Analysis And Improvement of Productivity by using Lean Manufacturing Tools in Foundry Industry - A Case Study

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***Abstract*- In today's global competitive environment there is a need for the casting set ups and foundries to develop the components in short lead time. Defect free castings with minimum production cost have become the need of this indispensable industry. Lean manufacturing (LM) is mostly enthused by the Toyota Production System (TPS) which has been absorbed on removal of waste and refining customer gratification. LM is a set of values, attitudes and business procedures to allow the execution of it, which is broadly recognized and applied since 1960.This project work addressed the various production processes that can be used in foundry industry, finding the problems existing in these processes, Gaining deep knowledge of lean manufacturing and lean tools, Implementing these lean tools practically in foundry industry at optimum level and Comparing the result of analysis.**

***Index Terms*- Toyota Production System (TPS) , Lean manufacturing (LM) , Multiple Criterion Decision-Making (MCDM) , Indian Institute of Foundry (IIF).**

I. INTRODUCTION

Metal casting is one of the direct methods of manufacturing the desired geometry of component. The method is also called as near net shape process. It is one of the primary processes for several years and one of important process even today in the 21st century. Sand casting is a casting process where the molten metal is poured into a mold made of sand. There are various types of sand castings like Green-sand molding, air set sand casting, dry sand molding and the lost form method. Sand casting is the most commonly used Casting Process because of the cost effectiveness of the process and the east availability of raw materials.

In sand casting, the molten metal is poured into the cavity, which has a pattern made of wood or metal. The pattern is an exact replica of the shape that the metal is to casted in. Molten metal in introduced into the cavity in the shape of the casting to be made. When the cast solidifies the mold is broken to remove the castings. Since, the initial method of wet and baked sand mold were expensive, new method of sand mixing have been invented where the use of chemical and adhesives are used to bind the aggregate.

The basic material which is the sand or the clay is usually taken from the banks or the lakes. Now a day's sand molds are made that can be used for automated casting processes. A variety of patterns is used like the match plate and copes and drag pattern for enabling in giving the required shape to the molten metals.

The cuts and cavities are made by making use of the cores. Mostly sand casting is manually executed, since the mold are broken on completion of the solidification process. But in order to speed up the casting process, machines are used for some special operation in sand casting process. Machine aids are used for sand preparation, mold preparation, production of casting boxes, ramming sand properly around the pattern, extraction of the finished work pieces, etc. Machines are also used for handling the castings, re preparation of the sand and for mixing the components for making molds. Sand casting is extensively used, for cast iron and steel parts of medium and large size where surface smoothness and dimensional precision are the main concerns. Sand casting is also used to make large parts in material like bronze, brass, aluminum, etc. Also used for casting sculptures this can have a certain amount of rough surface finish. In Jadhao steel alloys green sand casting is used to manufacture complex shapes of various sizes depending upon the customer requirements. Green sand casting isa commonly used form of sand casting; green sand casting gets its name because wet sand is used in the molding process.

II. RESEARCH METHODOLOGY

The primary aim of this study is to find out the needs and examine the degree to which the concepts of lean management are put into practice within various manufacturing Industry.

(i) This is an overview for finding the current situation of lean management practices in manufacturing industries.

(ii) It is a measure to identify the constrains that retains lean manufacturing in the infant stage in manufacturing firms and helps to identify the muda (waste) that evolves in an processing unit and gives out supporting measures to remove the same. The constraint that predict the implementation and sustainability of lean manufacturing tools and techniques are also discussed.

III. LITERATURE REVIEW

J. Jezierski, K. Janerka [1] the authors show that the usage of lean tools is at a lower level in domestic foundries than in similar plants abroad. This was the reason why a survey was prepared and over 300 foundry plants were questioned regarding the application of Lean Manufacturing tools. The questions (20 in total) asked if and what tools are implemented in the plant and what benefits have been achieved, or why lean tools have not been implemented in a particular plant. The answers were thoroughly analyzed and the results show that, among others, only 29% of all foundries use lean tools, and the main reason why most of them do not is that these tools are not understood well enough.

Sanjeev Kadian, Randeep Singh, Ashok Kumar Malik [2]This paper present the influence of using Lean Manufacturing Technology to increase the production in scientific equipments manufacturing industry. In this case study the scientific equipments manufacturing company employs part of the “seven basic quality control (QC) tools” to significantly improve the process rejection and rework. By implementing these quality tools as the problem solving techniques the rejection rate was reduced from 7.3% to 4% and Rework rate from 20% to 11.33%.

