IMPLEMENTATION OF LEAN MANUFACTURING FOR SMEs IN UTTAR PRADESH: A SECTORIAL ANALYSIS

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Abstract:
Modern manufacturing is under ever increasing pressure to develop solutions for highly complex tasks. In order to maintain the business survival in a highly competitive environment, it is vital to obtain customer satisfaction, which requires developing products with shorter lifecycles and higher quality meanwhile to reduce the production costs. In order to achieve such objectives a paradigm has been developed called "lean manufacturing". However according to the literature, this tool has been widely used within the large companies, there is still an ongoing research to prove their applicability in Small and Medium Enterprises (SMEs). This paper aims to assess the feasibility of applying lean manufacturing principles within SMEs using survey in Uttar Pradesh. This study aims to explore the causes and obstacles of lean manufacturing in Uttar Pradesh's small and medium-sized businesses. An 11.6% response rate was obtained from a survey that was distributed to 293 small and medium-sized enterprises (SMEs) in Uttar Pradesh in addition to their suppliers. The information collected through the questionnaires was examined using the statistical package for social science (SPSS) program. This research paper explores the implementation of Lean Manufacturing principles in Small and Medium Enterprises (SMEs) across various sectors. Lean Manufacturing is a systematic approach aimed at minimizing waste, improving efficiency, and enhancing overall productivity. The study focuses on understanding the challenges and opportunities associated with the adoption of Lean Manufacturing in different sectors, with an emphasis on how these principles can be tailored to suit the specific needs and characteristics of SMEs.

Keywords: Lean Manufacturing (LM); Analysis of Variances (ANOVA); Small and Medium- sized Enterprises (SMEs); Uttar Pradesh (UP).

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1. INTRODUCTION

After World War II, the Toyota plant in Japan developed the concepts of lean manufacturing (LM), which is a manufacturing approach to reduce or eliminate non- value- added processes (waste) in the production and operation system. At Toyota, the idea was first presented as the "Toyota Production System" (TPS) by Taiichi Ohno as well as Shigeo Shingo. Lean thinking is a potent antidote against waste (muda). "Lean thinking offers an approach to define value", arrange actions that create value in the most efficient order, carry out these tasks continuously anytime someone asks for them, and execute them out ever-more- efficiently. Lean thinking is lean because it offers an approach to accomplish more with less, including less time, space, equipment, and human labor, while at the same time becoming closer to providing clients exactly what they want. Understanding, assessing, and analyzing the organization's current production or manufacturing methods to eliminate muda is crucial in the current business environment and competitive market. Enhancing and eliminating muda from the current manufacturing system is conceivable by implementing and applying lean principles.

Regarding the Indian industrial landscape, the Ministry of Micro, Small, and Medium Enterprises (MSMEs) of the Government of India established the "National Manufacturing Competitive Council (NMCC)" in 2004 to promote and maintain the expansion of the manufacturing sector. The Ministry developed ten components for this program, the first of which is the "Lean Manufacturing Competitive Scheme". Its goals are to increase productivity, decrease waste, introduce novel procedures to boost overall competitiveness, instill good management systems, and foster a continuous improvement culture. The program has been in place since July 2009. For the scheme's execution, a three-tier structure is suggested, with the LM Screening and Steering Committee (SSC) at the top and a group of ten (72) MSME units designated as a Mini Cluster or Special purpose vehicle (SPV) at the lowest tier Fig. 1. The National Productivity Council (NPC), New Delhi is the nodal agency for the scheme, and the National Monitoring and Implementing Unit (NMIU) is in charge of carrying it out. The Government of India is providing financial support during the cost of running awareness campaigns and putting LM techniques into practice (GOIMSME, 2010). 98 lean consultants were sent out to assist in promoting the use of lean concepts, and 104 SPVs were established in clusters, corresponding to the MSMEs annual report for the year 2011- 12 (GOIMSME, 2012). This suggests that the Indian government is worried about the implementation of LM in Indian industries. In today's industrial world, the perception and inclination of lean manufacturing is gradually increasing. Lean is viewed to be the most important resource and its management is the foundation of success in today's industrial environment. Literature review shows that lean manufacturing research is very limited in Indian SMEs. Most of the work focused on the lean manufacturing in large industries. Lean manufacturing in SMEs differs from that in large industries.

The specific characteristics of SMEs require a unique application of lean manufacturing. The principles that apply to large industries cannot be easily scaled down and transferred to SMEs. There is a need for research on practical approaches of lean manufacturing in SMEs especially in the Uttar Pradesh context. These findings have spurred an investigation into the parallels and divergences between specific chosen lean manufacturing strategies and execution concerns. The Small and medium enterprises has started taking some lean manufacturing (LM) initiatives. We have considered the entire small and medium enterprises for a descriptive analysis.

