing the criteria elements and an alternatives cluster containing the alternative elements as shown in Figure 1. When clusters are connected by a line it means nodes in them are connected. The cluster containing the alternatives of the decision must be named Alternatives. Nodes and Clusters are organized alphabetically in the calculations, so an easy way to control the order is to preface the names with numbers.

The supermatrix

Their are three supermatrices associated with each network:

(1),the Unweighted Supermatrix,
(2),the Weighted Supermatrix and
(3),the Limit Supermatrix.

The unweighted supermatrix contains the local priorities derived from the pairwise comparisons throughout the network. The weighted supermatrix is obtained by multiplying all the elements in a component of the unweighted supermatrix by the corresponding cluster weight. The limit supermatrix is obtained by raising the weighted supermatrix to powers by multiplying it times itself. When the column of numbers is the same for every column, the limit matrix has been reached and the matrix multiplication process is halted.

Network structure of selecting manufacturing process

This network structure is developed by inserting the functions into the cluster and their sub criteria are also added**.** These structure shows arrow from one to another and themselves. The connecting arrow might be inner dependent or outer dependent. The inner dependent arrow creates loop which is also known as feedback loop. This feedback loop shows that the nodes in a cluster are depend on each other. In fig 1, the structure shows the resulting network of the manufacturing selection process.

III. Making Cluster Comparisons

To compare clusters take each cluster in turn (as the parent) and pairwise compare all the clusters it connects to for importance with respect to their influence on it. This is how the Cluster Matrix is generated. Keep in mind that the overall goal here is Market Share. For example, select Assess, Compare, Cluster comparisons and choose the Alternatives cluster. The comparison process now is used to pairwise compare the clusters for influence to which the parent cluster connects.

In the comparison process all the factors are compared to each other. This comparison is done by their weightage. Higher priority factor will get more importance. Fig 3 shows the one of the comparison process.

