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Abstract

Purpose – Lean manufacturing (LM) principles are one of the alternatives to improve manufacturing productivity, quality and customer satisfaction in Indian manufacturing industry. The purpose of this paper is to find the implementation status of LM principles across Indian manufacturing organizations through the empirical survey methodology.

Design/methodology/approach – The survey questionnaire was developed based upon literature review conducted on LM and also considered experts suggestion in the field of LM. The survey questionnaire was sent to 753 manufacturing organization located in India. The respondent organization details have gathered from the list of Confederation of Indian Industries directory for the year 2011.The selected respondents were production managers, quality managers, sales managers, maintenance managers, CEOs of the organization. The empirical survey collected 180 filled survey questionnaires from Indian manufacturing industries.

Findings – The study clearly identified that many manufacturing organizations were in initial transition stage and concentrating mostly in-plant operations instead of collaboration in all levels of business with suppliers and customers. The present study found that drivers for implementation of LM were customer satisfaction and organizational continuous improvement program. The present study also found that barriers to implement LM principles were employee resistance, implementing few elements of LM principles instead of the complete package of LM framework, budget constraints and lack of understanding of LM principles to shop floor managers. Finally the study concluded that Indian manufacturing organizations have to conduct continuous learning programmed to improve understanding of LM principles as well as to maintain their motivation level in apex point. The study also suggested that a systematic LM framework is needs to Indian manufacturing organizations, which will act as clear cut guiding torch to the organization managers to implement LM principles across organization.

Research limitations/implications – The sample size of the present study was moderate number than previous studies. However the study only concentrated on manufacturing organizations across India. The results of the present study cannot generalize across all the sectors of Indian organizations.

Originality/value – The concept of LM was very popular among developed and developing countries in the world. Many research studies were performed across world to find the status of LM implementation in their countries. Very few research studies reported the status of LM implementation in Indian manufacturing industries and those studies also with limited focus of the status of LM implementation. Hence the study presented details status of LM principles implementation in Indian manufacturing industries.

Keywords India, Empirical study, Lean manufacturing, Automotive industry

Paper type Research paper

1. Introduction

Manufacturing industry is one of the fastest growing industry sectors globally, especially in India (Sharma and Kodali, 2008). The growth of manufacturing sector generally follows the economic growth of a particular country. The economic cycle growth of any country is a cyclic fluctuation process due to various dynamic conditions

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of the country and the world (Eswaramoorthi *et al.*, 2011). An organization produces the manufacturing product with high efficiency and quality, and fulfills the customer requirements in a short span of time. Good business organizations will not be affected by the economic fluctuations of the country due to delivering the products to the customer superior than competitors in all aspects of the manufacturing product. However, the customer demand is increasing every instance that influences the speed of the delivery, quality and cost, which plays vital role in the present global market. Hence, getting a competitive edge in the present global market is very difficult task for the manufacturing organizations (Abioye *et al.*, 2011). Ferdousi and Ahmed (2009) have reported that the important factor that impacts on any organization business is how the organization is improving simultaneously both in terms of quality and productivity on continuous basis. To survive as well as to establish as market leader in the present global markets, the manufacturing organizations have lean manufacturing (LM) as one of the important alternatives (Abdulmalek and Rajgopal, 2007). According to Womack *et al.* (1990) and Upadhye *et al.* (2010), LM contains universal management principles and tools; it could be implemented in any system and in any organization. Shah and Ward (2003) reported that most of the cited LM articles commonly presented improvement in the aspects of productivity, quality, customer lead time, reduction of cycle time and manufacturing cost. Papadopoulou and Ozbayrak (2005) have reported that LM is one of the methodologies to achieve world class manufacturing in the organization through a cost reduction mechanism.

Indian economy has grown rapidly during the first decade of twenty-first century. The Gross Domestic Products (GDP) of the country progressed with average rate of nine percentages in tenth five years plan. Indian automobile industry also has grown along with GDP growth of the country. The total automobile unit sales crossed around 40 million vehicles per annum in India. The manufacturing organizations are projecting that India still has a lot of market opportunities to double the present sales within a span of five years. India is the second top most population country in the world. The availability of skilled and unskilled human resources is very high. The percentage of employment is very low (around 8 percent) and huge man power is available. Hence, many world class manufacturers started their manufacturing units in India. Automobile industry was protected in India up to last decade of twentieth century from the entry of global manufacturing players. In the early 1990's, economic liberalization was started in India, which opened Indian market to the global players. During the protected period of twentieth century, Indian manufacturing industry was not concentrating on productivity, quality and cost of the products except the production volumes. After the economic liberalization, global automobile players started their units in India. Many varieties of products are available to the customer in the Indian market. Hence the customer started looking for more quality with low cost. In the beginning of globalization, the global manufacturing players were superior to Indian manufacturing players with respect to quality, cost and productivity. The Indian market players started losing their market. As a consequence, the organizations started to think about advanced manufacturing system like total quality management, total productive maintenance, LM, etc. (Dangayach and Deshmukh, 2001; Chandra and Sastry, 1998). A very few Indian automobile industries implemented the LM principles by end of twentieth centenary. Now, it is almost two decades since the Indian manufacturing industries started implementing the advanced manufacturing systems. It has observed that many Indian manufacturing industries have implemented lean principles, but there are failed to implement long-term aspects. Many researchers (Anand and Kodali, 2009, 2010) have reported that manufacturing industries are failed to implement lean principles due to improper implementation such as implementing limited area of manufacturing organization, implementing of lean principles bits-and-pieces instead of as a whole organization simultaneously. A few researchers (Eswaramoorthi *et al.*, 2011) have performed research work to find out the root cause to fail in implementation of lean principles in Indian manufacturing organizations. The study has restricted to a particular field of manufacturing sector instead of to trace the complete manufacturing industries. In few cases, the studies such as Ghosh (2013) did not reveal the complete scenario about the root cause to the failure or not able to implement. Hence, the present study attempts to find out the implementation stage of lean principles and various hurdles to implement lean principles as well as its root causes in Indian automotive industry. It also suggests how to overcome the hurdles to implement lean principles in Indian manufacturing industry.

The structure of the paper is as follows: Section 2 gives information on literature review of LM principles. Section 3 deals with the research objective and methodology adapted to complete the present study. Section 4 is dedicated to present the analysis and key findings obtained from survey questionnaire of the study. Section 5 is about discussion on the present study's key findings. Finally, Section 6 is dedicated to conclusions and future directions proposed by the present study.

