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Impact of Lean Manufacturing in Bulker Manufacturing Organization: A Case Study

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Abstract

Growth of any manufacturing industry depends on its work culture and its focus towards resolving various manufacturing and management related issues within the organization. Organizations frequently search for the tools and techniques either to improve the productivity or to reduce the production cost in order to maximize the competitive advantage. According to previous studies lean manufacturing system (LMS) is one of the most successful improvement concept to eliminate waste and non–value adding activities that obviously occurs in industries. This study was conducted within three months in Akshay industries which is bulker manufacturing unit located at Govindpura Bhopal. In this study lean and other tools and techniques such as Jidoka (Autonomation), JIT, Kaizen, Kanban, Muda, Poka-Yoke, TPM and 5S were implemented in order to find out areas for the reduction of waste, work load and improving the efficiency of the organization. The results of this study have shown positive improvements in the company. LMS results in significant reduction in indirect cost of bulker manufacturing, simultaneously it improves the smoothness in working of organization. Change in the cutting plan also reduces the scrap of the sheet metalsignificantly. LMS has potential to further improve the performance in future.

Keywords: Bulker manufacturing industry; Kaizen;Lean manufacturing;Lean tools; Scrap reduction.

Introduction

Bulker Industry

Bulker is a means of material transport which is generally not known to the peoples except those who are related to the industry that is why it needs an introduction. Bulker manufacturing industry is one of the growing industries in India. Demand of bulker in the market is increasing day by day as it is the safest and most appropriate means of transporting materials in powder form. Bulker is a shelled structure made of sheet metal which is used to carry fly ash, cement and other material in form of powder. Bulker manufacturing industry has a great demand of bulkers in the cement industries for transporting cement in very large quantity and in power plants where fly ash is continuously produced as a byproduct of coal and needs to be carried to some other place (www.akshaybulker.com).

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This industry is one of the most unorganized industries as there are various operations that need to be performed and several sheet metal parts need to be manufactured at the same time. Manufacturing of bulker starts primarily with the cutting of various parts of different shape and size from sheet metal plate (mild steel). Because of continuous production, there is a lot of scrap which gets piled up around the cutting bed of plasma cutting machine. Secondarily, various sheet metal parts and other attachments are joined by welding and after that painting is done which also generates continuous scrap or waste. This industry frequently undergoes many problems related to material handling, material management, store management, scrap management, machine maintenance and miscellaneous. To overcome these issues and to reduce scrap or waste material, lean manufacturing philosophies need to be introduced in this industry.

Need for improved methodology

Companies and industries must continuously search for ways to remain competitive and keep going in the market. Lean manufacturing is one of the best suitable methodologies which help in improving the performance of manufacturing industry (Choomlucksana et al., 2015). Lean manufacturing is focused on continuously eliminating non-value added activities and maximizing value added activities through reducing costs and increasing the quality of organizational processes. Normally, non-value added activities add costs to the product without enhancing the value. Non-value added activities can be called as waste in lean manufacturing. Non-value added activities or waste refers to any activity that does not add value to the process and to activities that a customer would be unwilling to pay for (George, 2002).

Research Objectives

- To map the current manufacturing system of the selected company in order to understand the existing process.
- To identify the various lean manufacturing tools which can help in improving the performance of the Akshay Industries (Bulker manufacturing) Govindpura, Bhopal.
- To identify the impact of various lean manufacturing tools over the industrial performance.
- To compare the previous and present performance of the industry.

Literature Review

Lean is a production philosophy which considers that any activity which consumes resources but not create value for the end customer is wasteful and should be eliminated (Womack et al 1990; Shah and Ward 2007; Antony 2011). According to Sohal (1996) lean production eliminates unnecessary processes, align processes in continuous flow and solve problems through continuous improvements. In industries it is carried out through a set of lean practices.