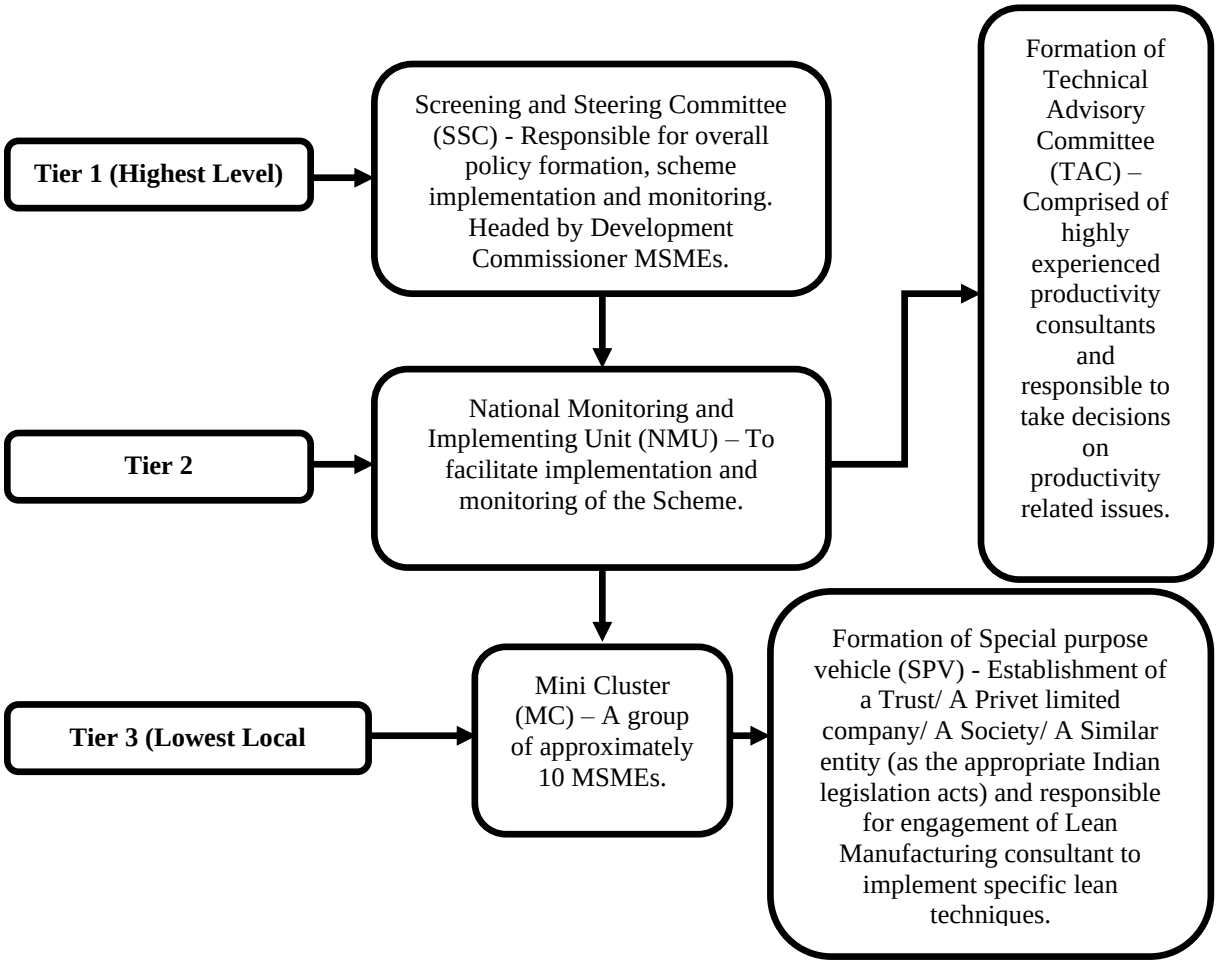

Fig. 1 Lean Manufacturing Competitive Scheme Implementation Structure

The objective is to investigate the similarities and dissimilarities of lean manufacturing practices among different selected sectors in the Uttar Pradesh SMEs, through designing and testing six hypotheses. In this thesis, hypotheses have been designed and tested through a questionnaire- based survey on ten selected sectors of Uttar Pradesh SMEs.

The next section of this paper deals with the design of hypotheses. Six hypotheses have been developed to achieve the objective for understanding variations among selected sectors. This is followed by the reliability analysis, Analysis of Variances (ANOVA), testing of hypotheses and discussion and conclusions of the results.

2. METHODOLOGY

2.1 Design of Hypotheses

We used the survey response of 34 respondents whose profile is already presented in paper. Survey responses will be analyzed in this paper to test a set of proposed hypotheses. These proposed hypothesis are given below in Table 1,

Table 1 Proposed Hypothesis

Hypothesis 01	Selected Sectors don't differ with respect to the involvement of following management positions in the use of lean manufacturing. (a) Top management, (b) Senior Managers, (c) Middle managers and (d) Supervisor Managers.
Hypothesis 02	Selected Sectors don't differ on following obstacles for introducing lean manufacturing and technologies in SMEs. (a) Difficulty in cost justifying new technologies, (b) Insufficient management time to support lean, (c) Not understanding the potential benefits of applying lean, (d) Underestimating employee attitudes/ resistance to change, (e) Insufficient workforce skills to implement lean and (f) Backsliding to the old inefficient ways of working.
Hypothesis 03	Selected Sectors don't differ on following competitive priorities of SMEs. (a) Analysis for process improvement, (b) Cost reduction, (c) Capability to meet customer satisfaction, (d) Control process and sustains performance, (e) Low inventory and waste management and (f) Quality improvement.

Hypothesis 04	Selected Sectors don't differ with respect to type of lean manufacturing technique that is critical to the success of the SMEs. (a) 5S system, (b) Heijunka, (c) Just in Time (JIT), (d) Kaizen, (e) Kanban and (f) Poka-Yoke.
Hypothesis 05	Selected Sectors don't differ the importance of using lean manufacturing in different areas of SMEs. (a) Maximizes product quality, (b) Improved productivity, (c) Better sustainability, (d) Minimizing waste, (e) Better lead time and (f) Improve customer service & satisfaction.
Hypothesis 06	Selected Sectors don't differ on the level of SMEs assessment on key lean manufacturing characteristics. (a) Cut down on surplus inventory, (b) Eliminating overproduction, (c) Increased staff productivity and morale, (d) Optimization of space, (e) Reduction in defects and (f) Timely human grooming regarding lean manufacturing.

In this research quantitative tools are used to test the above hypotheses. Quantitative tools include descriptive statistics, reliability analysis, and ANOVA. The results are obtained using Statistical Package for Social Sciences (IBM SPSS 29 version). Details of these results are given in the form of tables.

2.2 Descriptive Statistics

Descriptive Statistics is to describe and summarize the data in meaningful way. It provides the simple over view of the main characteristics of the data. Descriptive Statistics only describe the collected data. Making sense of data with the help of organizing and summarizing data. Simply starting the research findings without interpretation.

Descriptive Statistics has four key components-

- Measures of Central Tendency- Mean Median and Mode.
- Measures of Dispersion- Variance & Standard Deviation, Quartile Deviation and Range.
- Frequency Tables- Contingency table.
- Charts- Pie Chart, Bar Chart, Line Graph, Histogram, Frequency Polygon and Line Plot.

Some examples of descriptive statistics include mean and standard deviation. This was previously used for developing sector- specific and overall statistics for various lean manufacturing concerns. The standard deviation is a measure that indicates how much data scatter around the mean value. For mean value, simply by summing the all individuals and dividing it by the number of individuals than get a mean value.

For standard deviation, root of the sum of the squared deviation divided by the number of values.

$\sigma = \sqrt{1/n} \{\sum_{i=1...n} (x_i - x)^2\}$ There is a deviation by n.

$\sigma = \sqrt{1/(n-1)} \{\sum_{i=1...n} (x_i - x)^2\}$ There is a deviation by n-1.