2. Literature review of LM

The term LM was first introduced to the business world in the last decade of twentieth century. The term "lean production system" was initiated by John Krafcik (1988), while he was reviewing Toyota production system. However, later the word LM became familiar and got attention from the western manufacturing industry in the book titled "The machine that changed the World" published by Womack *et al.* (1990) from Massachusetts Institute of Technology (MIT), USA. LM is an integrated system with multi-dimensional tools like just-in-time, total quality management, customer relationship, supplier relationship management, pull and kanban etc. (Eswaramoorthi *et al.*, 2011). The definition of LM is "use less of everything – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering working hours to develop a new product in half the time. Also, it requires keeping far less than half the inventory on site, results in fewer defects, and produces a greater and ever growing quality of products" (Womack *et al.*, 1990). The main objective of LM is to produce finished goods according to the customer requirements with very less waste or without waste (Liker, 2003). Waste is an activity; it does not give any value to the finished product (Taj and Berro, 2006). Ohno's (1988) classified waste into seven categories that are: over production, waiting, transportation, inappropriate processing, unnecessary inventory, unnecessary motions and defects. To eliminate all these seven wastes, LM uses different kinds of elements like 5S, pull system, kaizen, quick changeovers etc. (Liker, 2003; Jina *et al.*, 1997). One of the best characteristics of the LM system is producing customer needed products at right time, right quantity, right place and take away unnecessary stocks (Tiwari *et al.*, 2011). All positive results of LM system rapidly spread across departments, industries and sectors. The successful impact of lean elements in Japanese manufacturing industry influenced many industry sectors like aerospace, automotive, auto-component, information technology and process industry and hence started to implement lean elements in their environment to achieve excellence in organizational business across the world (Sahoo *et al.*, 2008; Houlahan, 1994;

MacDuffie *et al.*, 1996). According to Eswaramoorthi *et al.* (2011), many industries have implemented lean practices, tools and techniques in their organization without actually realizing it. All these advantages have contributed to develop LM from system level to one of the successful philosophies (Bhasin and Burcher, 2006).

LM philosophy offered various benefits to the industrial world; however, many of the organizations were not able to grasp the advantages of LM philosophy yet. In particular, the industries in fastest developing countries like India up to recently were working on Henry Ford proposed mass production methodology. To survive in the present globalization environment competition, the Indian manufacturing industries started to implement LM practices after the globalization. Still so many industries in India are not able to implement LM principles due to lack of knowledge on LM practices, financial support, employee support and top management support. Hence the present study attempts to find out the implementation status of LM practices and list out various barriers to implement LM practices in Indian manufacturing industry. The present study has conducted literature survey to find out similar kind of studies in the past. The study found that many researchers have conducted similar kind of studies, which are survey-based lean principles' assessment work in Australian manufacturing industry (Sohal and Egglestone, 1994), electronics manufacturing (Doolen and Hacker, 2005), Spanish ceramic tile industry (Tomas and Antonio, 2006), Malaysian electrical and electronics industry (Wong *et al.*, 2009), Malaysian automotive industry (Nordin *et al.*, 2010) and across Thailand manufacturing industry (Rahman *et al.*, 2010).

The study further investigated to find out whether the similar kind of research studies was performed in India. It was found that Eswaramoorthi *et al.* (2011) conducted similar survey-based study on machine tool industry, which focussed on importance of implementation of LM principles in Indian machine tool industry. It also focussed on the priorities, barriers and familiar LM tools in Indian machine tool industry. The sample of the study was restricted to only 43 responses from Indian machine tool industry. Further it was found that Ghosh (2013) conducted research study to find out the important LM practices and the operational performance after implementation of LM principles in Indian manufacturing industry. The preceding study also found out the importance of various tools and techniques of LM through a given ranking based upon survey results. One of the constraints of the study was the sample size and was focussed only on limited area of LM elements and their performance on productivity, lead time etc. The study was restricted to only 79 survey responses across Indian manufacturing organizations. The present study tries to overcome all shortcomings of the previous studies in LM principles' assessment in Indian manufacturing organizations. Generally, many factors are impacting on lean principles implementation, which includes the back ground industry, understanding of lean principles, drivers for lean implementation, area of lean implementation, what type of obstacles faced by organizations to implement lean principles, what type of lean waste avoided by the organization, what type of benefits expected by the organization, what type awareness created among employees of the organization before implementation of lean principles, what type of lean tools used by the organization to implement lean principles. These factors are playing major role to find out the implementation status of lean principles in Indian manufacturing industry as well as why many Indian manufacturing organization have failed to implement lean principles in the organizations. Hence, the study tries to find out all aforementioned variables to find out the implementation status of lean principles in Indian manufacturing industry.

3. Research objective and methodology

The main objective of the present study was to trace the implementation status of LM principles across Indian manufacturing industry. The survey questionnaire methodology has been chosen to achieve the objective of the study. The cross-sectional study was conducted across Indian manufacturing industry. The survey questionnaire was developed with exceptional precautions to get proper response from the respondents. To conduct validity of the questionnaire, the study administered the survey questionnaire to professionals six each from academic and industry. The expert suggestions were incorporated in final format of the survey questionnaire. The present study also conducted pilot study to validate the content validity of the survey questionnaire in one of the major Indian auto-component industry.

The survey questionnaire was divided into two parts: part A and part B. Part A of the survey questionnaire captures: organization profile and personal information of the respondent. Part B of the survey questionnaire captures: what is motive of the lean principles implementation, which part of organizational operational area they have implemented lean principles, what kind of LM tools, techniques and practices they have used in the organization, what kind of lean waste they have removed from the organization, what is the respondent understanding of lean principles and what are all the major obstacles to implement lean principles in their organization. The present study used five-point Likert scale to get the responses for each item for the lean practices and other issues. The indication scale given to the respondents was in the following manner: first, indicates no implementation (0 percent); second, indicates little implementation (around 25 percent); third, indicates some implementation (around 50 percent); fourth, indicates extensive implementation (around 75 percent); and fifth, indicates complete implementation (100 percent). The present study collected manufacturing industry database from 2011-Directory of Confederation of Indian Industries. The present study targeted the respondents at the level of managing directors/CEO's, production managers, maintenance managers, logistics managers and also quality managers. The main manufacturing industry sectors considered are the automobile, electronics, engineering, process and textile industries (Sharma and Kodali, 2008).

Finally the survey questionnaire was sent to 753 targeted organizations to get the responses from the Indian manufacturing organizations. Dillman (1978) has proposed some of the practices to improve the response rate of any survey questionnaire from any industry sectors. The present study has implemented those suggestions to get more responses from the Indian manufacturing industry. The questionnaire was posted along with covering letter and stamped self-postal address envelop to the respective organizations. After six weeks, a second survey questionnaire was sent to those who did not respond for the first questionnaire. Moreover, some of the respondents have communicated through e-mail and telephone conversation. Simatupang and Sridharan (2004) have used similar kind of methodology to get huge responses in their empirical study. In all the present study received 196 responses from various Indian manufacturing industries. After complete evaluation of all the responses, the present study did not consider 16 responded survey questionnaires as they have not implemented any kind of LM principles. Hence the study has considered only 180 useful responses from the received responses. It clearly indicates that the response rate was 23.6 percent. If the response rate of any empirical survey is more than 18 percent, then it is considered as good response rate (Sharma and Kodali, 2008). The response rate from each individual sector were: automobile (28.22 percent); machine equipment (26.31 percent); electrical and electronics (17.37 percent); process (18.67 percent);

and textile (37.29 percent). The statistics of the individual sector responses are shown in Table I. The number of responses from the automobile sector was more than other sectors considered in the study, which was 31.66 percent (57 responses) of total responses received from all the sectors. Machine equipment industry sectors occupied second place in terms of response numbers, which was 22.22 percent (40 responses) of total responses. The remaining sectors, i.e., electrical and electronics, process industry and textiles industry responses' contributions were 18.33 percent (33 responses), 15.56 percent (28 responses) and 12.22 percent (22 responses), respectively of total responses received from all the sectors.