Lean manufacturing offers various tools and techniques to tackle and identify different types of waste effectively and improve efficiency in different situations (Bon et al., 2015). Various tools and techniques offered by lean manufacturing are 5s, kaizen, standardized work, plan-do-check-act (PDCA), poka yoke, kanban, just in time (JIT), total productive maintenance (TPM), value stream mapping (VSM), statistical process control (SPC), Heujunka, andon, Gemba, hoshin kanri, overall equipment effectiveness (OEE), bottleneck analysis, key performance indicators (KPI's), quality management program, scrap reduction, etc

According to Choomlucksana et al. (2015), by applying lean manufacturing principles the processing time of polishing stage in a sheet metal stamping industry was reduced from 6582 seconds to 2468 seconds or by 62.5%. Also non value added activities were reduced from 1086 activities to 261 activities or by 66.53%. Furthermore, overtime cost was reduced by

1764 Dollar per year. Lean tools implemented or used during this study period were visual control, poka yoke and 5S.

Considering small and medium sized enterprises Moeuf A et al, (2016) observed that the absence of functional organization, lack of methodology and deficiency of formal procedures are often the cause of difficulties experienced by SMEs during the implementation of Lean practices

Thus, it is understood that implementation of lean manufacturing practices has resulted in improvement in productivity and profitability in many organizations.

Research Methodology

As we can say that lean manufacturing is a fairly new concept in India, the intent of this research paper was to assess the current state of lean implementation in a bulker manufacturing industry.

The research methodology of this study is based on the combination of detailed interviewing technique, a survey based on a well set questionnaire on various tools of lean manufacturing and personal observations.

This bulker manufacturing industry is located at Govindpura industrial area Bhopal.

In the detailed interviewing technique various questions were asked from the head of the company in order to get the core details and information about the organization which helps in accessing the current working state of the organization.

A survey is also conducted by preparing a set of questionnaires which were answered by two respondents.

The items used in this questionnaire were initially developed reviewing different studies including Panwar et al (2015), on lean implementation in process industry. This covers questions related to lean tools, reasons of not implementing lean, and reasons of implementing lean manufacturing in that organization.

There are other set of questionnaire which were asked about the implementation level of various lean tools within the organization.

Other than this, a set of questions were also prepared which comes under the heading of principles of lean manufacturing. For measuring 5S implementation, questionnaires for various 5S parameters were also prepared apart from itself being a lean tool.

Another set of questions were prepared under the heading working state which tries to gain the information about the working condition of the industry which will provide the figures for the closeness to their ideal working condition and another set for case study (www.imcpa.com).

A five-point Likert scale was developed for each item of lean practices using the following criteria:

1. no implementation (0 percent);
2. little implementation (around 25 percent);
3. some implementation (around 50 percent);
4. extensive implementation (around 75 percent); and
5. complete implementation (100 percent).

Table 1 gives the details of the question and score on 5 point Likert scale

Table 1: Principles of lean manufacturing (Source: Self analysis)

Principles of lean manufacturing		
1	Standardized work	4.5
2	Kaizen	4.5
3	Quality programs	5
4	Pull system	4
5	Value stream mapping(analyze the current state and designing a future state for the series of events that take a product or service from its beginning through the customer)	3.5
6	Flow orientation	4.5
7	Employee involvement	5
8	Visualization	4.5
9	Customer focus	5
10	Stability and robustness	3.5
11	Workplace management	4
12	JIT (Just In Time)	4
13	Elimination of wastage	4.5
14	Continuous improvement	4
Mean		**4.37**

Table 2: Lean tools 1 (Source: Self analysis)

Lean tools 1		
1	5S	4.5
2	Total productive maintenance (TPM)	4.5
3	Visual control	4
4	Statistical process control (SPC)	4
5	Quality management program	4
6	Takt time (the rate at which a finished product needs to be completed in order to meet customer demand)	3.5
7	Poka yoke/error proofing	4
8	Scrap reduction	4
9	Two bin auto replenishment system	4
10	Heijunka/production smoothening/line balancing	4.5
Mean		**4.10**

Table 3: Lean tools 2 (Source: Self analysis)

Lean tools 2		
1	PDCA (plan, do, check, act)	4
2	KPIs (key performance indicators)	5
3	Jidoka (autonomation)	4.5
4	Gemba (the real place)	4
5	Andon (real time communication)	4
6	Bottlenecks analysis (strengthening weakest link)	4.5
7	Continuous flow (eliminate many forms of waste inventory,waiting time and transport)	4
8	Hoshin kanri (policy deployment)	4
9	Muda (waste)	5
10	OEE (overall equipment effectiveness)	4
Mean		**4.40**

Table 4: 5S (Source: Self analysis)