Where,

σ Standard deviation

n Number of people

x_i The size of each person

x The mean value of all persons

Usually we want to know the standard deviation of the whole population, for whole population we would take this equation with one divided by n. However it is usually not possible to investigate the entire population so we take a sample then we use this sample to estimate the standard deviation of the population in that case we use other equation with one divided by n-1, therefore whenever we have data of the whole population and we want to calculate the standard deviation for just this data we use one divided by n, if we only have one sample and we want to estimate the standard deviation we use one divided by n-1, so in a simple way, if your survey doesn't cover the whole population we always use the formula for standard deviation one divided by n likewise if we have conducted a sample study we always use the formula for standard deviation one divided by n-1. The standard deviation is the average distance from the mean.

For Standard Deviation, $\sigma = \sqrt{1/n} \{\sum_{i=1...n} (x_i - x)^2\}$

The variance is the squared average distance from the mean.

For Variance, $\sigma = 1/n \{\sum_{i=1...n} (x_i - x)^2\}$

The variance is the standard deviation squared and the standard deviation is the root of the variance.

2.3 Reliability Analysis

Reliability is the property by which consistent results are achieved when we repeat the measurement of something. Consistency of form and manner of asking questions generally ensure reliability.

A rule of thumb that applies to most situations is,

$\alpha > 0.9$ Excellent

$\alpha > 0.8$ Good

$\alpha > 0.7$ Acceptable

$\alpha > 0.6$ Poor

Cronbach's alpha should be greater than 0.7, then its reliable.

Reliability and internal consistency of the responses to the questions selected for developing hypotheses were assessed for the using Cronbach's alpha. Cronbbach's coefficient, having a value of more than 0.5 and 0.7 is considered adequate for such exploratory work. The values of alpha (α) have been found to be more than 0.5 with an average value of 0.969 as shown in Table 2. It implies that there is a high degree of internal consistency in the responses of the questionnaire.

Table 2 Reliability Measures

Hypothesis Number	Items	Coefficient α
Hypothesis 01	04	0.950
Hypothesis 02	06	0.975
Hypothesis 03	06	0.963
Hypothesis 04	06	0.987
Hypothesis 05	06	0.986
Hypothesis 06	06	0.955
Average Value		**0.969**

2.4 Correlation Analysis

Correlation analysis is performed to assess, association between constructs for lean manufacturing implementation in Uttar Pradesh Small and medium enterprises and business performance. The Pearson correlation coefficient is calculated. The degree to which an adjustment within one variable is accompanied by a comparable change in a different one is indicated by the Pearson correlation coefficient.

2.5 Analysis of Variances

Analysis of variance (ANOVA) is a statistical approach. It is employed to look into any number of variables that are purported to have some kind of an impact on the dependent variable. It can also look into how different categories among each of these parameters differ from one another, as each category may have a wide range of possible values. If we examine the differences among one factor's multiple categories, each of which has a wide range of potential values.

We consider it as a one way ANOVA. In this instance, it is employed to evaluate the importance of variations across multiple sample means. The p values are computed using a one-way ANOVA. The major disparities between the identified sectors are found using these values. Descriptive statistics are also utilized for establishing sector-specific statistics for a variety of problems. It has the standard deviation, mean, and so forth.

Analysis of Variance tests whether there are statistically significant differences between three or more samples. One method used when contrasting these ten sectors categories is the examination of variance. To determine the p values for finding the significant differences amongst sectors, one- way ANOVA is utilized.

Analysis of Variance (ANOVA) is a statistical method used to analyze the differences among group means in a sample. It is commonly used when there are three or more groups to compare. The primary objective of ANOVA is to determine whether there are any statistically significant differences among the means of the groups. ANOVA works,

Null Hypothesis (H0) - There is no significant difference among the group means.

Alternative Hypothesis (H1) - At least one group mean is significantly different from the others.

Analysis of Variance (ANOVA) assumptions-

- Independence- Data points within each group should be independent.
- Normality- The data within each group should be approximately normally distributed.
- Homogeneity of Variances- The variances of the groups should be approximately equal.

Types of ANOVA-

- One-way ANOVA- Used when there is one independent variable (factor) with three or more levels (groups).
- Two-way ANOVA- Used when there are two independent variables. It examines the interaction effect between the variables.

ANOVA helps us to analyze the impact of different factors on a dependent variable and identify where significant differences exist among groups.

3. FINDINGS

3.1 TESTING OF HYPOTHESES

A hypothesis is an assumption or conjecture about a relationship. The collected data, we can then analyze with the help of a hypothesis test. Hypotheses are formulated in such a way that in

the further research process they can be tested with collected data.

In order to test a hypothesis, it is necessary to define exactly, which variables are involved and how the variables are related. Hypotheses are therefore assumptions about the relationships between variables. A variable is a property of an object or event, which can take on different values. Two hypotheses are always formulated, that assert the opposite. There are called the null and alternative hypotheses.

- The null hypothesis, assumes that there is no difference between two or more groups.
- The alternative hypothesis, assumes that there is a difference.

It is important to note, that it is always the null hypothesis that is tested with a hypothesis test. Thus, the null hypothesis is always either rejected or not rejected. Hypothesis are distinguished between, difference hypotheses and association (correlation) hypotheses, as well as directed and undirected hypotheses (one- tailed and two-tailed). In Fig. 2,

- The difference hypotheses, test whether there is a difference between two or more groups. Thus in the case of difference hypotheses, there is one categorical variable and one ordinal or metric variable.
- The association (correlation) hypotheses, test whether there is a relationships or correlations between at least two variables, we have two ordinal or metric variables and test it.
- The directed hypotheses indicate the direction of the correlation or difference.
- The undirected hypotheses, whether there is a difference or correlation, regardless of the direction of the correlation or difference.

