Shop Floor Productivity Enhancement Using a Modified Lean Manufacturing Approach

Varun Tripathi, Suvandan Saraswat, GirishDutt Gautam, and Dhananjay Singh

Abstract Constantly improvement in shop floor management has become a necessity in today's worldwide industries. Various approaches are used to fulfill this requirement, mainly including lean manufacturing, kaizen, total quality management, six sigma, and lean six sigma approaches. These approaches are used to improve shop floor management and optimization of resources in the present industrial environment. In the present article, the authors developed a modified lean manufacturing approach to enhance the shop floor productivity through optimization. The purpose of this research article is to suggest an approach to improving and optimizing production on the shop floor by research work have done in the area of the lean manufacturing approach. The authors of the current research work strongly believe that the present research method will be more profitable for young researchers and industry people to improve production on the shop floor.

Keywords Lean manufacturing · Shop floor management · Process improvement · Non-value-added activities · Process optimization

1 Introduction

Process improvement is one of the most important needs of industries at a worldwide level. Several techniques are used to accomplish this need. Lean manufacturing (LM), kaizen, total quality management (TQM), six sigma, and lean six sigma (LSS) approaches are including in those techniques. LM is a prevalent technique in shop floor management and is also used for the optimization of resources [1]. As yet, LM was implemented in several industrial sectors such as mechanical, mining, mining

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machinery, pharmaceutical, defense, and automobile. There are several tools used in lean manufacturing and it depending on the production constraints and customer requirements in terms of product [2]. Here, constraints mean resources availability, delivery time, and production cost. Due to the global competitive environment and a plethora of problems, productivity enhancement has to challenge for the last few decades. Therefore, industries must continually need for an efficient technique to improve shop floor management.

Several researchers have suggested an efficient technique to improve production on the shop floor. Vinodh et al. [3] have suggested that the value stream mapping (VSM) technique was an efficient technique because the reductions have been obtained in production lead time (PLT), total cycle time (TCT), total uptime (TUT), defects, and work in progress (WIP). Rahani et al. [4] have investigated the implementation of the VSM in the automobile component manufacturing industry. The result revealed that hidden non-productive activities on the shop floor like stacking of parts, higher WIP, and more cycle time were eliminated by VSM implementation. Singh et al. [5] have presented VSM as an efficient technique by improvement obtained in an auto-parts manufacturing organization. The result of the study showed a reduction in WIP inventory, PLT, and cycle time. Jasti et al. [6] discussed how improvements could be made in the implementation of a LM approach in the industries. The result of the study proved that lean manufacturing brings out a positive impact on production in form of productivity improvement in terms of customer satisfaction.

Rohani et al. [7] have discussed a study of production line improvement in the chemical industry through VSM. The result of the study revealed that reduction has been obtained in TLT 8.5 days to 6 days and in value-added time (VAT) from 68 to 37 min. Chelbus et al. [8] have identified the three main pillars of a mine and that is the environment of work improvement, planned and autonomous maintenance, and standards in development. As a result of this work, it has been found that lean manufacturing as a technique can be applied to achieve better results in any other mining industry. Garre et al. [9] have identified production problems that occurred during the performance of activities in the production line and eliminated those production problems by the implementation of LM techniques. The result of the study reveals that improvement has been obtained in welding time. Diaz et al. [10] have studied the cycle time of aircraft assembly using LM. The result of the study reveals that reduction has been obtained in cycle time 20% from LM implementation, and 67% from automation implementation. Sharma et al. [11] discussed the implementation of the lean approach on the shop floor of Indian SMEs. As a result of this work, it was found that the implementation of the 5S technique on the SME shop floor effectively improved productivity and also improved the working environment of the employees.

Dadashnejad et al. [12] have investigated the impact of improvements achieved by VSM on overall equipment effectiveness. In the study, a structured questionnaire was designed. The analysis of the questionnaire concluded that VSM can increase performance, machine availability rate, and product quality in the industries surveyed. Gopi et al. [13] have identified wastes in an auto-ancillary unit using VSM. In the study working condition of the auto-ancillary unit has been drawn for the identification and

elimination of waste and determines the ideal state of working. The result revealed that manufacturing has been improved by 3.82% in 3 years. Esa et al. [14] discussed how to improve productivity level and production process time in an automotive manufacturing industry. As the result, the reduction has been obtained in setup time for changeover processes from 45 to 28 min as the result of this study. Boateng-Okrah et al. [15] have investigated the level of TQM implementation in the mining industry in Ghana. In this study, a statistical analysis was conducted for knowing the level of TQM in the industry from a questionnaire collection of 60 employees. The analysis of the survey reveals that 42% of employees agreed that TQM is being deployed in the industry. Seth et al. [16] discussed how to achieve lean implementation in heavy-duty power transformer manufacturing environments by implementation of VSM; and Taguchi's technique was also used in this study to improve. Systematic questioning techniques and shop floor observation were used for data collection. The study results showed a 17.3% reduction in cycle time, 29.78% in non-value-added activities, and 8.48% in value-added activities. The literature review on process improvement techniques implementation on shop floor management shows that there were only a few works has been performed on the improvement of production with optimization of resources since the last decade. It has been also found that productivity enhancement cannot be achieved by the implementation of process improvement techniques and process optimization without a strategy on the shop floor [17–20].

