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Streamlining Sand Mixer Machine Production: A study on the Implementation of Lean Approach and Performance Outcomes Across Various Industries

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Abstract
Lean manufacturing, a concept originating in Japan post-World War II, revolutionized manufacturing processes by minimizing waste and maximizing efficiency. Pioneered by Toyota, this methodology focused on reducing human effort, manufacturing space, investment, and engineering hours compared to the prevailing mass production techniques. The term "lean manufacturing" was later popularized by researchers from the International Motor Vehicle Program (IMVP) at the Massachusetts Institute of Technology and gained widespread recognition through Womack et al.'s (1990) book, "The Machine That Changed the World." Lean manufacturing emphasizes responsiveness to customer demand, waste reduction, and efficient, high-quality production.
This research seeks to address the gaps in lean implementation by exploring multi-domain lean practices and developing a suitable lean enterprise model for engineering goods manufacturing firms. By integrating various elements of change, this study aims to provide a comprehensive framework for wider and more effective adoption of lean manufacturing practices.
In this research work, an adoption of lean practices has been carried out where the reduction in time and minimizing the waste has shown significant improvement in the working efficiency of assembly work.
Keywords: Lean Manufacturing; Operational Performance; Quality Control; Just-in-Time (JIT); Process Optimization.

1. INTRODUCTION

The lean concept originated in Japan when the Second World War. Once Japanese manufactures accomplished that they may not afford the huge investment required to reconstruct the devastated Toyota began the method of developing manufacturing processes to minimize waste in all aspects of operations. They created autos with less of everything – the human effort, the manufacturing area, the investment, the engineering hours- compared with mass production, the current producing the, current producing method at that time. Also, it needed fewer inventories, had fewer defects, and created a larger and growing type of product. This was primarily due to the Japanese effective management of production and human resources (Womack et al. 1990)[14]. The term lean manufacturing came into existence from the International motor vehicle Programmed (IMVP) researchers of the Massachusetts Institute of Technology. The project was centered to bridge the numerous performance gap between Western and Japanese automotive industries. (Womack et al. 1990)[13] through their book The Machine that modified the world popularized lean thought in manufacturing. In early 1990s lean manufacturing thought was viewed as a counter intuitive various Fordism manufacturing model (Womack et al, 1990). The goal of Lean manufacturing (LM) is to become extremely responsive to customer demand by reducing the waste in human effort, inventory, time to market, and producing area whereas manufacturing quality product with efficiency and economically.

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Lean manufacturing provides competitive edge to the manufacturer as a result of reduced value, and improved productivity and quality. Lean manufacturing aims at manufacturing product and services at the lowest value and as fast as required by the customer. Many authors have posited lean production because the best possible production system which will be implemented in any company (Womack et al. 1990)[15]. A significant step in the journey towards lean is that the effective management of the flow of products and services through a series of activities concerned in providing value to the customer, called value stream.

Various authors have documented quantitative advantages of lean implementation like improvement in production lead time, processing time, cycle time, set up time, change- over time, inventory, defects & scrap, overall equipment effectiveness, etc. the varied qualitative advantages embrace improved worker morale, effective communication, job satisfaction, standardized work, team deciding, etc. Even in a company with numerous regulative requirements, lean practices completely affect operational performance (Gebauer et al, 2006). Lean manufacturing implementation started in automobile industry and shortly its application was adopted by alternative industries like textile, construction, food, medical, electrical & amp; electronics, services, etc. LM has been adopted by all varieties of Manufacturing systems – product layout, process layout, and fixed layout; batch production and mass productions; separate production and continuous production. It's found applications from manufacturing to service sector; mass production to high variety and low volumes production; labor-intensive industries to technology intensive industries to assembly industry; and medical health care to communication industry. However, the implementation of lean manufacturing within the continuous process company has been less partially due to certain difficulties within the implementation in these kind of industries (Jimenez et al. 2011)[1].