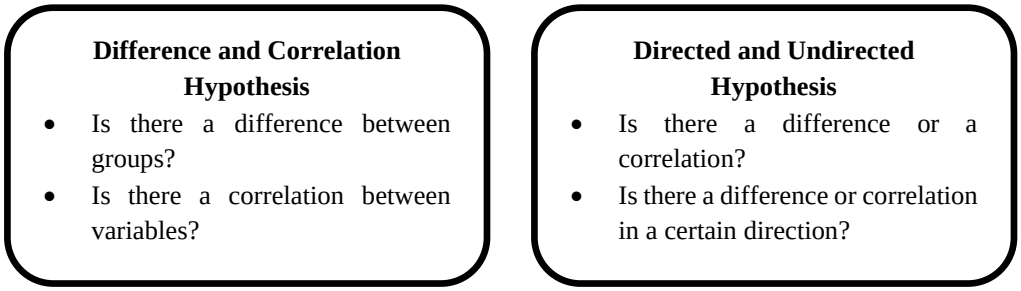

Fig. 2 Difference between Hypotheses

Hypotheses & hypothesis test, a hypothesis is an assumption about an expected association; our target is to either reject or retain this hypothesis. We can test our hypothesis based on our data. The analysis of the data is done with a hypothesis test, for analyzing the data we take t-test for independent samples. Whenever we want to prove or say something about the population with a sample.

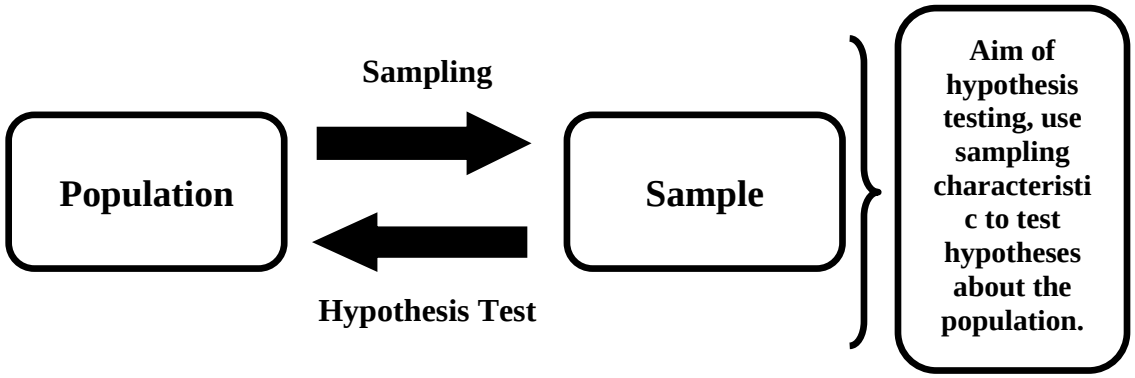

Fig. 3 Hypothesis Test Process

The t- test is a statistical test procedure, t- test does,

- One sample t- test
- Independent samples t- test
- Paired samples t- test

Hypotheses of t- test, one sample t- test, null hypothesis- the sample mean is equal to the reference value and alternative hypothesis- the sample mean is unequal to the reference value. Independent samples t- test, null hypothesis- the mean values in both groups are the same and alternative hypothesis- the mean values in both

groups are not equal. Paired samples t- test, null hypothesis- the mean of the difference between the pairs is zero and alternative hypothesis- null hypothesis- the mean of the difference between the pairs is not zero.

Hypothesis tests can only determine with a probability of error whether a hypothesis is accepted or rejected. Sample one and two differ, than based on each sample, slightly statements are made. In the worst case, you draw a sample that is very different from the population. This may cause you to make an incorrect statement.

P- Value, the probability of the observed result, plus even more extreme results, assuming that null hypothesis is true.

Significance level, is always determined before the examination, it may not be changed in order to obtain the desired statement, usually set at 5% oder 1% to ensure comparability.

- alpha ≤ 1% highly significant.
- alpha ≤ 5% significant.
- alpha > 5% not significant.

Result from hypothesis test, is the null hypothesis retained or rejected? In Fig. 4,

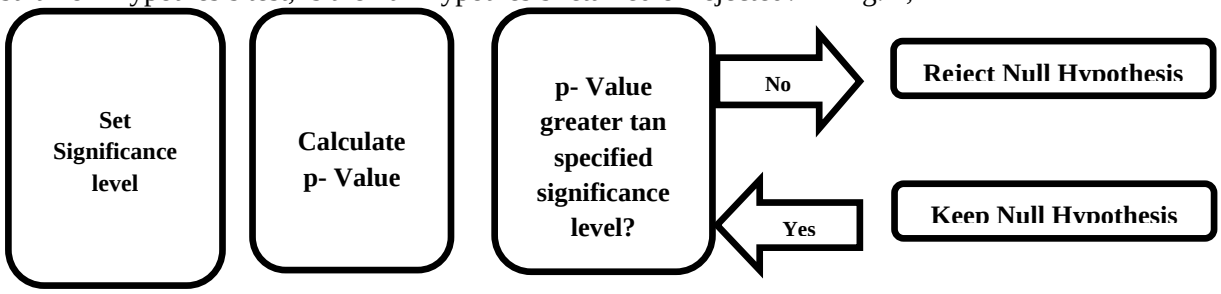

Fig. 4 Significance Level and P- Val

Types of errors in hypothesis testing, due to the sample selection, it may happen by chance that the alternative hypothesis is confirmed, although there is no difference in reality (null hypothesis is valid). Conversely, the result of the hypothesis test can also be that there is no difference in the sample (null hypothesis holds), but in reality, the alternative hypothesis is valid.

- α- error (Type 1 error) - If the alternative hypothesis is accepted although the null hypothesis holds.
- β- error (Type 2 error) - When the null hypothesis is retained even though the alternative hypothesis holds.

In under research process, in order to calculate a hypothesis test, you first have to define a research topic. Based on the topic, you write down your research question. Form the research question you derive a precisely formulated hypothesis about the population. In Fig. 5, finally, you choose a suitable hypothesis test, based on the hypothesis, in order to test the assertion.