5S		
1	Seiri (sort/eliminate which not needed)	4
2	Seiton (set in order/organize remaining items)	4.5
3	Seiso (shine/ clean and inspect work area)	4
4	Seiketsu (standardize/write standards for above**)**	4.5
5	Shitsuke (sustain/.regular apply the standards)	5
Mean		**4.40**

Table 5: Working state (Source: Self analysis)

Working state		
1	Your actions and activities aligned to your goals	4
2	You have the right inventory at the right places	5
3	You spend much time in observing	4
4	You have standard	4.5
5	Your tools always in the right places to help you to do the right things	4.5
6	Your Problem solving techniques are effectively working	4.5
7	You do sustainable changes	4.5
8	You try to surface or burry problems	4.5
9	Your kanban signals the right amounts	4
10	Your processes are visual	4.5
Mean		**4.40**

Table 7: Waste parameters (Source: Self analysis)

7 Waste parameters (Sources of waste)		
1	Over production	1
2	Waste of unnecessary motion	2.5
3	Waste of inventory	3
4	Production of defects	1.5
5	Waste of waiting	2
6	Waste of transportation	2
7	Waste of over processing	1.5

Table 7: Reasons of implementing lean (Source: Self analysis)

Reasons of implementing lean		
1	Elimination of wastes	3.5
2	To decrease production cost	3
3	To improve quality	4.5
4	To facilitate JIT production	3.5
5	To increase demand management efficiency	4
6	To increase customer satisfaction	3.5
7	To increase supply chain efficiency	4
8	To increase utilization of space	3.5

Table 8: Reasons of not implementing lean (Source: Self analysis)

Reasons of not implementing lean		
1	Production process is complex	2
2	Lack of education and expertise on lean	2.5
3	Lack of financial resources	2
4	Lack of time	1.5
5	Cultural barriers (Resistance to change)	1.5
6	Lean is complex to implement	2.5
7	Lack of senior management interest and support	1.5
8	Lack of area utilization/Limited area	2.5
9	Due to simultaneous work in various bays	2
10	Non availability or shortage of any component	2
11	Lead time is not specified for various components in the store	2

This methodology also comprises of personal observations and readings in order to access through the whole working process of the organization. It includes both technical as well as managerial aspects of the organization. These are the observations for the duration of three months in order to collect various data of the organization.

Various changes are implemented under different lean tools which are given as follows-:

a. Kaizen

Under kaizen,, the change in cutting plan is implemented. First of all in which dish cutting is changed as in previous working state the dish is to be cut by joining two sheets of dimensions 5×1530×7500 as the maximum diameter of dish to be cut is 2000 mm, the rest of the sheet metal left after cutting the dish is scrap so to minimize the scrap coming out of the dish cutting, a sheet having width of 2000 mm is ordered which reduces scrap from 58% to 35% when calculating over circular dish of diameter 1750 mm. This also eliminates extra cost and time for welding of two sheets which finally forms dish as shown in Figure 1.

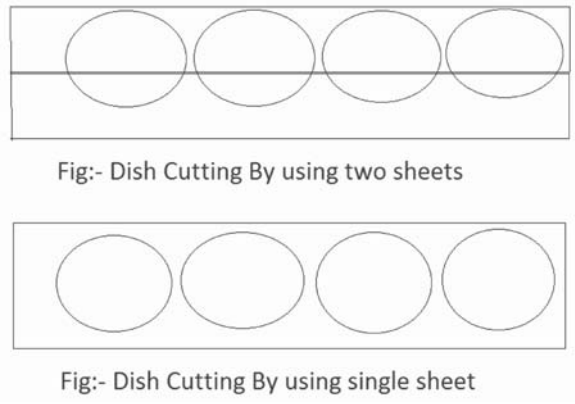

Figure 1: Dish Cutting Plan (Source: Own creation)

As in Figure 2 the previous process flow chart shows that the outer leakage and surface testing is performed after primer painting. Due to some technical issues the outer leakage and surface testing is performed before primer painting as shown by the current process flow diagram in Figure 3. As after primer painting, if any leakage is detected then it is proofed by welding, when welding is performed over primer painted surface, it damages the nozzle of the CO2 welding machine. The nozzle of CO2 welding machine is very costly. So by applying these changes the reduction in damage of CO2 nozzle is reduced by 20%.