Neha Verma, Basant Raghuvanshi, Tukesh Verma [3] In this paper they study about the production in a way to improve the industrial lay out and line balancing of these small to medium industries, making the valuation of lean application, contributing to the knowledge about this kind of process. Study and analysis of lean manufacturing to production process, with low level of intermediate inventories, more productivity and shortest times of supply, has been the main challenge imposed to the small to medium enterprise of industrial. Normally with unbalanced lines in their processes, the small to medium foundry industry is characterized by a higher level of inventory of raw material near its production area and a great volume of semi-elaborated products inside the production area, which turns arduous the internal movement of materials and the creation of a lay out to make flow the production.

K.Ravi Kumar, Dr. Y. Venkata Mohan Reddy, Dr. B.Uma Maheswar Gowd, D.Baswaraj[4] Productivity improvement techniques can be applied effectively in enterprises of any size, from one-person companies to corporations with thousands of staff. The majority of the techniques were first seen in mass-production operations but the benefits they can yield in SMEs are not to be underestimated. Many organizations are nowadays interested to adopt lean manufacturing strategy that would enable them to compete in this competitive globalization market. In this respect, it is necessary to assess the implementation of lean manufacturing in different organizations so that the important best practices can be identified. This paper describes the development of key areas which will be used to assess the adoption and implementation of lean manufacturing practices. Lean manufacturing is often seen as a set of tools that reduce the total cost and improve the quality of manufactured products. The lean management philosophy is one which targets waste reduction in every facet of the manufacturing business. This paper will review the current literature and describe how lean methodology can provide a framework mechanism for environmentally sustainable manufacturing sectors.

V. R. Murugananthan, K. Govindaraj, D.Sakthimurugan [5] A value stream is all the actions (both value added and non-value added) required to bring a product through the main flows essential to every product for the production flow from raw materials into the arms of the customer and to design the flow from concept to launch as a lean manufacturing tool. Taking a value stream perspective means working on the big picture, not just individual processes and improving the whole not just optimizing the parts. In this paper, in a casting foundry with results are considered with current state maps and future state maps after following the different steps starting from the detailed time study for mapping the processes from raw materials to final product. When they engage in true process improvement, they seek to learn what causes things to happen in a process and to use this knowledge to reduce variation, remove activities that contribute no value to the product or service produced, and improve customer satisfaction. Process improvement means examine all of the factors affecting the process, the materials used in the process, the methods and machines used the transform the materials into a product or service, and the people who perform the work.

IV. SYSTEM DEVELOPMENT

4.1 Production Processes carried out in JSA

1.Drawing And Pattern :

This is the first phase of steel casting production process. In J.S.A. the drawing and design of the reuired product is usually done by using Catia software.Catia is a multi-platform computer-aided design (CAD) software suite developed by the French company. In J.S.A. there is a separate department which does the work of design and drawing.

A pattern is a replica of the object to be cast, used to prepare the cavity into which molten material will be poured during the casting process. Patterns used in sand casting may be made of wood, metal, plastics or other materials. In J.S.A. patterns are ordered for making the required casting to fulfil the requirements of customer. In the present condition, in J.S.A. there are about approximately 3000 types of pattern currently available. The pattern is generally of wooden, aluminium and casting.

2. Analysis Of Drawing And Pattern:

This is the next phase of steel casting production process, In which the analysis of design and drawing is done using ansys software in J.S.A.Also in this phase the material required for the production is generally ordered.

The detail analysis of drawing, design and pattern is generally done in this phase and if the result is satisfactory then next procedures are done.

3.Raw Material Purchased:

In this phase the respective raw material requied for the production is purchased by the purchased and audit department in J.S.A.

4.Lab Inspection:

This is the is the important step in the production.The raw material purchased is then tested in the lab in separate department of J.S.A. If the results are satisfactory then it is then suppiled to the fondry for the further procedure.Otherwise it is returned to the suppiler.

5.Sand Preparation:

Sand used for sand preparation in J.S.A. is of 3 types

a)Wet sand

b)Dry sand

c)Green sand

Other raw materials used are

1)Coke

2)Pig iron

3)M.S. scrap

4)C.I. scrap

5)Railway scrap

This phase is consist of two processes

A)Mould preparation

In this process the melting of raw material is done in fondry of J.S.A. In J.S.A. There are 2 cupola furnace (capacity 4-5 tonn/hr) and one induction furnace (capacity 500kgs/hr) in J.S.A. for the melting of raw materials.The minimum working temperature of cupola is 1200 degree centigrade.In J.S.A. still now 1600 degree centigrade temperature have been used for the production of steel casting based on requirement.