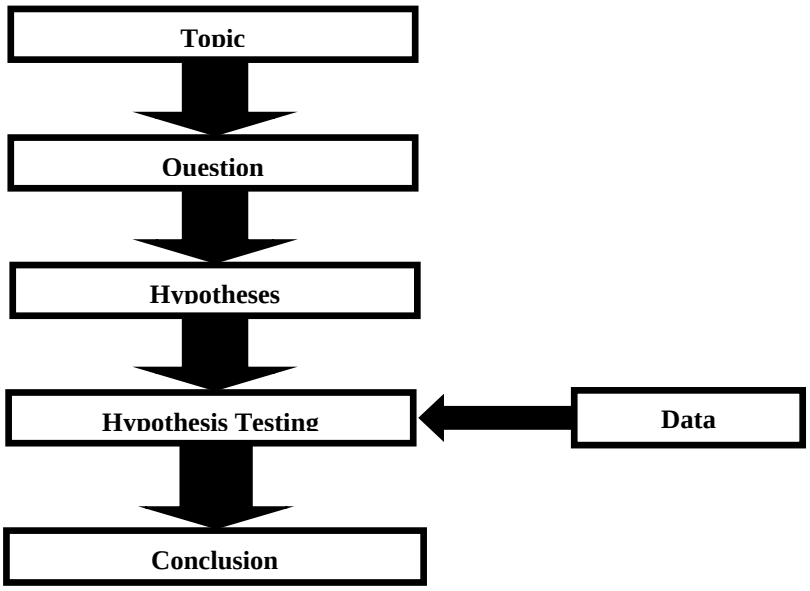

Fig. 5 Research Process

One- way ANOVA is used to test the formulated hypotheses. Using the IBM SPSS 29 version software, descriptive statistics and ANOVA results are obtained. The accompanying subsections comprise a presentation and discussion of them. Every sector that was chosen was appropriately labeled as indicated in Table 3,

Table 3 Labeling of all the Selected Sectors

Serial Number	Sectors	Label
1	Automobile Components	AC
2	Machinery and Equipment parts	ME
3	Chemicals and Pharmaceuticals	CP
4	Leather and Leather Goods	LG
5	Food Processing	FP
6	Agricultural Products	AP
7	Telecommunication	TC
8	Textiles & Garments	TG
9	Electrical & Electronics	EE
10	Semi Finished Good	SG

3.1 Observations of Hypothesis 1

Hypothesis 01 Sectors do not differ with respect to the involvement of following management positions in the use of lean manufacturing. (a) Top management, (b) Senior Managers, (c) Middle managers and (d) Supervisor Managers.

Different sectors have been compared with respect to the involvement of management positions in the use of lean manufacturing in their Uttar Pradesh SMEs. One- way ANOVA test is conducted to compare the sectors under four categories covered in the questionnaire. Comparison is made for the involvement of lean manufacturing at the different management positions. It has been observed that the various management positions are namely top management (0.076), senior managers (0.059), middle managers (0.053) and supervisor managers (0.062). The numerical value within the brackets of various management positions indicates the significance of difference. As the p value indicating the significance of difference are more than 0.05 for all the cases, it means that the sectors do not significantly differ on the management positions in their Uttar Pradesh SMEs. Therefore, this hypothesis is statistically validated.

Further, details are given in Table 4. It has been observed that the most important priority for all sectors is middle managers, particularly for automobile components (Mean = 3.00), machinery and equipment parts (Mean = 3.33), chemicals and pharmaceuticals (Mean = 4.00), leather and leather goods (Mean = 4.00), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00) and semi finished good (Mean = 4.00). Supervisor managers attains the least the priority by the automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.42), chemicals and pharmaceuticals (Mean = 3.00), leather and leather goods (Mean = 3.67), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics and semi finished good (Mean = 4.00) among all selected sectors.

In Uttar Pradesh SMEs, the most important management positions is found to be middle managers which appears to be right because Uttar Pradesh SMEs are passing through an expansion phase due to the strong demand of lean manufacturing. Also it has been observed that all four management positions are considered significantly essential by all selected sectors. The relationship between the competing values framework's four organizational cultural types and three lean manufacturing implementation components- management participation, lean six sigma methodologies and lean six sigma infrastructure.

Table 4 Involvement of Management Positions for Lean Manufacturing with Sectors

Variables/ Sectors		Top Management	Senior Managers	Middle Managers	Supervisor Managers
AC	**Mean**	2.00	2.00	3.00	2.00
	SD	0.00	0.00	0.00	0.00
ME	**Mean**	2.67	2.75	3.33	2.42
	SD	0.49	0.45	0.49	0.51
CP	**Mean**	3.00	4.00	4.00	3.00
	SD	0.00	0.00	0.00	0.00
LG	**Mean**	3.67	4.00	4.00	3.67
	SD	0.58	0.00	0.00	0.58
FP	**Mean**	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00
AP	**Mean**	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00
TC	**Mean**	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00
TG	**Mean**	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00
EE	**Mean**	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00
SG	**Mean**	4.00	5.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00
P Values		**0.076**	**0.059**	**0.053**	**0.062**

3.2 Observations of Hypothesis 2

Hypothesis 02 Sectors do not differ on following obstacles for introducing lean manufacturing and technologies in the industries. (a) Difficulty in cost justifying new technologies, (b) Insufficient management time to support lean, (c) Not understanding the potential benefits of applying lean, (d) Underestimating employee attitudes/ resistance to change, (e) Insufficient workforce skills to implement lean and (f) Backsliding to the old inefficient ways of working.

Different sectors have been compared with respect to the obstacles for introducing lean manufacturing technologies. One- way ANOVA test is conducted to compare the sectors under six categories covered in the questionnaire. Comparison was made for the obstacles to introducing lean manufacturing technologies. From Table 5.5 it has been observed that all the selected sectors consider these obstacles as significantly strong for introducing new ideas and technologies in their respective industries.

It has been observed that the various obstacles are namely difficulty in cost justifying new technologies (0.054), insufficient management time to support lean (0.063), not understanding the potential benefits of applying lean (0.065), underestimating employee attitudes/ resistance to change (0.075), insufficient workforce skills to implement lean (0.072) and backsliding to the old inefficient ways of working (0.067).

The numerical value within the brackets of various obstacles indicates the significance of difference. As the p value indicating the significance of difference is more than 0.05 for all the cases, it means that the sectors do not significantly differ on the obstacles in their Uttar Pradesh SMEs. Therefore, this hypothesis is statistically validated. Further, details are given in Table 5. It has been observed that the most important priority for all sectors is Insufficient workforce skills to implement lean, particularly for automobile components (Mean = 3.00), machinery and equipment parts (Mean = 3.17), chemicals and pharmaceuticals (Mean = 4.00), leather and leather goods (Mean = 4.00), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00), semi finished good (Mean = 4.00). Difficulty in cost justifying new technologies attains the least the priority by the automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.42), chemicals and pharmaceuticals (Mean = 3.00), leather and leather goods (Mean = 3.67), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00) and semi finished good (Mean = 4.00) among all selected sectors.