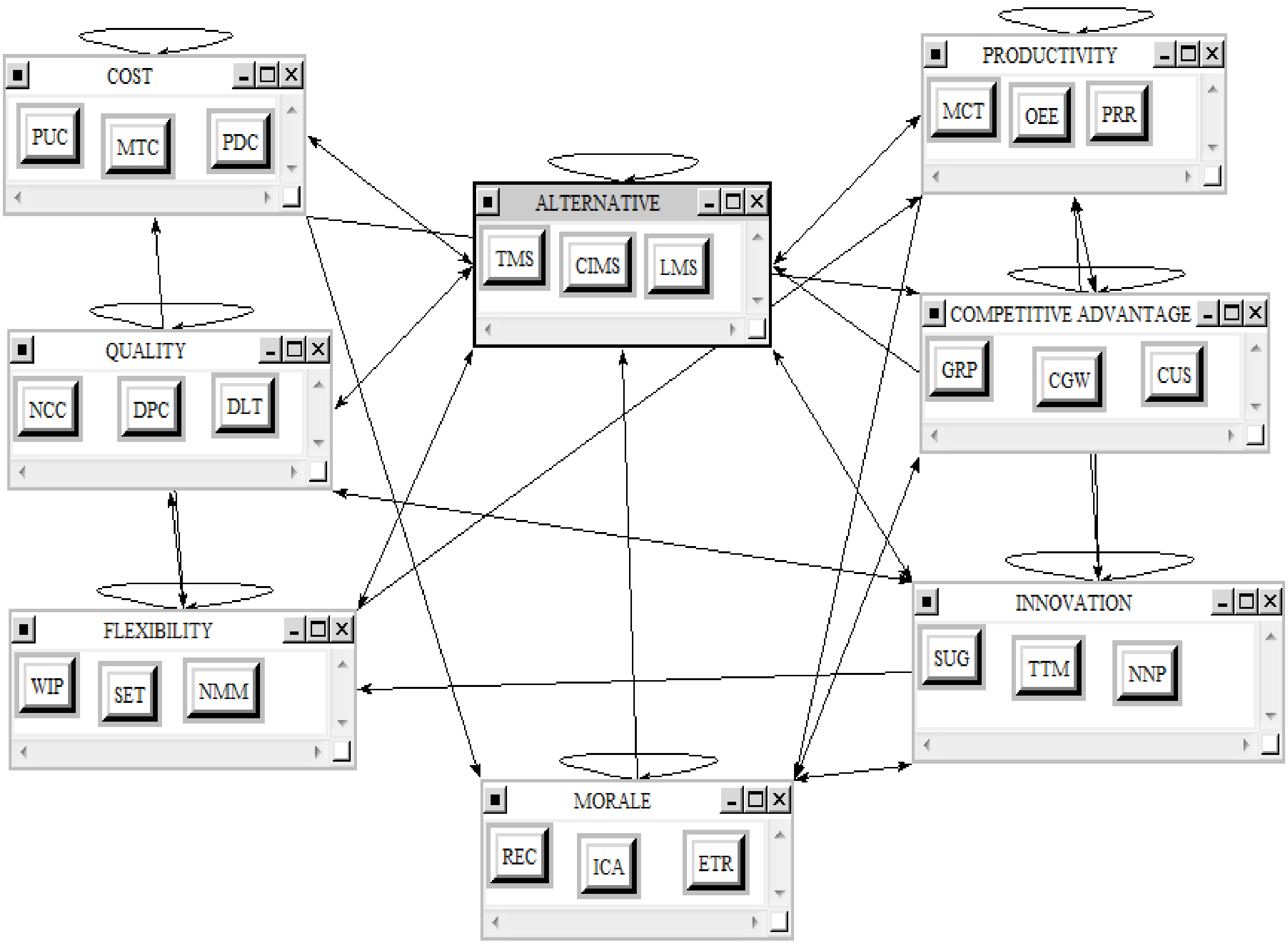

Fig 1: Resulting super decision structure for selecting manufacturing process

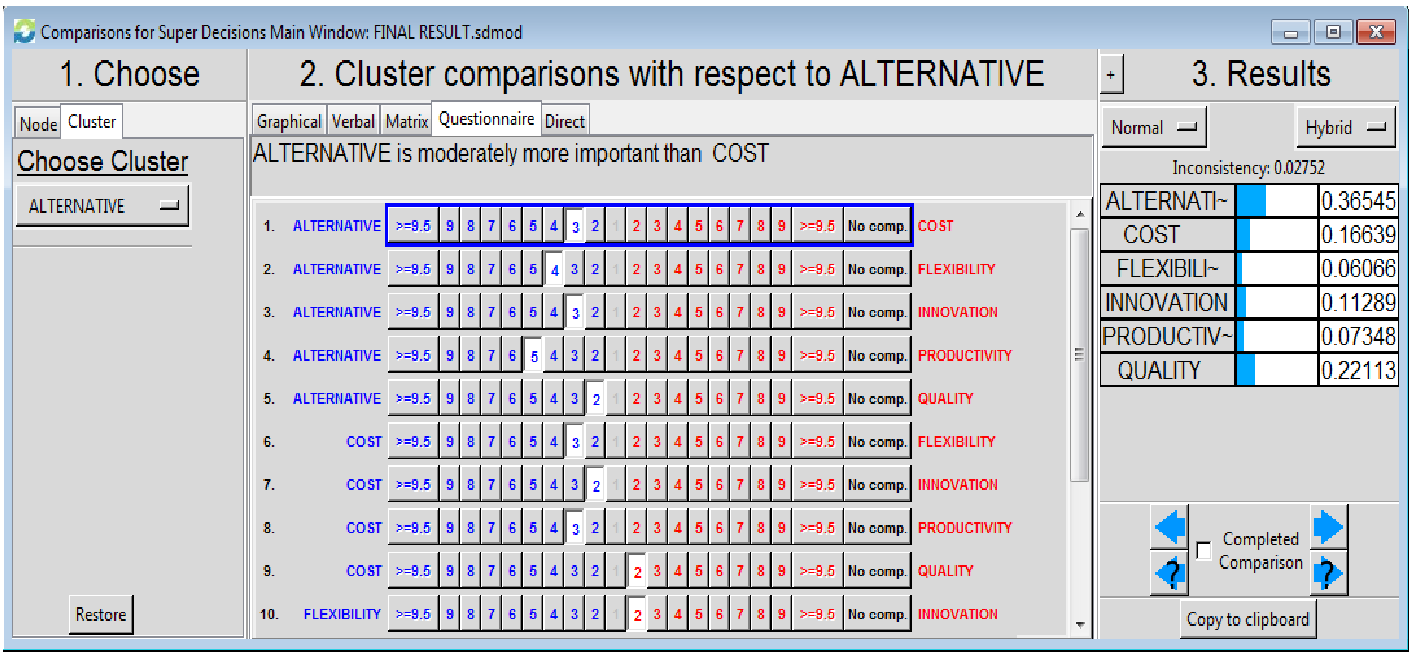

Fig 2: Cluster comparison with respect to Alternative

Fig: Priority of the alternatives

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IV. Result

The final result shows that the lean manufacturing is best among the three manufacturing processes. This result is obtained by the relative comparisons of the seven criteria's and their sub criterias of the manufacturing function. This result will help people to know about the advantages of lean manufacturing system. It is clear that the lean manufacturing is the best manufacturing process among the alternatives.

Alternative Rankings

Graphic	Alternatives	Total	Normal	Ideal	Ranking
	CIMS	0.1014	0.3145	0.5943	2
	LMS	0.1706	0.5292	1.0000	1
	TMS	0.0504	0.1563	0.2953	3

Fig: Alternative ranking

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