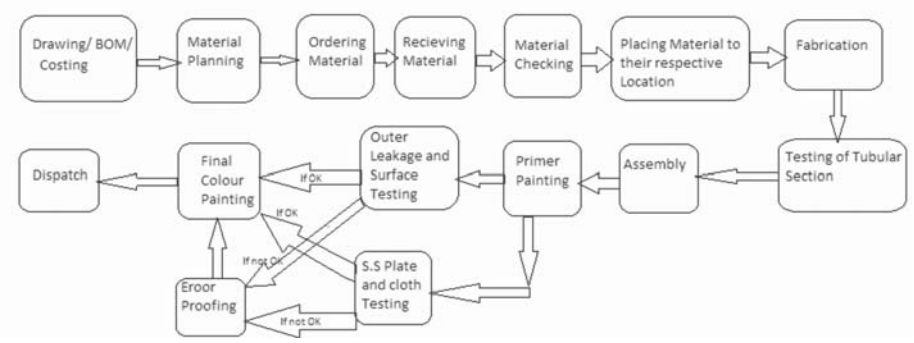

Figure 2: Previous process flow diagram (Source: Own creation)

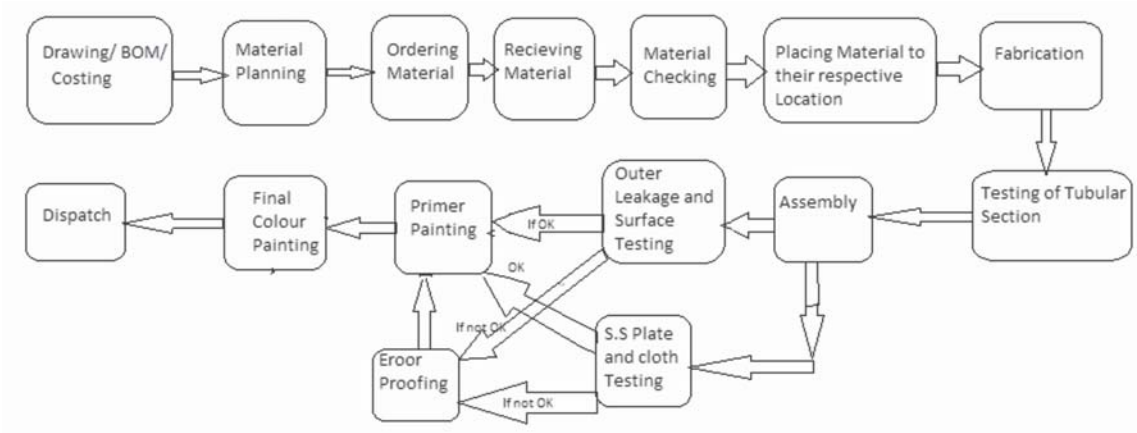

Figure 3: Current process flow diagram (Source: Own creation)

b. Autonomation (Jidoka)

It can be defined as automation with human touch. Under this tool the approach area of hoist is increased from 50% to 75% of the total area of the industry as shown in Figure 4 and Figure 5 which reduces the extra cost paid to the hydra crane vendor on each call on per hour basis. Simultaneously it also reduces human effort and waiting time for other relevant operations. This change in approach area can be seen in plant layout.

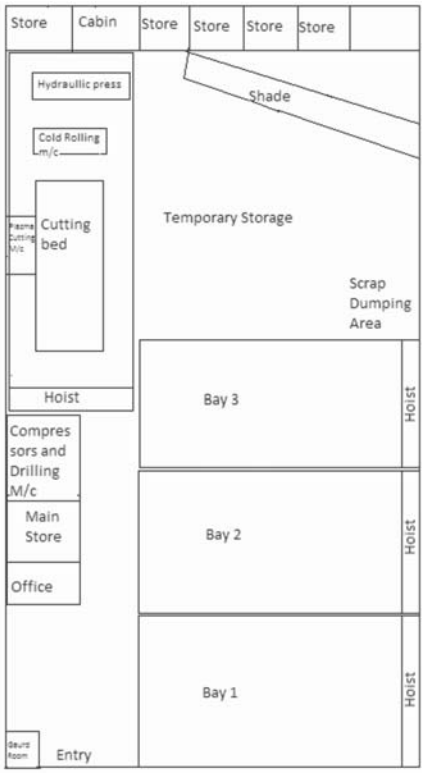

Figure 4: Old Plant Layout
(Source: Own creation)