2. LITERATURE REVIEW

P. Kumar et al [11] concluded that for a successful lean implementation, it's necessary to look at lean as a philosophy instead of a strategy. It's necessary to have an organizational cultural transformation together with a bunch of implementation tools. Lean includes a major strategic significance, through its implementation procedure, HRM implications, and general approach to the supplier base including the general universal conviction of viewing lean as a group of techniques instead of embracing it as a philosophy that advocates that it contributes to the relatively low variety of successful lean initiatives. Bhasin; Burcher (2006) [12] have viewed lean as a philosophy instead of a strategy. Lean manufacturing could be included as a continuous improvement method for higher results, and supplier involvement is a must if a company is to reap the rewards of lean practices. Womack et al (1990)[13] explained the transformation of the producing principles from craft production to mass production and then to lean production in the automotive phase. Seifermann et al (2014)[7] found that continuous improvement efforts are means that to achieve high levels of pull production by eliminating variability within the system and thereby reducing defects in the organization. Dhamija et al (2011) expressed that lean organizations are those that utilize less material to form their work, less human efforts to perform the work, less time to design and develop less energy and area. Lean organizations target customer demand and thereby manufacturing top quality product and services within the most effective and economical manner. Ferdousi; Ahmed (2009) [3] surveyed the result of lean principles during a Bangladesh garment industry for performance improvement. The survey indicated that firms have adopted a large kind of lean tools and techniques and gained several performance improvements. Holweg et al (2007) [30] suggested that Lean manufacturing extends the scope of the Toyota production philosophy by providing an enterprise-wide term that draws together the five elements – product development process, supplier management process, customer management process, and policy focusing process. Jafri Mohd Rohani et al. (2015)[1] apply one of the most significant lean manufacturing techniques called Value Stream Mapping (VSM) to improve the production line of a color industry as a case of study. To achieve this goal, lean fundamental principles was implemented to construct VSM for identification and elimination of wastes by using

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team formation, product selection, conceptual design, and time-frame formulation through takt time calculation. Based on the future VSM, final results showed that by implementing some lean thinking techniques, Production Lead-time (PLT) decreased from 8.5 days to 6 days, and the value added time decreased from 68 minutes to 37minutes. Juthamas Choomlucksana et al. (2015)[21] explores a real work case study of the manufacturing sheet metal stamping process to demonstrate how lean manufacturing can help improve work efficiency. This study was conducted within 10 months, started from July 2013 till April 2014. Lean and other improvement tools and techniques such as visual control, Poka-Yoke, and 5s were applied to help companies identify areas of opportunity for waste reduction and improve the efficiency of production processes. Studies of the company processes showed that the deburring and polishing processes tend to create the most non-value added activities and should be addressed as quickly as possible. The significant results indicate that the processing time of a polishing stage, after applying lean manufacturing principle, was reduced from 6,582 seconds to 2,468 seconds or by 62.5%. Also non-value added activities were reduced from 1,086 activities to 261 activities, or by 66.53%. Furthermore, overtime cost was reduced by 1,764 Dollar per year. Denish B.Modi et al. (2014) [22] apply various lean manufacturing principles, which includes advantages, implementation strategy and hurdles in implementation for manufacturing industry. The study specially focuses on the Green manufacturing which is highly in demand in new era. It indicates the use of processes that doesn't harm environment, provides safety to consumers & employers. Lean manufacturing is a precise approach for economical utilization of raw product and eliminating waste through continuous improvement, and aimed to provide qualitative product to the customers. Praveen Saraswat et al. (2015) represent the research paper in which value stream mapping (VSM) tool used in a bearing manufacturing industry by focusing both process on their cycle time for a product UC -208 INNER which is used in a plumber block.in order to use Value Stream Mapping ,relevant data has been collected and analyzed. The lean principle and technique implemented or suggested and future state map was created and the total lead time was reduced from 7.3 days to 3.8 days. The WIP at each station has also been reduced. The production lead time was reduced from, 409 second to 344 second. William M. Goriwondo et al. (2011) published this research with the use of Value Stream Mapping (VSM) tool. VSM is a World Class Manufacturing tool that can be used to minimize waste in manufacturing. Companies are experiencing intense competitive pressure due to globalization hence they cannot afford to operate with waste in their processes. This paper details the use of the VSM tool in reducing waste in bread manufacturing for a company in Zimbabwe. The case study shows how the VSM tool was used to identify and reduce defects by 20%, unnecessary inventory by 18% and motion by 37%.

3. METHODOLOGY

- Identify working of each assembly in Rhino Mixer Cooler.
- Process study of each assembly in Rhino Mixer Cooler.
- Time study before work instruction of each assembly in Rhino Mixer Cooler.
- Prepare work instruction Rhino Mixer Cooler.
- Time study after work instruction of each assembly in Rhino Mixer Cooler.

3.1 Work instruction:

By using work instruction any worker easily know how many parts required, function of each assembly and which processes used for particular parts for each assembly. Work instruction will also help in reducing unnecessary movements. The main benefit of using Work instruction is to reduce the waiting time. Any worker can easily work based on work instruction and thus does not depend on any other worker.

3.2 Time study:

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The first step is to calculate the time taken by each process before and after work instruction. The difference in time study can be reduced at each step of manufacturing, production and assembly with the help of time study.

3.3 5s:

Organize the work area:
- Sort (eliminate that which is not needed)
- Set In Order (organize remaining items)
- Shine (clean and inspect the work area)
- Standardize (write standards for above)
- Sustain (regularly apply the standards)

5s help to eliminate waste that results from a poorly organized work area (e.g. wasting time looking for a tool).