In Uttar Pradesh SMEs, the most important obstacles for introducing lean manufacturing technologies is found to be Insufficient workforce skills to implement lean which appears to be right because Uttar Pradesh SMEs are passing through an expansion phase due to the strong demand of lean manufacturing. Also it has been observed that all six obstacles for introducing lean manufacturing technologies are considered significantly essential by all selected sectors. Unsuccessful implementation can have a significant impact on an industry's resources, but it can also have a negative influence on employee's faith in the lean ideology.

Table 5 Obstacles for Lean Manufacturing Technologies in SMEs with Sectors

Variables/ Sectors		Difficulty in cost justifying new technologies	Insufficient management time to support lean	Not understanding the potential benefits of applying lean	Underestimating employee attitudes/ resistance to change	Insufficient workforce skills to implement lean	Backsliding to the old inefficient ways of working
AC	**Mean**	2.00	2.00	2.00	2.00	3.00	2.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
ME	**Mean**	2.42	2.75	2.67	2.58	3.17	2.50
	SD	0.51	0.45	0.49	0.51	0.39	0.52
CP	**Mean**	3.00	3.00	3.00	3.00	4.00	3.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
LG	**Mean**	3.67	4.00	3.67	3.33	4.00	3.67
	SD	0.58	0.00	0.58	0.58	0.00	0.58
FP	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
AP	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TC	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TG	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
EE	**Mean**	4.00	4.50	4.00	4.50	4.00	4.00
	SD	0.00	0.71	0.00	0.71	0.00	0.00
SG	**Mean**	4.00	5.00	4.00	5.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
P Values		**0.054**	**0.063**	**0.065**	**0.075**	**0.072**	**0.067**

3.3 Observations of Hypothesis 3

Hypothesis 03 Sectors do not differ on following competitive priorities of their industries. (a) Analysis for process improvement, (b) Cost reduction, (c) Capability to meet customer satisfaction, (d) Control process and sustain performance, (e) Low inventory and waste management and (f) Quality improvement.

Different sectors have been compared with respect to the competitive priorities of their industries. One- way ANOVA test is conducted to compare the sectors under six categories covered in the questionnaire. Comparison was made for the competitive priorities of their industries. From Table 6 it has been observed that all the selected sectors consider these competitive priorities as significantly strong for introducing new ideas and technologies in their respective industries.

It has been observed that the various competitive priorities are namely analysis for process improvement (0.068), cost reduction (0.055), capability to meet customer satisfaction (0.064), control process and sustain performance (0.086), low inventory and waste management (0.068) and quality improvement (0.066). The numerical value within the brackets of various competitive priorities indicates the significance of difference. As the p value indicating the significance of

difference is more than 0.05 for all the cases, it means that the sectors do not significantly differ on the competitive priorities in their Uttar Pradesh SMEs. Therefore, this hypothesis is statistically validated.

Further, details are given in Table 5.6. It has been observed that the most important priority for all sectors is quality improvement, particularly for automobile components (Mean = 3.00), machinery and equipment parts (Mean = 3.33), chemicals and pharmaceuticals (Mean = 4.00), leather and leather goods (Mean = 4.00), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00), semi finished good (Mean = 4.00). Analysis for process improvement attains the least the priority by the automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.58), chemicals and pharmaceutical (Mean = 3.00), leather and leather goods (Mean = 3.67), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.50), semi finished good (Mean = 5.00) among all selected sectors.

In Uttar Pradesh SMEs, the most important competitive priorities of their industries for introducing lean manufacturing technologies is found to be quality improvement which appears to be right because Uttar Pradesh SMEs are passing through an expansion phase due to the strong demand of lean manufacturing. Also it has been observed that all six competitive priorities of their industries for introducing lean manufacturing technologies are considered significantly essential by all selected sectors.

Table 6 Competitive Priorities for Lean Manufacturing with Sectors

Variables/ Sectors		Analysis for process improvement	Cost reduction	Capability to meet customer satisfaction	Control process and sustain performance	Low inventory and waste management	Quality improvement
AC	**Mean**	2.00	3.00	2.00	2.00	2.00	3.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
ME	**Mean**	2.58	3.17	2.75	2.75	2.67	3.33
	SD	0.51	0.39	0.45	0.45	0.49	0.49
CP	**Mean**	3.00	4.00	3.00	4.00	3.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
LG	**Mean**	3.67	4.00	4.00	4.00	4.00	4.00
	SD	0.58	0.00	0.00	0.00	0.00	0.00
FP	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
AP	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TC	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TG	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
EE	**Mean**	4.50	4.00	4.50	4.00	4.50	4.00
	SD	0.71	0.00	0.71	0.00	0.71	0.00
SG	**Mean**	5.00	4.00	5.00	5.00	5.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
P Values		**0.068**	**0.055**	**0.064**	**0.086**	**0.068**	**0.066**

3.4 Observations of Hypothesis 4

Hypothesis 04 The sectors do not differ with respect to type of lean manufacturing technique that is critical to the success of the industries. These lean attributes are (a) 5S system, (b) Heijunka, (c) Just in Time (JIT), (d) Kaizen, (e) Kanban and (f) Poka-Yoke.

Different sectors have been compared with respect to type of lean manufacturing technique of their industries. One- way ANOVA test is conducted to compare the sectors under six categories covered in the questionnaire. Comparison was made for the type of lean manufacturing technique of their industries. From Table 7 it has been observed that all the selected sectors consider this type of lean manufacturing technique as significantly strong for introducing new ideas and technologies in their respective industries. It has been observed that the types of lean manufacturing technique are namely 5S system (0.086), Heijunka (0.064), Just in Time (JIT) (0.068), Kaizen (0.096), Kanban (0.066) and Poka-Yoke (0.072).

The numerical value within the brackets of various type of lean manufacturing technique indicates the significance of difference. As the p value indicating the significance of difference is more than 0.05 for all the cases, it means that the sectors do not significantly differ on the type of lean manufacturing technique in their Uttar Pradesh SMEs. Therefore, this hypothesis is statistically validated.

Further, details are given in Table 7. It has been observed that the most important priority for all sectors is 5S system, particularly for automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.75), chemicals and pharmaceuticals (Mean = 2.00), leather and leather goods (Mean = 3.00), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00), semi finished good (Mean = 5.00). Kaizen attains the least the priority by the automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.42), chemicals and pharmaceutical (Mean = 2.00), leather and leather goods (Mean = 2.00), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00), semi finished good (Mean = 4.00) among all selected sectors.