4. Analysis and key findings

The present study attempted to find several factors such as respondents' understanding of LM principles, the main drive force to implement it in their organization, which part of the operations area LM principles were implemented, what are the main obstacles to implement LM principles in their organizations, what kind of LM waste removed from their organization, the familiar LM elements among the respondents, and finally, which are the LM principles implemented in their organization.

4.1 Industry background

The present study focusses on the background of the industries and the respondents responded to the survey. The study found that 57.22 percent of the respondents were working in Indian-based organizations. Around 28.33 percent of the respondents were working in foreign-based organizations. The remaining 14.45 percent of the responded professionals was working with joint venture organizations. Around 91.83 percent of the respondent organizations have implemented some sort of LM principles in their organization. Few of the organizations were implementing some kind of advanced manufacturing techniques like total quality management, total productive maintenance, etc., which are the part of the LM principles (Shah and Ward, 2003). Hence the study considered only the responses from LM principles' implemented organizations to do the analysis. The present study further concentrated to find out the respondent size of the organization. The classifications of organizations are based upon following the guidelines given by Rahman *et al.* (2010). The preceding study proposed that organizations having employees more than 200 numbers could be classified as large scale (LS) industry. Accordingly the present survey data revealed that 71.67 percent of the respondent organizations were LS industry. The remaining 28.33 percent of the respondents were representing small and medium scale (SMS) industry.

Table I. The statistics of the individual sector responses

Industry	No. of responses received by post	No. of responses received by e-mail	Total no. of responses received	Sample size	Response rate
Automobile	28	29	57	202	28.22
Machinery equipment	16	24	40	152	26.31
Electrical and electronics	9	24	33	190	17.37
Process	11	17	28	150	18.67
Textile	7	15	22	59	37.29
Total	71	109	180	753	23.90

The study also finds out how long a particular organization has been implementing LM principles. The response of the survey shows that many of the organization have started implementation of LM principles; around 57.22 percent of the responded organizations have implemented the LM principles more than one year and less than five years period. The study further analyzed and found that only 21.11 percent of the organizations have implemented LM principles in their organization more than five years and less than ten years. The study also found from the survey that only 15 percent of the responded organizations have implemented the LM principles in their organization for more than ten years. It clearly indicates that most of the Indian organizations have started implementation of LM principles very recently. Table II shows the key characteristics of the respondents.

4.2 Understanding of LM

In order to find out the understanding of LM principles among the respondents, the present study requested them to indicate what they are thinking about LM principles. The respondents were given eight choices to describe the LM principles (Wong *et al.*, 2009). The main emphasizes of LM is waste elimination and continuous improvement methodology. Out of 180 valid received responses, the study revealed that many of the respondent organizations have understood that it is a waste reduction (average mean score value 4.32) and continuous improvement process (average mean score value 4.19), which clearly shows that many of the professionals have knowledge about LM principles from Indian manufacturing industry. Moderate number of the industry professionals understand LM as tools and techniques to improve operations (average mean score value 3.14) and Toyota production system (average mean score value 3.02). Interestingly, the roots of LM came from Toyota production system (Krafcik, 1988), which might be the reason for many respondents to reply in that manner. A closer investigation on survey data revealed that only small number of the respondents have understood that LM is a fully integrated manufacturing philosophy (average mean score value 1.6). The results clearly show that organizations have started to believe LM principles as long-term manufacturing philosophy across Indian manufacturing industry (Bhasin and Burcher, 2006). A very few professionals (average mean score value 1.12) of the respondent organizations understood that LM principles were a way of life. The mean average score values of understanding of LM by the respondents is given Table III.

	Frequency	%
Number of employees		
⩽200	51	28.33
>200	129	71.67
Ownership		
Indian owned	103	57.22
Foreign owned	51	28.33
joint owned	26	14.45
Lean implementation		
0 < years < 1	13	7.22
1 < years < 5	103	57.22
5 < years < 10	37	21.11
10 < years	27	15.00

Table II. The key characteristics of the respondents

Table III.
The mean average score values of understanding of LM by the respondents

Sl. no.	Understanding of lean manufacturing	SMS industries mean	LS industries mean	Total mean
1.	Waste reduction	3.79	4.53	4.32
2.	Continuous improvement	3.76	4.36	4.19
3.	Tools and techniques to improve operations	2.08	3.56	3.14
4.	Toyota production system	2.16	3.36	3.02
5.	A fully integrated management philosophy	1.72	2.14	1.60
6.	A system to organizing and managing product development, supplier and customer relations	1.2	1.55	1.45
7.	Headcount reduction	1.10	1.45	1.35
8.	A way of life	1.02	1.16	1.12

4.3 Drivers of lean implementation

The present study analyzed the drive force to implement LM principles in the respondent organizations. In this regard, the study requested the respondents to provide what are the influencing factors for implementation of LM principles in their organization. The similar methodology was performed by Wong *et al.* (2009) in their study on Malaysian electrical and electronics industry. According to the present survey, the main influencing factor to implement LM principles in their organizations is customer satisfaction. It exhibited average mean score 3.56. Many of the SMS manufacturing industries implemented LM principles due to their customer requirements. Other driving factors, which influenced to implement LM principles in their organizations are continuous improvement program (average mean score 3.18) and best manufacturing practices (average mean score 3.15). The driving factor that influenced the least to implement LM principles in their organization was increased flexibility of the production (average mean score 1.933). The average mean score values of the drivers to implement LM principles are given in Table IV.

4.4 Area of LM implementation

One of the objectives of the present study is to find out the implementation status of LM principles in key area of the organization. Wong *et al.* (2009) have mentioned 14 key areas of the manufacturing organization to implement LM principles. The key areas of the organizations are: scheduling; inventory; material handling; equipment;

Table IV.
The average mean score values of the drivers to implement LM principles

Sl. no.	Drive force to implement lean principles	SMS industries mean	LS industries mean	Total mean	SD
1.	Drive to focus on customers	3.64	3.53	3.56	0.77
2.	Part of the organization's continuous program	2.81	3.33	3.18	0.91
3.	Desire to employ world best practice	2.56	3.38	3.15	0.98
4.	Development of key performance indicators	2.34	2.66	2.57	0.81
5.	The need for survival from internal constraints	2.45	2.74	2.66	0.98
6.	To increase market share	1.43	2.30	2.05	0.67
7.	To increase flexibility	1.24	2.21	1.93	0.89

work processes; quality; employees; layout; suppliers; customers; safety and ergonomics; product design; management and culture; and tools and techniques. The present study finds out the average mean score for each key practice area. A higher average mean score designates a higher degree of implementation of the particular key area. The average mean score of all 14 key areas are ranging from 1.96 to 4.49. While arranging the average mean score in descending order, the study found that customer key area showed high average mean score value of 4.49. The second highest ranked key area of LM principles implementation in Indian manufacturing industry was inventory key area (average mean score 4.32). The subsequent key areas are quality, suppliers and layout with average mean scores of 4.15, 4.06 and 3.88, respectively. Whereas, the least average mean score of the key area was product design, which was 1.96. The study further investigated the reason behind the low average mean score for product design. The study understood that many of the SMS industries and a few of LS industries have received their product designs from the customer. Hence many of the SMS and LS industries did not implement LM principles in their product designs. The average mean score values of implementation area wise is given in Table V.