3.4 Plan - Do – Check – Act (PDCA):

An iterative methodology for implementing improvements:
- Plan (Established plan and expected results)
- Do (Implement Plan)
- Check (Verify expected results achieved)
- Act (Review and assess; do it again)

PDCA helps to apply a scientific approach to making improvements: Plan (develop a hypothesis), Do (run experiment), Check (evaluate results), Act (refine your experiment; try again).

4. EXPERIMENTAL SETUP

In the experiment, the study was taken on the machine RMC to calculate the time taken for the whole assembly which the company has to deliver as per the requirements.
Here, for the experiment purpose, the company manufactures 60% of the whole production on RMC machines and they export the same. Thus, we have taken time study analysis and after implementing the above methodologies, we have recalculated the time for the whole assembly.

FIGURE 1. Rhino Mixer Cooler Machine

5. RESULTS AND DISCUSSION

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Here we have calculated the time before and after implementation of the above stated methods.

Table 1. Time Before implementation of methodology

RMC assembly	Manufacturing time(Hr)	Assembly time (Hr)	Total Time (Hr)
Top plate assembly	291	48	339
Slow tool assembly	51	24	75
Fast tool assembly	79	24	105
Side scraper assembly	53	32	85
Discharge door assembly	112	48	160
Fluidizing assembly	140	48	188
Shell assembly	291	80	371
Batch hopper assembly	42	16	58
Butterfly valve assembly	51	48	99
Water circuit	0	8	8
Leg support	2	16	18
Expension cyclon chamber	21	16	37
Heater mounting pipe	8	16	24

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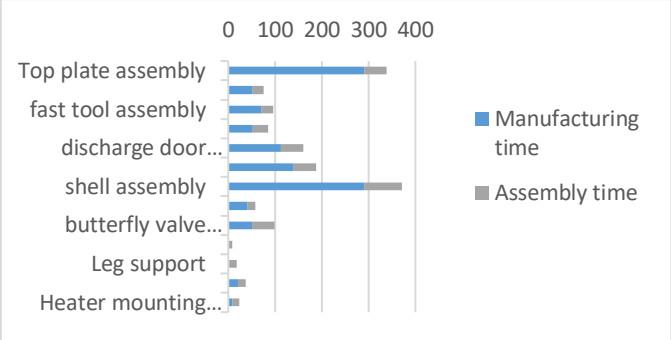

FIGURE 2. Gantt Chart (Before Implementation)

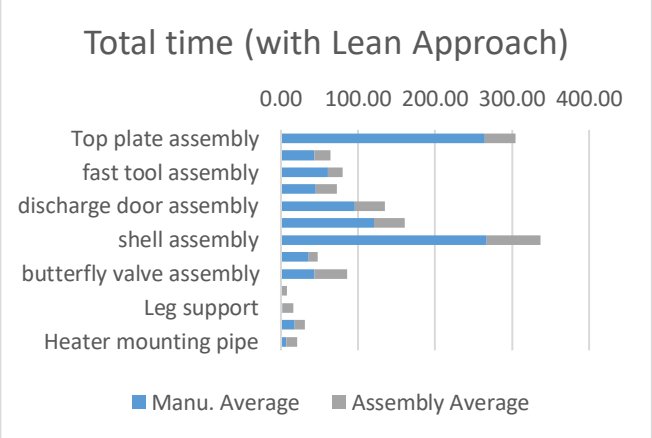

FIGURE 3. Gantt Chart (After Implementation of Lean Approach)

CONCLUSION

• After applying work instruction and 5s methodology of RMC it was observed that 13.77% time has been reduced in Manufacturing time and assembly time. Thus, 196 hours of total time has been reduced after the implementation of work instruction.
• The departmental checklist has been provided to keep 5s principles active throughout the process and regular usage of the same helps the industry for proper utilization of space and resources.
• Implementation of work instruction has improved better understanding of assembly components which has helped the workers to perform assembling operations without ambiguity.
• A proper methodology for machining and assembling is being followed by the given worksheet which has helped the company for smooth functioning and channelized operations.

REFERENCES

[1] J. M. Rohani and S. M. Zahraee, "Production Line Analysis via Value Stream Mapping: A Lean Manufacturing Process of Color Industry," Procedia Manuf., vol. 2, no. February, pp. 6–10, 2015.
[2] D. B. Shinde and P. N. Shende, "Improvement of Plant Layout by using 5S technique-An industrial case study," vol. 4, pp. 141–146, 2014.
[3] A. N. Alam, K. N. Ahmed, S. Ishtiyak, and S. Z. Hasan, "Review of 5S Technique," vol. 4, no. 4, pp. 927–931, 2015.
[4] F. Filgueiras, "LEAN PRODUCTION APPLIED IN A LARGE COMPANY," pp. 1–8.
[5] S. Dhankhar, A. Manderna, and V. K. Dahiya, "Leanness of Indian Industries : A questionnaire survey approach to find out the lean status of Indian industries," vol. 3, no. 11, pp. 158–166, 2014.
[6] S. Arslankaya and H. Atay, "Maintenance Management and Lean Manufacturing Practices in a Firm Which Produces Dairy Products," Procedia - Soc. Behav. Sci., vol. 207, pp. 214–224, 2015.
[7] S. Seifermann, J. Böllhoff, J. Metternich, and A. Bellaghnach, "Evaluation of Work Measurement Concepts for a Cellular Manufacturing Reference Line to enable Low Cost Automation