In Uttar Pradesh SMEs, the most important to type of lean manufacturing technique of their industries for introducing lean manufacturing technologies is found to be 5S system which appears to be right because Uttar Pradesh SMEs are passing through an expansion phase due to the strong demand of lean manufacturing. Also it has been observed that all six type of lean manufacturing technique of their industries for introducing lean manufacturing technologies are considered significantly essential by all selected sectors.

Table 7 Type of Lean Manufacturing Technique with Sectors

Variables/ Sectors		5S system	Heijunka	Just in Time (JIT)	Kaizen	Kanban	Poka-Yoke
AC	**Mean**	2.00	2.00	2.00	2.00	2.00	2.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
ME	**Mean**	2.75	2.67	2.67	2.42	2.50	2.50
	SD	0.45	0.49	0.49	0.51	0.52	0.52
CP	**Mean**	2.00	2.00	2.00	2.00	2.00	2.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
LG	**Mean**	3.00	2.67	2.67	2.00	2.00	2.00
	SD	0.00	0.58	0.58	0.00	0.00	0.00
FP	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
AP	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TC	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TG	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
EE	**Mean**	4.00	4.50	4.00	4.00	4.00	4.00
	SD	0.00	0.71	0.00	0.00	0.00	0.00
SG	**Mean**	5.00	5.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
P Values		**0.086**	**0.064**	**0.068**	**0.096**	**0.066**	**0.072**

3.5 Observations of Hypothesis 5

Hypothesis 05 Selected Sectors don't differ the importance of using lean manufacturing in different areas of SMEs. (a) Maximizes product quality, (b) Improved productivity, (c) Better sustainability, (d) Minimizing waste, (e) Better lead time and (f) Improve customer service & satisfaction.

Different sectors have been compared with respect to the importance of using lean manufacturing in different areas of SMEs. One- way ANOVA test is conducted to compare the sectors under six categories covered in the questionnaire. Comparison was made for the importance of using lean manufacturing in different areas of SMEs. From Table 8 it has been observed that all the selected sectors consider these importances of using lean manufacturing as significantly strong for introducing new ideas and technologies in their respective industries. It has been observed that the importance of using lean manufacturing are namely maximizes product quality (0.083), improved productivity (0.069), better sustainability (0.076), minimizing waste (0.066), better lead time (0.053) and improve customer service & satisfaction (0.068).

=The numerical value within the brackets of various importance of using lean manufacturing indicates the significance of difference. As the p value indicating the significance of difference is more than 0.05 for all the cases, it means that the sectors do not significantly differ on the importance of using lean manufacturing in their Uttar Pradesh SMEs. Therefore, this hypothesis is statistically validated.

=Further, details are given in Table 8. It has been observed that the most important priority for all sectors is maximizes product quality, particularly for automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.92), chemicals and pharmaceuticals (Mean = 4.00), leather and leather goods (Mean = 4.00), food processing (Mean = 4.00), agricultural products (Mean = 4.50), telecommunication (Mean = 5.00), textiles & garments (Mean = 5.00), electrical & electronics (Mean = 5.00), semi finished good (Mean = 5.00). Improve customer service & satisfaction attains the least the priority by the automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.58), chemicals and pharmaceutical (Mean = 3.33), leather and leather goods (Mean = 4.00), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00), semi finished good (Mean = 4.00) among all selected sectors.

In Uttar Pradesh SMEs, the most important to importance of using lean manufacturing in different areas for introducing lean manufacturing technologies is found to be maximizes product quality which appears to be right because Uttar Pradesh SMEs are passing through an expansion phase due to the strong demand of lean manufacturing. Also it has been observed that all six type of lean manufacturing in different areas of SMEs for introducing lean manufacturing technologies are considered significantly essential by all selected sectors.

Table 8 Importance of using Lean Manufacturing in Different Areas of SMEs with Sectors

Variables/ Sectors		Maximizes product quality	Improved productivity	Better sustainability	Minimizing waste	Better lead time	Improve customer service & satisfaction
AC	**Mean**	2.00	2.00	2.00	2.00	2.00	2.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
ME	**Mean**	2.92	2.83	2.83	2.67	2.75	2.58
	SD	0.51	0.39	0.39	0.49	0.45	0.51
CP	**Mean**	4.00	3.67	3.33	3.00	3.00	3.33
	SD	0.00	0.58	0.58	0.00	0.00	0.58
LG	**Mean**	4.00	4.00	4.00	3.67	4.00	4.00
	SD	0.00	0.00	0.00	0.58	0.00	0.00
FP	**Mean**	4.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
AP	**Mean**	4.50	4.00	4.00	4.00	4.00	4.00
	SD	0.71	0.00	0.00	0.00	0.00	0.00
TC	**Mean**	5.00	4.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TG	**Mean**	5.00	5.00	4.00	4.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
EE	**Mean**	5.00	5.00	4.50	4.50	4.50	4.00

	SD	0.00	0.00	0.71	0.71	0.71	0.00
SG	**Mean**	5.00	5.00	5.00	5.00	5.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
P Values		**0.083**	**0.069**	**0.076**	**0.066**	**0.053**	**0.068**

3.6 Observations of Hypothesis 6

Hypothesis 06 Selected Sectors don't differ on the level of SMEs assessment on key lean manufacturing characteristics. (a) Cut down on surplus inventory, (b) Eliminating overproduction, (c) Increased staff productivity and morale, (d) Optimization of space, (e) Reduction in defects and (f) Timely human grooming regarding lean manufacturing.

Different sectors have been compared with respect to the level of SMEs assessment on key lean manufacturing characteristics. One- way ANOVA test is conducted to compare the sectors under six categories covered in the questionnaire. Comparison was made for the level of SMEs assessment on key lean manufacturing characteristics. From Table 9 it has been observed that all the selected sectors consider these importances of using lean manufacturing as significantly strong for introducing new ideas and technologies in their respective industries. It has been observed that the level of SMEs assessment on key lean manufacturing characteristics are namely Cut down on surplus inventory (0.065), Eliminating overproduction (0.058), Increased staff productivity and morale (0.061), Optimization of space (0.055), Reduction in defects (0.057) and Timely human grooming regarding lean manufacturing (0.063).

The numerical value within the brackets of the level of SMEs assessment on key lean manufacturing characteristics indicates the significance of difference. As the p value indicating the significance of difference is more than 0.05 for all the cases, it means that the sectors do not significantly differ on the importance of using lean manufacturing in their Uttar Pradesh SMEs. Therefore, this hypothesis is statistically validated.