The present study further finds out what are the differences in implementation of LM principles in SMS and LS industries. The study observed that there was significance differences in terms of average mean score in the key areas of product design, safety and ergonomics, employees, management and culture and scheduling. The LS industries are relatively financially stronger than SMS industries. Hence the LS industries can spend more budget resources in the above mentioned five key areas, which was one of the factors that may be influencing differences in terms of average mean score value. The study clearly identified that LS industry employees were well trained and empowered than SMS industry. The LS industries have well established product design and development teams compared with SMS industries.

4.5 Obstacles of implementing LM principles

The present study also investigated the obstacles of implementing LM principles in Indian manufacturing industry. The study identified 16 obstacles to implement LM principles in any manufacturing organization based on literature survey as well as communicated with industry professional (Wong *et al.*, 2009; Eswaramoorthi *et al.*, 2011).

Sl. no.	Key areas	SMS industries mean	LS industries mean	Total mean	SD
1.	Customer	4.56	4.46	4.49	0.59
2.	Inventory	3.54	4.62	4.32	0.81
3.	Quality	4.22	4.12	4.15	0.84
4.	Suppliers	3.90	4.12	4.06	0.87
5.	Layout	3.30	4.11	3.88	0.83
6.	Tools and techniques	3.22	3.97	3.76	0.88
7.	Work processes	3.51	3.78	3.70	0.96
8.	Material handling	3.12	3.82	3.62	0.85
9.	Equipment	2.93	3.90	3.62	0.98
10.	Scheduling	2.20	3.97	3.47	1.05
11.	Management and culture	2.23	3.65	3.25	1.20
12.	Safety and ergonomics	2.12	3.25	2.93	1.29
13.	employees	2.56	2.88	2.79	1.19
14.	Product design	1.09	2.31	1.96	1.05

Table V. The average mean score values of implementation area wise

The 16 obstacles to implement LM principles are: lack of top management support; failure of past lean projects; financial benefits not recognized; does not practice what is preached; lack of time to implement; lack of know – how to implement; company culture or national culture; budget constraints; employee resistance; backsliding to the old ways of working; lack of communication; lack of manufacturing facility; lack of support from suppliers; frequent design changes; the customer orders are highly fluctuating/varying; and lower volume of demand. The present survey revealed that major obstacle to implementation of LM principles in Indian manufacturing industry was employee resistance, which showed an average mean score of 3.76. In many organizations, employees were lacking job security due to lean implementation in their organization, which is a myth in reality. Hence the study suggested that the organization needs to conduct training and create trust in the mind of employees before going to implement LM principles in their organization. The second and third major obstacles were: a systematic lean approach missing or lack of know-how to implement and budget constraint, with average mean scores of 3.44 and 3.37, respectively. The study separated the SMS industry responses from the LS industry responses. It clearly indicates that the SMS industries were struggling to implement LM principles due to inadequate manufacturing facility and lack of support from their top management, which was reflected in the present survey responses. The averages mean score value of obstacles to implement LM principles in Indian manufacturing industry is given in Table VI.

4.6 Type of LM waste

The main objective of LM is to find out the non-value added activities and to avoid these activities from the manufacturing line. According to Ohno (1988), waste could be classified into seven categories, which are: over production; waiting; unnecessary motion; transportation; inventory; inappropriate processing; and defects. The present

Table VI.
The average mean score values of obstacles to implement LM principles in Indian manufacturing industry

Sl. no.	Obstacles	SMS industries mean	LS industries mean	Total mean	SD
1.	Employee resistance	3.62	3.82	3.76	0.81
2.	Lack of systematic lean approach or lack of know – how to implement	3.22	3.38	3.44	0.83
3.	Budget constraints	3.81	3.27	3.37	0.80
4.	Backsliding to the old ways of working	3.12	3.06	3.22	0.93
5.	Lack of communication	2.98	2.88	3.09	1.12
6.	Lack of time to implement	2.89	2.81	3.04	0.65
7.	Lack of manufacturing facility	3.92	2.54	2.84	1.27
8.	The customer orders are highly fluctuating/ varying	2.81	2.44	2.77	1.00
9.	Frequent design changes	2.12	2.03	2.48	0.84
10.	Lack of top management support	3.75	1.94	2.42	1.22
11.	Company culture or national culture	3.02	1.82	2.33	1.17
12.	Lower volume of demand	2.12	1.69	2.24	0.86
13.	Does not practice what is preached	2.69	1.58	2.16	1.01
14.	Lack of support from suppliers	1.78	1.47	2.08	0.88
15.	Failure of past lean projects	1.56	1.31	1.96	0.89
16.	Financial benefits not recognized	1.62	1.15	1.85	0.57

research tried to find out which types of wastes were removed from their respondent organizations. The first highest waste that could be reduced by these respondent industries was inventory waste with average mean score value of 4.05 of the total respondent organizations. Many of the respondent industries effectively reduced defects waste level of the organization with average mean score value of 3.77 of total respondent organizations. It clearly indicates that most of Indian manufacturing industries have struggled with more inventory and defects in the production, which may be one of the reasons to implement LM principles. A very few industries had identified transportation waste by applying LM principles in their organization. The averages mean score values of each waste identified by Indian manufacturing industries are given in Table VII.

4.7 Benefits of LM principles

Generally many of the organizations and case study research works have reported that LM principles implemented organizations have benefitted in various aspects of production. Hence the present research also tried to find out the benefits enjoyed by the implemented organizations in respect of cost, quality, inventory, productivity, decrease in response time, flexibility, etc. The present research survey revealed that many of the organizations have benefited more in reduced inventory due to implementation of LM, with average mean score value of 4.1of the total respondent organizations. The present study also revealed that the quality of the product and productivity of the manufacturing lines improved significantly with the help of LM principles with respective average mean score values of 4.00 and 3.95 of the total respondent organizations. When the quality of the product and productivity of the manufacturing have improved, it reduces the production scrap. The survey also revealed that respondent organizations have benefited in terms of scrap reduction due to implementation of LM principles with average mean score value of 3.52 of the total respondent organizations. Many of the research studies have proved that response times improve drastically due to implementation of LM principles. The present research survey also revealed similar kind of results in terms of response time improvement benefit received due to implementation of LM principles with average mean score of around 3.41 of the total respondent organizations. The averages mean score values of organizations received benefits from LM implementation is given in Table VIII.