B)Core preparation

In this process the core required for the casting is made in sand plant in fondry of J.S.A.The core is generally made from resin sand,sodium silicate and co2 mixture in sand plant.Core size is generally ranged between 500-600 mm and 12-13 gram and is generally depend on requirement.It can be manually done or most of the time machines are used for core prepration.Core shooter is the machine used for core preparation in J.S.A.

6.Final Moulding:

After the mould and core preparation final moulding is done.

7.Pouring:

The molten metal fron cupola or induction furnace is then poured in the casting box through runner.This process is done by using machine as the temperature of molten metal is very high and could be dangerous for the workers.But for the small jobs it is sometimes done manually.

8.Knockout:

After pouring the it is then let to cool to obtain required casting.Knockout is the process of opening the casting from casting box.It is sometimes done by using machine (sand plant) or sometimes manually.This process is generally done after 6 hrs after the above process.

9.C.B.T:

C.B.T. stands for chipping, brushing and transfer.This process is generally done in order to remove chips and dust remain on casting.After that it is then transfer to the SHORT BLAST machine.

10.Short Blast Machine:

This machine is used for fininshing purpose.In this machine steel particles are bombarded on casting for the removal of sticky dut and other impurities.There are 3 types of short blast machines in J.S.A.

1)Table type
2)Hanging type
3)300 small machine
3)301

11.Grinding:

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. There is a separate department in J.S.A. where the grinding done for removing sand from casting and sharpening the tool.

12.Painting:

After all the process finally painting is done in order to make it corrosion resistant and to look attractive using machines or most of the time manually.

13.Quality :

The importance of quality is it in product or service cannot be overemphasized. Just study some of the tips given from time to time to make matters easier for everyone. Superior quality is the buzzword at Jadhao Steel Alloys. We are keenly administered by sound management ethics, right from the initial stage of procuring raw material to the market dispatch of the final product. This adherence to quality control measures at every stage of our process facilitates in flawless production. Every aspect is dealt with an extra care that minimizes even the smallest possibility of quality degradation.