Further, details are given in Table 9. It has been observed that the most important priority for all sectors is Reduction in defects, particularly for automobile components (Mean = 3.00), machinery and equipment parts (Mean = 3.33), chemicals and pharmaceuticals (Mean = 4.00), leather and leather goods (Mean = 4.00), food processing (Mean = 4.00), agricultural products (Mean = 4.00), telecommunication (Mean = 4.00), textiles & garments (Mean = 4.00), electrical & electronics (Mean = 4.00), semi finished good (Mean = 4.00). Optimization of space attains the least the priority by the automobile components (Mean = 2.00), machinery and equipment parts (Mean = 2.00), chemicals and pharmaceutical (Mean = 2.33), leather and leather goods (Mean = 3.00), food processing (Mean = 3.00), agricultural products (Mean = 3.00), telecommunication (Mean = 3.00), textiles & garments (Mean = 3.00), electrical & electronics (Mean = 3.00), semi finished good (Mean = 3.00) among all selected sectors.

In Uttar Pradesh SMEs, the most important the level of SMEs assessment on key lean manufacturing characteristics for introducing lean manufacturing technologies is found to be reduction in defects which appears to be right because Uttar Pradesh SMEs are passing through an expansion phase due to the strong demand of lean manufacturing. Also it has been observed that all six level of SMEs assessment on key lean manufacturing characteristics for introducing lean manufacturing technologies are considered significantly essential by all selected sectors.

Table 9 Level of SMEs Assessment on Key Lean Manufacturing Characteristics with Sectors

Variables/ Sectors		**Cut down on surplus inventory**	**Eliminating overproduction**	**Increased staff productivity and morale**	**Optimization of space**	**Reduction in defects**	**Timely human grooming regarding lean manufacturing**
AC	**Mean**	3.00	2.00	3.00	2.00	3.00	2.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
ME	**Mean**	3.17	2.42	3.33	2.00	3.33	2.83
	SD	0.39	0.51	0.49	0.00	0.49	0.39
CP	**Mean**	4.00	3.00	4.00	2.33	4.00	3.00
	SD	0.00	0.00	0.00	0.58	0.00	0.00

LG	**Mean**	4.00	3.67	4.00	3.00	4.00	4.00
	SD	0.00	0.58	0.00	0.00	0.00	0.00
FP	**Mean**	4.00	4.00	4.00	3.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
AP	**Mean**	4.00	4.00	4.00	3.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TC	**Mean**	4.00	4.00	4.00	3.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
TG	**Mean**	4.00	4.00	4.00	3.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
EE	**Mean**	4.00	4.00	4.00	3.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
SG	**Mean**	4.00	4.00	4.00	3.00	4.00	4.00
	SD	0.00	0.00	0.00	0.00	0.00	0.00
P Values		**0.065**	**0.058**	**0.061**	**0.055**	**0.057**	**0.063**

4. CONCLUSIONS

In this paper, ten selected sectors have been compared or their similarities and dissimilarities regarding lean manufacturing strategic and implementation issues in Uttar Pradesh SMEs. In this survey, selected sectors are from Uttar Pradesh small and medium enterprises and grouped under the categories of automobile components (AC), machinery and equipment parts (ME), chemicals and pharmaceuticals (CP), leather and leather goods (LG), food processing (FP), agricultural products (AP), telecommunication (TC), textiles & garments (TG), electrical & electronics (EE) and semi finished goods (SG). All the six hypotheses have been tested for their significance in implanting and using lean manufacturing.

Hypothesis 1 reveals that all the selected sectors have similarities with respect to the level of involvement of management positions in the use of lean manufacturing in their SMEs. The most significant level of involvement of management positions in the use of lean manufacturing identified for Uttar Pradesh SMEs is middle managers. Uttar Pradesh SMEs are passing through a phase of change and also facing lot of competition at both global and local level. Hence, the position of middle managers is very important for their proper involvement.

Hypothesis 2 reveals that all the selected sectors have similarities with respect to the major obstacles for introducing lean manufacturing technologies in SMEs. The most significant level of the major obstacles for introducing lean manufacturing technologies identified for Uttar Pradesh SMEs is insufficient workforce skills to implement lean. Uttar Pradesh SMEs are passing through a phase of change and also facing lot of competition at both global and local level. Hence, the obstacles of insufficient workforce skills to implement lean are very important for their proper implementation.

Hypothesis 3 reveals that all the selected sectors have similarities with respect to the competitive priorities of SMEs. The most significant competitive priorities of SMEs identified for Uttar Pradesh SMEs is quality improvement. Uttar Pradesh SMEs are passing through a phase of change and also facing lot of competition at both global and local level. Hence, the issue of quality improvement is very important for their survival.

Hypothesis 4 reveals that all the selected sectors have similarities with respect to the type of lean manufacturing technique that is critical to the success of the SMEs. The most significant the type of lean manufacturing technique of SMEs identified for Uttar Pradesh SMEs is 5S system. Uttar Pradesh SMEs are passing through a phase of change and also facing lot of competition at both global and local level. Hence, the technique of 5S system is very important for their implementation.

Hypothesis 5 reveals that all the selected sectors have similarities with respect to the importance of using lean manufacturing in different areas of SMEs. The most significant importance of using lean manufacturing in different areas of SMEs identified for Uttar Pradesh SMEs is maximizes product quality. Uttar Pradesh SMEs are passing through a phase of change and also facing lot of competition at both global and local level. Hence, the importance of maximizes product quality is very important for their survival.

Hypothesis 6 reveals that all the selected sectors have similarities with respect to the level of SMEs assessment on key lean manufacturing characteristics. The most significant assessment on key lean manufacturing characteristics of SMEs

identified for Uttar Pradesh SMEs is reduction in defects. Uttar Pradesh SMEs are passing through a phase of change and also facing lot of competition at both global and local level. Hence, the characteristic of reduction in defects is very important for their assessment.

The stated assumptions have been tested using information obtained from surveys of SMEs in Uttar Pradesh. They were created using the results of empirical research conducted throughout the field and a review of the literature. These theories so support the national blueprint for the chosen industries. The aforementioned research indicates that lean manufacturing techniques have implications for a variety of industries, and these industries are implementing them under their unique limits, needs, and working environments. This indicates that the chosen sectors operations and functioning have both fundamental similarities and differences, which may account for the observed similarities and differences in their lean manufacturing approaches.

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