4.8 Awareness of LM elements

Many of the research articles have proposed and implemented various elements and techniques under LM system. Some of the researchers have tried to gather the complete list of the LM processes, tools and techniques used in various research studies. In this category of the study, Pavnaskar (2001) has conducted research and identified a total of

Sl. no.	Type of waste	SMS industries mean	LS industries mean	Total mean	SD
1.	Inventory	3.84	4.13	4.05	0.50
2.	Defects	3.94	3.70	3.77	0.94
3.	Inappropriate processing	3.16	3.27	3.24	1.13
4.	Waiting	2.92	3.04	3.01	0.85
5.	Unnecessary motion	2.45	3.06	2.89	0.84
6.	Over production	2.34	2.57	2.51	0.88
7.	Transportation	1.88	2.14	2.07	0.84

Table VII. The averages mean score values of each waste identified by Indian manufacturing industries

101 LM elements, techniques and practices from the existing literature. The preceding study tried to help the organizations to establish relationship between lean elements and manufacturing waste. Shah and Ward (2003) identified 21 LM elements in their literature review study. Anand and Kodali (2009) conducted literature survey to find out the unique elements of LM to propose conceptual comprehensive framework of LM. The conceptual framework proposed 69 elements from the existing literature survey of the LM. The present study adapted complete set of LM practices, tools and techniques proposed by Anand and Kodali (2009). The preceding study also proposed conceptual LM framework along with stepwise procedure for implementation of LM. Nordin *et al.* (2010) classified all lean elements into five categories. The five categories are: process and equipment, manufacturing planning and control, human resource management, supplier relationship and customer focus. The present study combined supplier relationship and customer focus under roof of supply chain management.

One of the objectives of the present study was to find out the real awareness of LM elements among Indian manufacturing industry professional. The study clearly revealed that a value of 2.88 was found as the total average of the levels of awareness of the investigated lean elements. The study clearly indicates that the awareness of LM elements among Indian manufacturing industry professional were fairly good. The most popular LM elements among Indian manufacturing professional were cross-functional team and multi-functional workers, which have mean score of 4.22 and 4.17, respectively. The study revealed that concurrent engineering (average mean score = 1.09), focussed factory production (average mean score = 1.12), rolling production plans (average mean score = 1.12) and 5S (average mean score = 1.17) have least popular LM elements among Indian manufacturing industry professionals. The study also analyzed that mistake proofing or poka yoke, one piece flow, kanban system, pull production were most familiar elements among professionals, which reveals that in terms of average mean score more than 4.00 in five point scale. The average mean score of LM elements awareness is given in Table IX.

4.9 LM implementation

The responses of survey questionnaire revealed the status of LM principles implementation in Indian manufacturing organization with the mean value varying from 4.01 to 1.2. The most popular constructs were multi-skill workforce, cross-functional team working, kanban system, statistical process control, small lot production and pull production in LM principles implementation among Indian manufacturing organizations with respective average mean scores of 4.19, 4.14, 4.11, 4.11, 4.08 and 4.02 on five-point scale. The LM constructs like concurrent engineering,

Table VIII. The average means score values of organizations received benefits from LM implementation

Sl. no.	Benefits	SMS industries mean	LS industries mean	Total mean	SD
1.	Decreased inventory	3.54	4.32	4.10	0.54
2.	Improved quality	3.70	4.12	4.00	0.63
3.	Improved productivity	3.47	4.14	3.95	0.59
4.	Reduced waste or scrap	2.50	3.92	3.52	0.79
5.	Improved response time	2.98	3.58	3.41	0.91
6.	Increased profit	3.08	3.37	3.29	0.94
7.	Reduced cost	2.89	3.23	3.13	1.12
8.	Improved flexibility	2.27	3.12	2.88	1.14

Sl. no.	Tools/elements/constructs	SMS industries mean	LS industries mean	Total mean	SD
1.	Cross-functional team working	3.48	4.51	4.22	0.76
2.	Multi-skilled workforce	3.44	4.45	4.17	0.82
3.	Kanban system	3.98	4.08	4.05	0.89
4.	Pull production	3.88	4.07	4.02	1.01
5.	One piece flow	3.87	4.07	4.01	0.88
6.	Poka yoke or mistake proofing or defect prevention	3.79	4.08	4.00	0.80
7.	Statistical process control	3.27	4.27	3.98	0.81
8.	Just-in-time delivery (from suppliers and within workstations)	3.73	4.04	3.95	0.81
9.	Small lot production	3.65	4.05	3.93	0.75
10.	Takt time or takt calculations	3.63	4.03	3.92	0.99
11.	Value stream mapping	3.67	3.99	3.90	0.70
12.	Successive checking	3.50	4.05	3.89	0.91
13.	Defects at source (self-inspection)	3.63	3.96	3.87	0.91
14.	Multi-functional training	3.56	3.98	3.86	0.86
15.	Elimination of waste	3.61	3.96	3.86	0.84
16.	Single minute exchange of dies	3.48	4.00	3.86	0.81
17.	Commonization and standardization of parts	3.42	4.02	3.85	0.79
18.	Layout change or *U*-shaped cell	3.51	3.97	3.84	0.86
19.	Workload or line balancing	3.48	3.97	3.83	0.91
20.	Order-based production	3.30	4.01	3.81	0.79
21.	WIP Reduction	3.51	3.94	3.82	0.87
22.	Design for manufacturing	3.68	3.85	3.80	0.89
23.	Continuous improvements	2.50	4.31	3.80	0.82
24.	Work Standardization	3.71	3.77	3.75	0.83
25.	Use of problem solving tools	3.67	3.76	3.73	0.95
26.	Total productive maintenance	3.43	3.81	3.70	0.99
27.	Visual control	3.10	3.91	3.68	0.86
28.	Cycle time and lead time reduction	3.45	3.75	3.67	0.87
29.	Use of EDI with suppliers	3.55	3.69	3.65	0.95
30.	Sole sourcing or supplier reduction	3.46	3.70	3.63	0.82
31.	Rewards and recognition	3.48	3.65	3.60	0.80
32.	Standardized containers	3.41	3.58	3.53	0.79
33.	Information sharing with suppliers	3.38	3.57	3.52	0.79
34.	Production smoothing or load levelling	3.26	3.54	3.46	0.92
35.	Synchronization	3.13	3.57	3.44	0.83
36.	Maintain spare capacity	3.21	3.44	3.37	0.80
37.	Quality circles	2.11	3.72	3.27	0.93
38.	Supplier proximity	2.81	3.23	3.11	1.07
39.	Supplier involvement in design	2.22	3.40	3.07	0.67
40.	Total quality management	2.72	3.15	3.03	1.27
41.	Cellular manufacturing	2.15	3.02	2.77	1.00
42.	Group technology	2.11	3.00	2.75	0.93
43.	Computer integrated manufacturing (CAD/CAM/CAE)	1.30	2.86	2.42	1.22
44.	Supplier training and development	1.98	2.51	2.36	1.18
45.	Use of multiple small machines	1.98	2.34	2.24	0.79
46.	Process sharing	1.87	2.29	2.17	0.94

(*continued*)