4.2 Production Processes Flow Chart

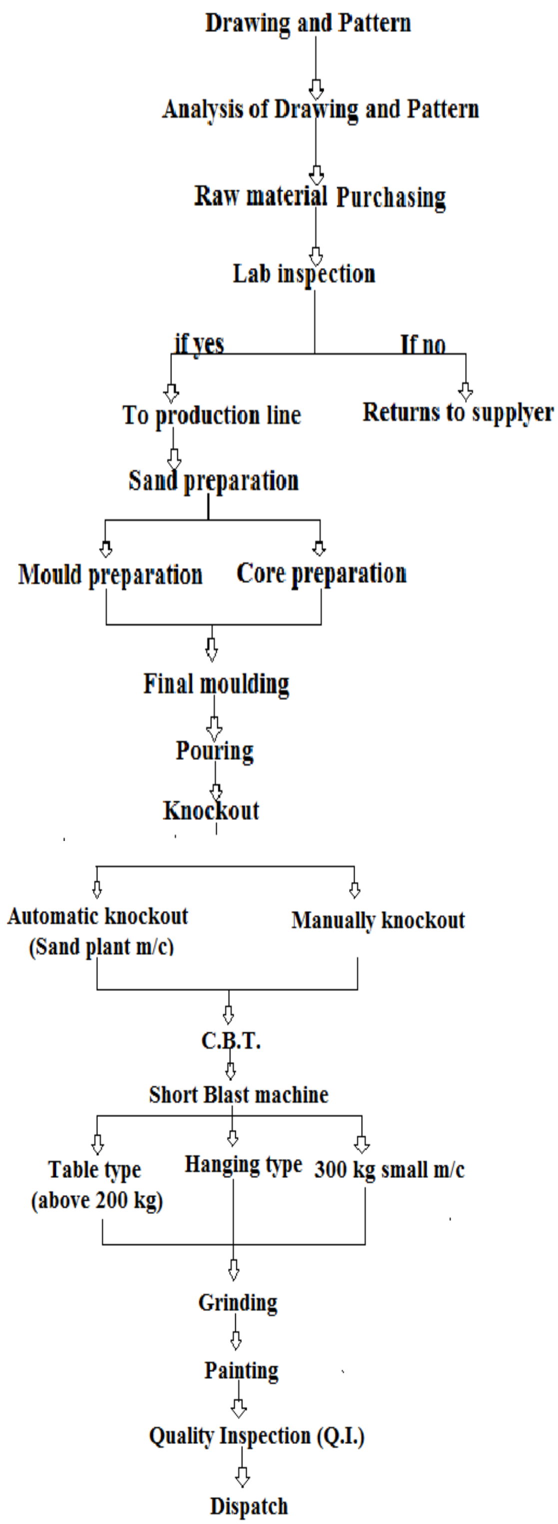

Fig 4.1.: Production processes flow chart.

4.3 Lean Manufacturing Techniques

1. Value In lean production, the value of a product is defined solely by the customer. Identifying the value in lean production means to understand all the activities required to produce a specific product, and then to optimize the whole process from the view of the customer.
2. Continuous improvement The transition to a lean environment does not occur overnight. A continuous improvement mentality is necessary to reach your company's goals. The term "continuous improvement" means incremental improvement of products, processes, or services over time, with the goal of reducing waste to improve workplace functionality, customer service, or product performance.
3. Customer focus A lean manufacturing enterprise thinks more about its customers than it does about running machines fast to absorb labour and overhead. Ensuring customer input and feedback assures quality and customer satisfaction, all of which support sales.
4. Perfection The concept of perfection in lean production means that there are endless opportunities for improving the utilization of all types of assets. The systematic elimination of waste will reduce the costs of operating of an enterprise and it fulfill customer's desire for maximum value at the lowest price.
5. Focus on waste The aim of Lean Manufacturing is the elimination of waste in every area of production including customer relations, product design, supplier networks and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products and less space to become highly responsive to customer demand while producing top quality products in the most efficient and economical manner possible.

4.4traditional Vs.Lean Manufacturing

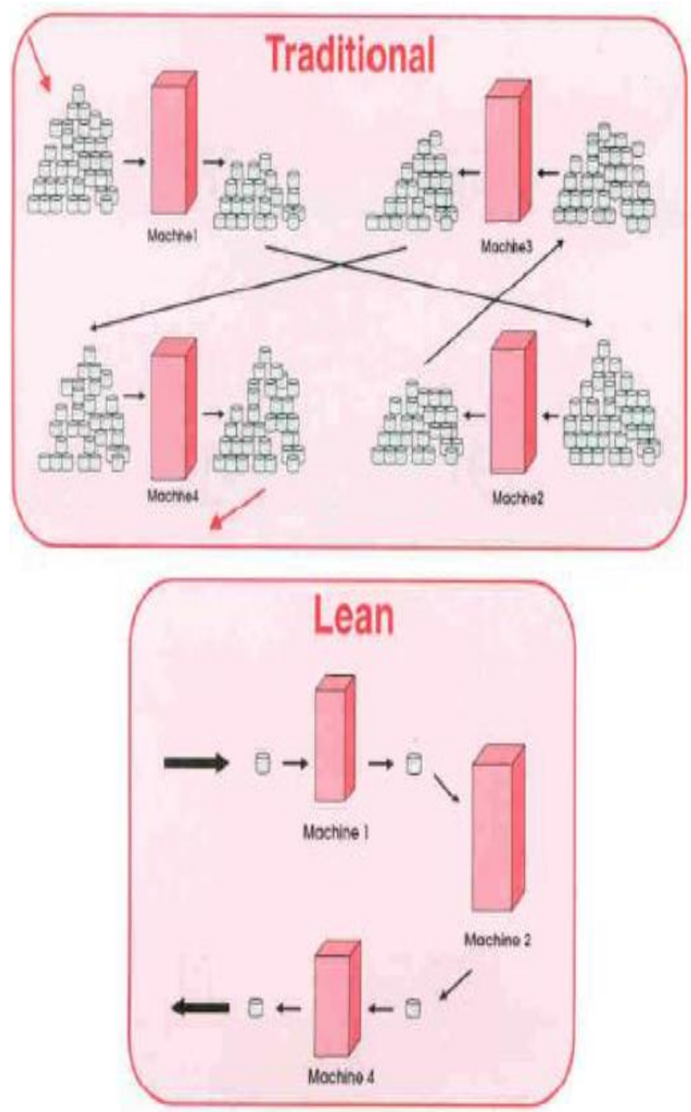

Fig 4.2: Traditional Vs Lean Manufacturing.