for Lean Machining," Procedia CIRP, vol. 17, pp. 588–593, 2014.
[8] R. Sundar, A. N. Balaji, and R. M. Satheesh Kumar, "A review on lean manufacturing implementation techniques," Procedia Eng., vol. 97, pp. 1875–1885, 2014.
[9] P. Nowotarski, J. Pas, and J. Matyja, "Improving Construction Processes Using Lean Management Methodologies – Cost Case Study," vol. 161, pp. 1037–1042, 2016.
[10] N. T. Lam, L. M. Toi, V. T. T. Tuyen, and D. N. Hien, "Lean Line Balancing for an Electronics Assembly Line," Procedia CIRP, vol. 40, no. 1, pp. 437–442, 2016.
[11] P. Kumar and S. Kajal, "Implementation of Lean Manufacturing in a Small-Scale Industry.," IUP J. Oper. Manag., vol. 14, no. 2, pp. 25–33, 2015.
[12] Bhasin S, Burcher P (2006). "Lean viewed as a philosophy". Journal of Manufacturing. Technology &Management., 17(1): 56-72.
[13] Womack, J. P., Jones, D. T., & Roos, D. (1990). The Machine That Changed the World. New York, NY: Simon & Schuster.
[14] Womack, J. P., & Jones, D. T. (1996). Lean Thinking: Banish Waste and Create Wealth in Your Corporation. New York, NY: Simon & Schuster
[15] Womack, J. and Jones, D. (2003), Lean Thinking, Simon & Schuster, London.
[16] Womack, J., & Jones, D. T. (2005), Lean Solutions, Free Press, New York.
[17] F. Ferdousi and A. Ahmed, "An Investigation of Manufacturing Performance Improvement through Lean Production : A Study on Bangladeshi Garment Firms," vol. 4, no. 9, pp. 106–116, 1996.
[18] T. Huzzard, "THE IMPACT OF LEAN THINKING ON ORGANIZATIONAL LEARNING," pp. 1–19.
[19] J. Pettersen, "Defining Lean Production : Some conceptual and practical issues," pp. 285–300, 2008.
[20] Holweg, M., (2006), "The genealogy of lean production", Journal of Operations Page | 174 Management, vol. 25, pp. 420-437.
[21] J. Choomlucksana, M. Ongsaranakorn, and P. S. F, "Improving the productivity of sheet metal stamping subassembly area using the application of lean manufacturing principles," *Procedia Manuf.*, vol. 2, no. February, pp. 102–107, 2015.
[22] D. B. Modi and H. Thakkar, "Lean Thinking : Reduction of Waste , Lead Time , Cost through Lean Manufacturing Tools and Technique," *Int. J. Emerg. Technol. Adv. Eng.*, vol. 4, no. 3, pp. 339–344, 2014.
[23] K. Mahmood, "Productivity Improvement by Implementing Lean Production Approach," pp. 183–188.
[24] V. C. Patel and H. Thakkar, "A Case Study: 5s Implementation in Ceramics Manufacturing Company," *Bonfring Int. J. Ind. Eng. Manag. Sci.*, vol. 4, no. 3, pp. 132–139, 2014.
[25] M. D. Singh, S. Singh, A. Chokshi, H. Chavan, and D. Dabhi, "Process Flow Improvement through 5S , Kaizen and Visualization," *Int. J. Innov. Res. Sci. Eng. Technol.*, vol. 4, no. 3, pp. 1103–1112, 2015.
[26] N. S. Patel, C. U. Patel, and P. Brahmbhatt, "Study and Implementation of Lean Manufacturing," no. 4, pp. 54–59, 2015.
[27] N. Verma, B. Raghuvanshi, and T. Verma, "Application of Lean Manufacturing - A Case Study on Jindal Steel Power Limited," vol. 3, no. 4, pp. 446–449, 2015.
[28] P. M. Rojasra, "Performance Improvement through 5S in Small Scale Industry: A case study," *Int. J. Mod. Eng. Res. (IJMER*, vol. 3, no. 3, pp. 1654–1660, 2013.
[29] A. Adhiutama, S. Business, and I. Bandung, "The Application of Lean Manufacturing for Operation Improvement : A Case Study of Black Cough Medicine Production in Indonesia," vol. 6, no. 1, pp. 56–64, 2013.