Table IX. The average mean score values of LM elements awareness

Sl. no.	Tools/elements/constructs	SMS industries mean	LS industries mean	Total mean	SD
47.	Andon (warning lights)	1.58	2.20	2.03	1.02
48.	Jidoka (autonomation)	1.67	2.08	1.96	0.89
49.	Long-term supplier relationship	1.13	2.13	1.85	0.57
50.	Product and process simplification	1.28	1.93	1.74	0.57
51.	Flat organization structure	1.12	1.91	1.69	0.60
52.	Storage space reduction	1.12	1.90	1.68	0.59
53.	Long-term employment	1.16	1.83	1.64	0.59
54.	Automation	1.12	1.77	1.58	0.58
55.	Quality certification (suppliers and manufacturers)	1.12	1.77	1.58	0.59
56.	New process or equipment technologies	1.04	1.77	1.56	0.58
57.	Suggestion schemes	1.01	1.73	1.53	0.55
58.	Mixed model manufacturing/scheduling	1.05	1.72	1.53	0.54
59.	Elimination of buffers	1.09	1.65	1.49	0.50
60.	Communication between employees	1.03	1.62	1.46	0.52
61.	Employee empowerment	1.12	1.56	1.44	0.54
62.	Employee participation	1.17	1.51	1.42	0.53
63.	Job rotation or flexible job responsibilities	1.12	1.45	1.36	0.51
64.	Job enlargement or Nagara System	1.17	1.34	1.29	0.50
65.	Safety improvement programs	1.01	1.38	1.27	0.49
66.	Housekeeping (5S)	1.01	1.24	1.17	0.43
67.	Focussed factory production	1.01	1.16	1.12	0.34
68.	Rolling production plans	1.01	1.16	1.12	0.32
69.	Concurrent engineering	1.00	1.12	1.09	0.29

Table IX.

rolling productions roll, focussed factory production and mixed model manufacturing/scheduling, have least priority with respect to implementation of LM principles in Indian manufacturing organizations, which reveals an average mean score values of 1.56, 1.56, 1.67 and 1.80, respectively. The study also analyzed that poka yoke, value stream mapping, workload or line balancing, work standardization, single minute exchange of die, one piece flow, visual control were moderately implemented in Indian manufacturing organizations, which reflected in terms of average mean score value of above 3.8. The study further concentrated only on group/category of the LM average mean score that revealed manufacturing planning and control and process and equipment have 3.29 and 3.10, respectively. The main group/category like human resource management and supply chain management of the LM practices have least average mean score in the present survey, which are 2.65 and 2.95, respectively. The averages mean score of implementation of LM elements are given in Table X.

The present study also tried to find out which LM elements have been mostly used to avoid popular seven LM waste in their organization. The study found that many of the LM elements have been used to avoid defects, inventory and inappropriate processing kinds of LM waste. The study revealed that 53 LM elements have been used to avoid defect LM waste from the manufacturing processes of the responded organizations. The study revealed that 38 LM elements were used to remove inventory LM waste. The study further revealed that 35 LM elements were used to avoid inappropriate processing. The LM elements like kanban, pull production system, small lot size and just-in-time delivery have been used widely among Indian manufacturing organization to avoid inventory LM waste. The study also revealed that poka yoke,

Sl. no.	Group/category	Lean elements	SMS industries mean	LS industries mean	Total mean	SD
1.	Process and equipment		2.27	3.42	3.10	0.78
1.1		Statistical process control	3.10	4.51	4.11	0.95
1.2		Poka yoke or mistake proofing or defect prevention	3.30	4.25	3.98	0.76
1.3		Work standardization	3.65	4.11	3.98	0.76
1.4		Value stream mapping	3.01	4.36	3.98	0.67
1.5		Single minute exchange of dies	3.21	4.26	3.96	0.76
1.6		One piece flow	3.57	4.02	3.89	0.83
1.7		Takt time or takt calculations	2.97	4.10	3.78	0.99
1.8		Successive checking	2.93	4.02	3.71	0.83
1.9		Commonization and standardization of parts	2.99	3.94	3.67	0.84
1.10		Standardized containers	3.21	3.85	3.67	0.86
1.11		Continuous improvements	2.34	4.17	3.65	0.73
1.12		Use of problem solving tools	2.78	3.95	3.62	0.87
1.13		Design for manufacturing	2.65	3.82	3.49	0.81
1.14		Layout change or *U*-shaped cell	3.10	3.59	3.45	0.76
1.15		Maintain spare capacity	2.45	3.79	3.41	0.74
1.16		Defects at source (self-inspection)	2.86	3.47	3.30	0.87
1.17		Total productive maintenance	2.80	3.39	3.22	0.86
1.18		Total quality management	2.13	3.62	3.20	0.98
1.19		Synchronization	2.12	3.32	2.98	0.99
1.20		Cellular manufacturing	1.58	3.53	2.98	0.79
1.21		Group technology	1.67	3.37	2.89	1.06
1.22		Computer integrated manufacturing (CAD/CAM/CAE)	1.10	3.14	2.56	0.97
1.23		Andon (warning lights)	1.20	3.10	2.56	0.88
1.24		Use of multiple small machines	1.56	2.80	2.45	0.85
1.25		Process sharing	1.76	2.47	2.27	0.99
1.26		Housekeeping (5S)	1.03	2.50	2.08	0.56
1.27		New process or equipment technologies	1.04	2.39	2.01	0.51
1.28		Automation	1.02	2.23	1.89	0.42
1.29		Product and process simplification	1.12	2.17	1.87	0.51
1.3		Focussed factory production	1.04	1.92	1.67	0.45
1.31		Concurrent engineering	1.00	1.78	1.56	0.32
2.	Manufacturing planning and control		2.77	3.5	3.29	0.78
2.1		Kanban system	3.45	4.37	4.11	0.82
2.2		Small lot production	3.65	4.25	4.08	0.83
2.3		Pull production	3.77	4.12	4.02	0.94
2.4		Workload or line balancing	3.24	4.27	3.98	0.87
2.5		Visual control	3.12	4.15	3.86	0.78
2.6		Production smoothing or load levelling	3.12	3.87	3.66	0.87
2.7		Order-based production	2.97	3.79	3.56	0.84

(*continued*)