4.5 Lean Manufacturing Tools

Lean tools are used to enhance productivity, reduce cost and maximize customer value while minimizing waste during the production processes. Lean method signifies balanced production plan and producing goods on time and in the right quantity and quality

List of the most common lean tools, such as

- Kaizen (Japanese for “improvement” or “change for the better”) –A strategy where employees work together proactively to achieve regular, incremental improvements in the manufacturing processes.

- Value Stream Mapping
  A tool used to visually map the flow of production. Shows the current and future state of processes in a way that highlights opportunities for improvement. Exposes waste in the current processes and provides a roadmap for improvement through the future state.
- Kanban (Japanese for "signboard" or "billboard", which is a scheduling system for just-in-time JIT production)-A method of regulating the flow of goods both within the factory and outside suppliers and customers. Based on automatic replenishment through signal cards that indicate when more goods are needed.
- Benchmarking (standardized work)-
  Eliminates waste by consistently applying best practices. Forms a baseline or future improvement activities.
- TPM (Total Productive Maintenance)-
  Creates a shared responsibility for equipment that encourages greater involvement by plant floor workers. In the right environment this can be very effective in improving productivity (increasing up time, reducing cycle times and eliminating defects).

4.6 Implementation Of Vsm Tool.

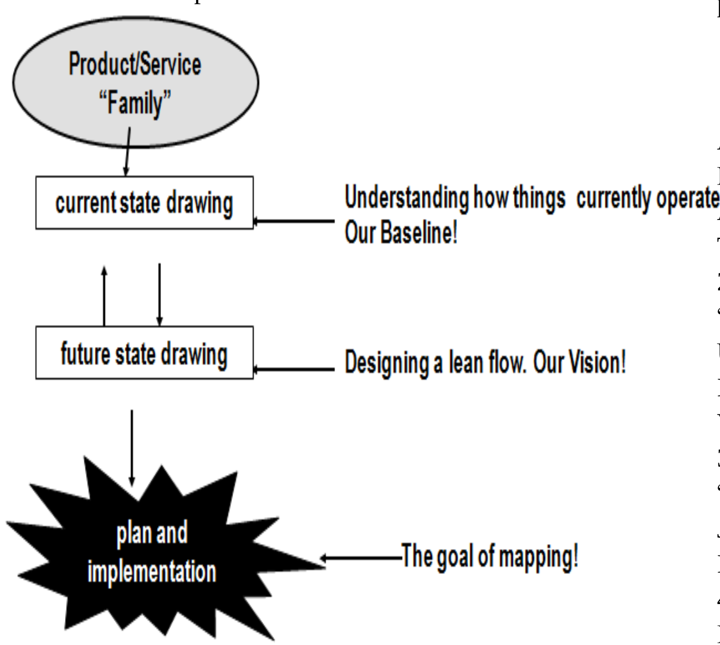

Fig 4.3 : Implementation of VSM tool.

V. CONCLUSION

- After analysis, experiences that the impact of lean tools and techniques is quite noticeable in the company to find out how Lean production can be able to improve productivity in a manufacturing company. The tools – VSM, Kanban, Dedicated Flow, kaizen and 5s improves safety and productivity. The problem of WIP inventories is nearly sort out and they reduced from 16M.T to 13M.T per day and production time is also reduced from 12.5 days to 6.66days.
- In today's world where globalization is now everywhere, it is important for companies to continuously strive for improvements in order to stay competitive.

VI. FUTURE SCOPE

There is an infinite number of ways of implement Lean Manufacturing in these Industries. In this project I use three major tools that contribute lots in improvement of productivity. Many industries are not aware of these tools. Regarding Implementation of 5s it is popular at higher management level, but by referring this project it will be popular in a worker also. By using 5s, kaizen and kanban moral of workers can be increased. But this is possible in future by conducting training program of such types in small to big industries.

REFERENCES

1. Digvijay B. Sutar, B. R. Jadhav ; "A Simulation Approach to Improve Performance in
Foundry Industry". International Journal for Research in Applied Science & Engineering
Technology (IJRASET) Volume 3 Issue V, May 2015
2. Sanjeev Kadian, Randeep Singh, Ashok Kumar Malik; "Increase Production in Small Scale Industry of India by Use of Lean Manufacturing Technology".IPASJ International Journal of Mechanical Engineering (IIJME) Volume 3, Issue 4, April 2015
3. Neha Verma, Basant Raghuvanshi, Tukesh Verma; "Application of Lean Manufacturing - A Case Study on Jindal Steel Power Limited". IJEDR,Volume 3, Issue4, ISSN: 2321-9939, 2015.
4. Kashif Mahmood; "Productivity Improvement by Implementing Lean Production Approach".Parnu, 2015, 183-188.