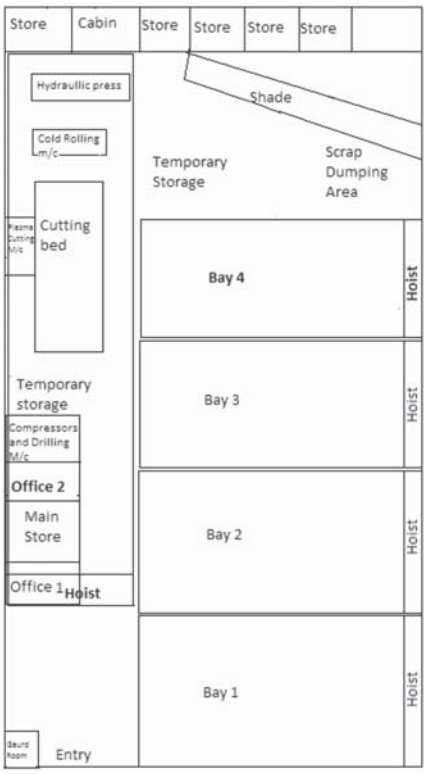

Figure 5: New Plant Layout
(Source: Own creation)

c. Andon

This is the real time visual feedback system of the plant floor that indicates current production status. So under this tool an Office 2 is built at the left centre of the industry which can be seen in the plant layout in Figure 5. Initially there was 0% real time visual feedback from the main office as shown in Figure 4 and from office 2 it gives around 50% of real time visual control over production system.

d. Poka yoke (Error Proofing)

This is one of the tools of lean manufacturing which focuses on minimizing the defects or errors in the final product so under this tool material and product is tested at various stages which are

- Checking of material at the time of receipt
- Checking of Dish dimensions
- Checking of shell dimensions
- Tubular section testing
- Outer leakage testing
- Surface finish testing
- Grinding test
- Welding test
- Color paint testing

e. Takt Time

It is the pace of production that aligns production with customer demand calculated as planned production time/Customer demand. It provides a simple, consistent, intuitive method of pacing production. So for this industry takt, time can be measured as total number of units manufactured per month. The information gathered from the interview reflect that if the pace of production is 20 units/month then it is a no profit no loss condition. Normally the pace of production of this industry is 30 units/month.

Case study

Asper the information provided by the employees of the industry, the industry works as per the demand of the customers for which he is spending large amount of money. They regularly survey their customers for input features which add value to the product and customers are willing to pay for the same. They used to bring their valued customers to the plant and note down any comments for changes to look business practices through customer's eyes. The old working condition and new working conditions are quite different from each other. Few changes were implemented and it is continuously being tried to make many changes in future. The availability of space as per the production rate of the industry is vey less so there is obviously a patchwork of add-on processes and equipments dropped where space was available without thought to a smooth production flow or efficient use of operators, but they try to locate equipments for a smooth flow. They keep on trying to challenge their employees for improved operations and recognition. In addition to that there is provision for numerous award and incentive programs to suggest improvements and identify ways to eliminate unnecessary steps in an effort to become lean. They have an automated system to collect input and a reward system. They have trained their employees in such a manner that employees view each other as customer which means employees understand how their output impacts someone else's process or that they are the "customer" receiving material from upstream. If we talk about their inventory turnover

rate they have better than the average. On discussing about the communication, needs and timeframes with the distributer and supplier they are well connected to each other.

Results and Discussions

Table 9: Outcome of various lean parameters (Source: Self analysis)

Principles of lean manufacturing	4.37
Lean tools 1	4.10
Lean tools 2	4.40
Overall lean performance (lean tools 1 & lean tools 2)	4.25
5S	4.40
Working state	4.40

Table No.9 compiles the outcome of various lean parameters from Tables 1, 2, 3, 4, 5. The implementation of lean tools is fairly well in this industry according to the input given by the employee of the industry because all the parameters in the Table no.9 are greater than 4 which varies from 4.10 for lean tools 1 to 4.40 for 5S and working state simultaneously of the industry. It can also be concluded that there is a scope for improvement in all the factors primarily set in the questionnaire.

From the table No.6we can easily identify that the factors which are mostly responsible for the waste in the industry are waste of inventory and waste of unnecessary motion.

The factors due to which the lean manufacturing needs to be implemented from Table no.7 are to improve the quality and to increase supply chain efficiency with rating of 4.5&to increase demand management efficiency simultaneously with a rating of 4.