Table X. The average mean score values of implementation of LM elements

Sl. no.	Group/category	Lean elements	SMS industries mean	LS industries mean	Total mean	SD
2.8		Elimination of waste	3.10	3.74	3.56	0.77
2.9		WIP reduction	3.16	3.61	3.48	0.94
2.10		Cycle time and lead time reduction	3.10	3.59	3.45	0.81
2.11		Jidoka (autonomation)	1.12	2.46	2.08	0.78
2.12		Mixed model manufacturing/ scheduling	1.05	2.10	1.80	0.48
2.13		Rolling production plans	1.12	1.73	1.56	0.41
3.	Human resource management		1.66	3.04	2.65	0.6
3.1		Cross-functional team working	3.10	4.62	4.19	0.84
3.2		Multi-skilled workforce	3.67	4.33	4.14	0.78
3.3		Rewards and recognition	3.10	3.67	3.51	0.97
3.4		Multi-functional training	2.10	3.94	3.42	0.93
3.5		Quality circles	1.93	3.40	2.98	0.94
3.6		Suggestion schemes	1.01	3.02	2.45	0.45
3.7		Safety improvement programs	1.05	2.79	2.30	0.44
3.8		Communication between employees	1.03	2.66	2.20	0.51
3.9		Flat organization structure	1.06	2.46	2.06	0.54
3.10		Long-term employment	1.02	2.36	1.98	0.48
3.11		Employee participation	1.06	2.34	1.98	0.41
3.12		Job enlargement or Nagara System	1.02	2.30	1.94	0.32
3.13		Employee empowerment	1.08	2.21	1.89	0.38
3.14		Job rotation or flexible job responsibilities	1.03	2.23	1.89	0.46
4.	Supply chain management		1.86	3.38	2.95	0.72
4.1		Sole sourcing or supplier reduction	2.78	4.18	3.78	0.95
4.2		Information sharing with suppliers	2.40	4.28	3.75	0.81
4.3		Just-in-time delivery (from suppliers and within workstations)	3.10	3.87	3.65	0.75
4.4		Use of EDI with suppliers	2.70	3.90	3.56	0.84
4.5		Supplier proximity	2.25	3.92	3.45	0.79
4.6		Supplier involvement in design	1.56	3.86	3.21	0.78
4.7		Supplier training and development	1.45	3.04	2.59	0.89
4.8		Quality certification (suppliers and manufacturers)	1.04	2.66	2.20	0.59
4.9		Elimination of buffers	1.04	2.66	2.20	0.57
4.10		Storage space reduction	1.08	2.45	2.06	0.45
4.11		Long-term supplier relationship	1.04	2.35	1.98	0.52

Table X.

supplier sourcing, quality circles, statistical process control, multiple skilled workforce were most frequently used LM elements to avoid defect LM waste from Indian manufacturing organization. The popular list of LM elements used to avoid each LM waste is given in Table XI.

5. Discussion

The present study tried to present significant insight into current state of LM principles' implementation among Indian manufacturing organization. The study also

Sl. no.	Type of LM waste	LM elements	No. of LM elements used
1.	Over production	Order-based production, storage space reduction, small lot production, use of EDI with suppliers, mixed model manufacturing/scheduling, job enlargement or Nagara System, elimination of buffers, workload or line balancing, group technology, communication between employees	10
2.	Waiting	Information sharing with suppliers, layout change or *U*-shaped cell, use of multiple small machines, use of EDI with suppliers, production smoothing or load levelling, maintain spare capacity, workload or line balancing, synchronization, communication between employees, single minute exchange of dies	37
3.	Unnecessary motion	Layout change or *U*-shaped cell, cross-functional teams, Kanban system, maintain spare capacity, total productive maintenance, group technology, single minute exchange of dies, communication between employees, value stream mapping, successive checking	13
4.	Transportation	Supplier proximity, group technology, information sharing with suppliers, synchronization, use of EDI with suppliers, sole sourcing or supplier reduction, commonization and standardization of parts, cellular manufacturing, storage space reduction, just-in-time delivery (from suppliers and within workstations)	10
5.	Inventory	Small lot production, Kanban system, pull production, continuous improvement program or kaizen, long-term supplier relationship, just-in-time delivery (from suppliers and within workstations), sole sourcing or supplier reduction, cross-functional teams, one piece flow, cellular manufacturing	38
6.	Inappropriate processing	Cross-functional teams, suggestion schemes, visual control, multi-skilled workforce, continuous improvement program or kaizen, work standardization, quality circles, total quality management, multi-functional training, supplier training and development	31
7.	Defects	Multi-skilled workforce, quality circles, suggestion schemes, Poka yoke or mistake proofing or defect prevention, sole sourcing or supplier reduction, defects at source (self-inspection), cross-functional teams, statistical process control, successive checking, use of problem solving tools	53

Table XI. The popular list of LM elements used avoid each LM waste

concentrated on various factors related to LM principles and its impact on various operational activities:

- The study tried to find out the implementation of LM principles in SMS industries and LS industries. The LS industries (around 71.67 percent) were more advanced in respect of LM principles implementation than SMS industries (around 28.33 percent). Majority of the SMS industries (around 60 percent) have implemented LM principles recently, i.e., just a few years back. According to Papadopoulou and Ozbayrak (2005) and Sim and Rogers (2009), LM is the long-term manufacturing strategy, which needs to be implemented in organizations with long-term goals and benefits. The SMS industries have always tried to focus on short-term benefits and profits than long-term quality achievement due to financial instability. Most of the customers of the SMS industries were LS industries. The LS industries have to come forward and help their suppliers in respect of LM principles implementation so that both organizations will get the complete benefits of the LM principles in terms of quality, productivity and cost of the product. Most of the Indian LS industries (around 60 percent) have also partially implemented LM principles in various departments of the organization very recently (less than five years) and have started to get the partial benefits with respect to cost, quality and productivity of the organization. However the Indian LS industries have to implement LM principles in their entire organization instead of particular area of the organization to get the complete benefits of the LM principles.

- It has revealed that many organizations have implemented lean practices to achieve the customers satisfaction (mean value is 3.56) and continuous improvement (mean value is 3.18) in the manufacturing plant. Many researchers (Anand and Kodali, 2010, 2009) have reported that implementation of lean principles also provides lot of flexibility to the organization in the aspects of manufacturing various products. But very few organizations have understood that the importance of lean principles to improve the flexibility of the organizations (mean value is 1.93). Hence, the study suggests the organizations management has to provide the complete training program to understand and get the attention of employees about lean principles by revealing various benefits obtained with the implementation of lean principles.
- Many of the Indian manufacturing industries have understood LM principles as waste reduction process (mean value is 4.32) and continuous improvement program (mean value is 4.19). According to Bhasin and Burcher (2006), LM is a fully integrated management philosophy that delivers long-terms benefits to the organization. Still many of the Indian manufacturing organizations have implemented it as only a waste reduction process in manufacturing operations in shop floor. Very few of the Indian manufacturing organization professionals have understood that it is fully integrated management philosophy. Hence the Indian manufacturing industries have to expose LM principles to their professionals as a way of life (mean value is 1.12) and long-term management philosophy (mean value is 1.60) instead of the waste reduction process only in the manufacturing activities within the shop floor of the organization.
- The present study tried to focus on area of the implementation of LM principles in the Indian manufacturing organization. The study revealed that many of the Indian manufacturing industries have implemented in the area of customer (mean value is 4.49). Many of the organizations have neglected to implement LM principles in the area of product design, employees and safety and ergonomics, it is clearly reflects in average mean values are 1.96, 2.79 and 2.93, respectively. Many of the studies have proved that lean product development and design is one of the best methodologies to develop successful product within market acceptable cost. In the present global scenario, the important factor of the product development is time to market (Gupta and Wilemon, 1990; Thomke and Fujimoto, 2000). The traditional development processes have to consider one initial good idea and use it to do the development to achieve the final acceptable outcome (Ward *et al.*, 1995). Generally the entire traditional process used to work within the boundary wall of the initial idea. Whereas, lean product development processes is different than normal traditional product development processes with respect to thinking beyond the boundaries (Stalk Jr, 1988). It broadly tries to

collect all the possible set of initial ideas, gradually eliminate weaker solutions and unite several solutions to decide the ultimate solution of the product (Clark and Fujimoto, 1989). Many of the professionals used to think that gathering lots of ideas and discarding to find the final solutions is the waste and time consuming process. But, the information gathered from this processes is recoded and reused for future needs, which is considered as value added waste. The important finding from the present study is that organizations have given least importance to the employee area. If any organization has to implement LM principles in their organization the employees of the organization should be well equipped in terms of knowledge. Otherwise the objective of the implementation of LM principles cannot be fulfilled without help of the employees of the organization. The study also revealed that safety and ergonomics was another important factor neglected by Indian manufacturing industries. The organizations have to concentrate more on safety and ergonomics to improve the morale and reduce the fatigue of the employees. These two factors also impact on productivity of the organization (Gyekye, 2006).