5. Mr. Nikunj S Patel, Mr. Chetan U Patel, Dr. Pragnesh Brahmbhatt; "Study And Implementation of Lean Manufacturing Tool - 5s".Technical Research Organization India,Volume-1, Issue-4, 2015.
6. Kashif Mahmood, Tallinn University of Technology (Estonia), Productivity Improvement by Implementing Lean Production Approach, (2015) 183-185
7. Sumit Kumar Singh, Kuldeep Sharma, Deepak Kumar, Tarun Gupta; " Role & Importance of Lean Manufacturing in Manufacturing Industry". The International Journal Of Engineering And Science (IJES), Volume 3, Issue 6, Pages 01-14, 2014.
8. V. R. Murugananthan, K. Govindaraj, D.Sakthimurugan; "Process Planning Through Value Stream Mapping In Foundry".International Journal of Innovative Research in Science, Engineering and Technology Volume 3, Special Issue 3, March 2014
9. Sudip Kr. Deb, Abhijit Chakraborty, Ranjan Bhattacharya; "Effects of Lean Tools In Small Scale Enterprises".
10. K.Ravi Kumar, Dr.Y.Venkata Mohan Reddy, Dr. B.Uma Maheswar Gowd, D.Baswaraj; " Improving the performance of manufacturing sector-lean methodology and its impact". International Journal of Engineering Science Invention, Volume 2, Issue 3, March. 2013
11. J. Jezierski, K. Janerka; "The Lean Manufacturing Tools In Polish Foundries Stan Wykorzystania Narzedzi Lean Manufacturing W Polskich Odlewniach". Archives of Metallurgy and Materials, volume 58, issue 3, 2013
12. Young, David D; "Applying Lean Tools and 5S Method at Company RBC".American Psychological Association, 6th edition , spring, 2013
13. Vasudev Krishnan, C. Mallika Parveen; "Comparative Study of Lean Manufacturing Tools Used in Manufacturing Firms and Service Sector". Proceedings of the World Congress on Engineering (WCE), Vol I, 2013, London, U.K.
14. Carlborg P, Kindstrom D, Kowalkowski C. A lean approach for service productivity improvements: synergy or oxymoron?., Managing Service Quality Vol. 23 No. 4, 2013, pp. 291-304
15. Anvari, A.R., Norzima, Z., Rosnay, M.Y., Hojjati, M.S.H. and Ismail,Y. (2010). A comparative study on journey of lean manufacturing implementation, Vol. 3 No. 2, pp. 77-85
16. Billesbach,T. et.al (2009). "Applying lean production principles to a process facility". Production and Inventory Management Journal. p. 5-25.
17. Clênio Senra de Oliveira, Eduardo Barbosa Pinto; "Lean manufacturing paradigm in the foundry industry". Vol. 4, issue 3: 218-230, 2008.
18. Abdulmalek F.A., Rajgopal J., Analyzing the benefits of lean manufacturing and value stream mapping via simulation: A process sector case study. Int. J. Production Economics 107 (2007) 223 – 236.
19. fawaz A Abdulmalek Jayant Rajgopal.(2007) 'Analyzing the benefits oflean manufacturing and value stream mapping via simulation :A process sector case study', Elsevier 2007
20. R.K.Sigh, S.Kumar (2006) 'Lean tool, selection in a die casting unit : a fuzz –based decision support heuristic', Taylor& Francis Vol:44 No.7 April 2006
21. Mr. Vijayandra Singh, Mr.Lalit Yadav.'Implementation of lean manufacturing insmall company', ISSN 2248-4622
22. M.kumar J. Antony, R.K. Tiwari.'Implementing the Lean sigma frame work in an Indian SME: a case study', Taylor & francis.
23. Mr. Irish. C.Pune, Pro. G.R.Naik.'Application of process activity mapping for waste Reduction A case study in foundry Industry', International journal of modern engineering Research (IJMER) Vol.2 ISSN 2249-6645.
24. Eaton M., The lean practitioner's hand book., Kogan page limited, London, Philadelphia, New Delhi