The factors due to which the lean manufacturing sees the difficulties in implementation from Table 8 are lack of education and expertise on lean,lean is complex to implement, lack of area utilization/limited area with simultaneous maximum rating of 2.5 as compared to other factors.

There are various changes implemented under different lean tools which are given as follows along with the factors and their final result as well -:

Conclusions

The main purpose of this study was to map the current manufacturing system of the identified company in order to understand the existing process, identify the various lean manufacturing tools which can help in improving the performance, to identify the impact of various lean manufacturing tools over the industrial performance and to compare the previous and present performance of the industry. From the analysis done, it can be easily concluded that lean manufacturing tools have a very positive impact on the performance of the organization

The most dominating factor among all waste factors is waste of inventory. This means that the material handling and distribution among all the contractors needs to have a special focus.

The findings of this study show that the implementation of all the lean tools,e.g kaizen, jidoka, andon, takt time and poka yokeis very impressive and improved the performance of the industry in terms of time, money and reduced wastage as well.

Limitation and Future Scope

This case study was conducted only over a single industry and on a single bulker out of its various variants manufactured by the industry. If the study is conducted over more than one

Table 10: Impact of lean tools on industrial factors (Source: Self analysis)

Lean tools	Factors	Impact
Kaizen	Dish cutting scrap	Reduced from 58% to 35%
	Damage of CO2 nozzle	Reduced by 20%
Autonomation (Jidoka)	Hoist approach area	Increased from 50% to 75% and deduction in hydra crane call up.
Andon	Visual feedback	Increased from 0% to 50%
Poka-yoke	Error proofing	Testing at various stages eliminates defects in the final product.
Takt time	Pace of production	Fluctuates as per the demand

industry then we could have more knowledge about the manufacturing sector ofbulker industry and its work culture. The calculations for dish cutting are also limited to single variant of dish only. Every industry has their own secrets especially their financial status and strategies which they do not reveal due to which this study is only limited to external inputs and outputs

The future scope of this work can be of wider range in this industry, we have taken only limited number of tools into account and their effect on the performance of the industry. The tools we have taken into consideration for study were kaizen, jidoka, poka yoke, andon and takt time. These are other tools which we have studied on a macroscopic level of the organization, but there are other tools which work on the microscopic level of the organization and better results of the impact of lean manufacturing on bulker manufacturing industry can be obtained.

References

- Antony, J., (2011),"Six sigma vs lean: some perspectives from leading academics and practitioners", *International Journal of Productivity and Performance Management*, Vol. 60, No. 2, pp. 185-190.
- Bon, A.T., Kee, T.S., (2015),"Implementation of lean manufacturing for productivity improvement in Malaysia", International Conference on Industrial Engineering and Operations Management Dubai, UAE, March 3-5 (2015).
- Choomlucksana, J., Ongsaranakorn, M.,Suksabai, P., (2015),"Improving the productivity of sheet metal stamping subassembly area using the application of lean manufacturing principles", Procedia manufacturing 2, International Materials Industrial and Manufacturing Engineering conference 102-107.
- George, M.L. (2002),"Lean Six Sigma: Combining Six Sigma Quality with Lean Speed", McGraw-Hill, New York.
- Moeuf,A., Tamayo, S., Lamouri, S., Pellerin,R., Lelievre, A., (2016),"Strengths and weaknesses of small and medium sized enterprises regarding the implementation of lean manufacturing", IFAC-PapersOnline 49-12 (2016) 071-076.
- Panwar,A., Jain,R., Rathore,A.P.S., (2015),"Lean implementation in Indian process industries: some empirical evidence", *Journal of Manufacturing Technology Management*, Vol. 26,Iss 1 pp. 131-160.
- Shah, R., Ward, P.T., (2007),"Defining and developing measures of lean production", *Journal of Operations Management*, Vol. 25, No. 4, pp. 785-805.
- Sohal, A.S., (1996),"Developing a lean production organization: an Australian case study", International Journal of Operations and Production Management, Vol. 16, No. 2, pp. 91-102.
- Womack, J.P., Jones, D.T., Roos, D., (1990),"The Machine That Changed the World",Harper Perennial, New York, NY.
- www.imcpa.com: Viewed on:28/03/2017
- www.akshaybulker.com Viewed on:25/07/2016