- While the study focussed to find out the obstacles of LM principles to implement in Indian manufacturing industries. The present research has revealed that employee resistance (mean value is 3.76) is the major obstacle to implement LM principles in Indian manufacturing industry. Many of the shop floor workers felt that LM principles were increasing their activities and giving a sense of job insecurity. Hence the organizations have to create complete awareness about LM principles and its impact on the organization business, productivity and workers flexibility (Haynes, 1999). Many of the Indian manufacturing industries have struggled with lack of systematic approach (mean value is 3.44) to implement LM principles in their organizations. The study found that many of the researchers (Doolen and Hacker, 2005; James-Moore and Gibbons, 1997), have proposed various frameworks to implement LM principles in the various organizations. But the studies failed to focus on defining the various steps of implementation procedure and also relationship between various LM elements. Hence the present study suggested to the researchers across the world to not only develop a framework comprising of various LM elements, but also incorporating various steps and procedures to implement LM principles and also there has to be explanation of clear relationship between the various LM principles. The literature survey of the study found that only one framework has shown clear steps and procedure to implement LM elements across manufacturing organizations, which was developed by Anand and Kodali (2010).

- The study also analyzed what type of LM waste could be removed with the help of LM elements in Indian manufacturing organization. The study found that Indian manufacturing industries were concentrated mostly on inventory, defects and inappropriate processing, which clearly reflects in its mean values are 4.05, 3.77 and 3.24, respectively. It is clearly indicates that Indian professionals have used LM elements as waste reduction process in operational area only. Many of the Indian manufacturing industries were not able to identify transportation waste (mean value is 2.07) due to lack of knowledge to apply LM elements. Jasti *et al.* (2012) found 35 percentage transportation wastes in one of the Indian process industry and suggested to avoid transportation waste through their case study research methodology. The case study also concluded that transportation waste can help to improve green supply chain management. Hence the professionals have to understand the importance of all seven wastes and try to avoid all types of waste instead of concentrating on few LM wastes.

- The study analyzed the awareness of the LM elements among Indian manufacturing professionals. The study found that 29 LM elements (69 LM elements) were least understood by Indian manufacturing organizations. Most of the professionals have awareness on most popular and frequently used LM elements instead of the complete set of LM elements. Some of the most popular LM elements like jidoka (mean value is 1.96) and 5S (mean value is 1.17) have least average mean score. To get maximum benefits of the LM implementation, the professionals should have clear knowledge on the complete set of LM elements. The organizations should develop continuous training program to create awareness as well as interest to implement LM elements in their organizations.
- The study brings out the implementation status of LM elements among Indian manufacturing organization. The similar kind of analysis was performed by Eswaramoorthi *et al.* (2011) to find out the most frequently implemented LM elements in the Indian machine tool industries. The preceding study revealed that a very few number of LM elements were practicing effectively across Indian machine tool industries. However Indian machine tool industries were in the beginning stage of LM principles' implementation. The present study considered different types of manufacturing industries to comment on implementation of LM elements across Indian manufacturing industries. The study found that 31 LM elements have been given least preference to implement among Indian manufacturing organizations. The numbers of LM elements that have been implemented in Indian manufacturing industries are quite in line with the awareness of the LM elements among organization professionals. The study found similar kind of results regarding awareness of LM elements among the professionals. The study found important evidence that many of the manufacturing organizations were projecting that LM principle can be implemented only in manufacturing planning and control (mean value is 3.26) as well as process and equipment (mean value is 3.10) groups. Many of the Indian manufacturing industries have not implemented effectively LM elements in human resource management group except very few LM elements like cross-functional team working and multi-skill force. Hence the present study suggested that all LM elements of four groups should be implemented effectively across Indian manufacturing industry to get real fruit of LM implementation. The study also tried to show the most important LM elements to avoid various LM wastes from the Indian manufacturing industries, which may help the beginners of the LM implementation manufacturing industries.

6. Conclusion

The present research study has given a significant insight to find the present status of LM principles implementation and its related issues among Indian manufacturing industries. The study prepared a survey questionnaire to identify existing level of understanding of LM principles among professionals, drive force to implement LM principles, areas of implementation of LM principles, obstacles to implement LM principles, type of LM waste avoided by implementation of LM principles, benefits received from LM principles implementation, awareness among manufacturing professional about LM principles, the implementation status of various LM principles among Indian manufacturing industries and identification of popular LM principles to avoid popular seven LM wastes. The survey questionnaire administered to six experts each from academic and industry to conduct content validation. The result of the survey clearly shows that most of the respondent organizations have implemented some sort of LM principles in their organization. The study revealed that majority of the organizations was categorized in transition mode (< 5 years) of LM principles implementation. The Indian manufacturing industries should be aware and understand the main purpose of LM principles implementation. The major constraints to implement LM principles were employee resistance and lack of awareness about LM principles among industry professionals. The study also revealed that majority of the organizations have implemented in specific area of the manufacturing operation with very few popular tools of LM instead of following any systematic approach to implementing LM principles across whole organization. The study suggests to the future researchers to not only propose new LM frameworks but also to propose the steps and stages to implement the LM frameworks across manufacturing industries. The study found that many of the manufacturing industries have used LM principles to avoid few LM wastes instead of the complete list of LM wastes. Hence the present study strongly suggests that Indian manufacturing organizations should conduct frequent training programs to their organization workforce to understand how to practice LM concepts in details in their organization and encourage them continuously to achieve the vision and mission of LM principles. The present study exposed the problems facing by the organization to implement lean principles effectively. The study also suggests how to overcome the existing problems in the organizations. The study will help to encourage the future researchers to develop new frameworks for effective implementation of lean principles in the organization. The study is also useful to the practitioners to find out the problems to implement lean principles in the organization and also encourage adopting a particular framework to implement lean principles instead of using very few familiar lean tools in the organization.

The limitation of the present study is the survey data limited to only 180 Indian manufacturing organizations. Hence the conclusions of the present study may not be generalized to the whole Indian industry sectors especially across sectors like infrastructure, services sectors. In the end, the present study suggests to future researchers to carry out similar kind of surveys to find out the status of implementation of LM principles across various Indian organization sectors as well as find the difficulties the organizations have faced to implement LM principles and provide possible solution to overcome these difficulties.

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