2 Research Objective

The main objective of this research work is to explore the effect of applying process improvement techniques in a case example of the industry's loader vehicle manufacturing process. The main steps taken to carry out the present work are enumerated below:

(a) The beginning of the research work is to collect information on the working condition in the industry's loader vehicle manufacturing process through discussion with employees and observing problems in shop floor management.
(b) This step identified the most frequently occurring waste and determines reasons using the fishbone diagram.
(c) Observed how the implementation of process improvement techniques could bring value to the production process.
(d) Which technique would bring improvement in shop floor management and optimization of resources?
(e) Finally, a conclusion is presented considering improvements achieved by the implementation of lean manufacturing technology in the company's production.

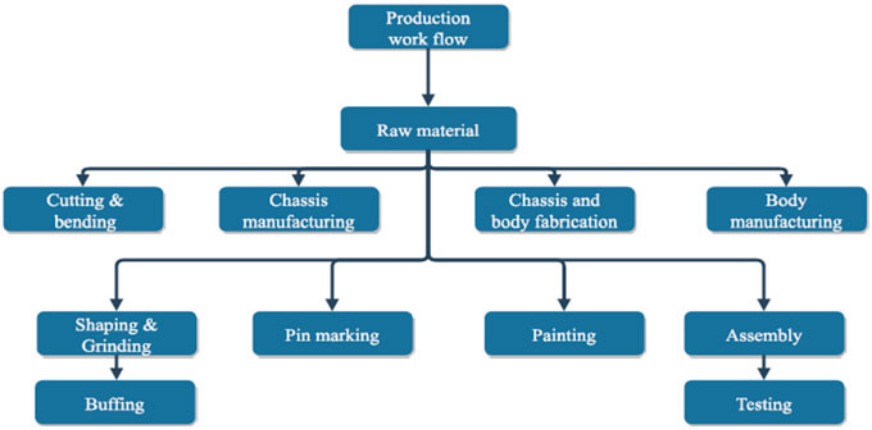


Fig. 1 Flow chart of production processes

3 Production Description

The present work has been carried out in a loader vehicle manufacturing industry located at the National capital region, India. This vehicle is in high demand due to environmental issues, low maintenance costs and less requirement of labor. Figure 1 shows a flow chart of the major production process involved in the manufacturing of the vehicle.

4 Implementation of Process Improvement Technique

LM is a prevalent process improvement technique and it has been mostly implemented in previous research work based on shop floor management [21–24]. The authors studied the literature review to understand the working style of LM, and It was found that LM first identifies the cause of waste generation and then tries to eliminate waste by taking appropriate action [25–27]. At present research work, the loader vehicle manufacturing process was studied and production information has been collected by observation and discussion. Table 1 shows the production condition of the shop floor.

The loader vehicle manufacturing process was categorized into subsections and then focusing on individual work activities. Productivity improvement depends on the elimination of waste and reduction of the processing time in the process [28–30]. The shop floor problem was analyzed by implementing lean techniques. The production problems have been identified using the fishbone diagram. The fishbone

Table 1 Production information on the shop floor

Production data	Quantity
Number of workers	8
Working time	510 min
Number of shifts	2
Production time	560 min
Idle (waste) time	260 min
Number of processes	18
Production per day	5
Break Time	45 min

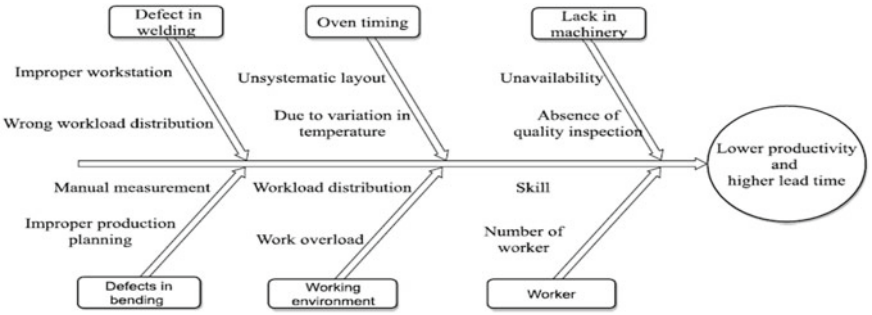


Fig. 2 Fishbone diagram

diagram of waste in the production processes on the shop floor that was obtained from discussing and brainstorming is shown in Fig. 2. Table 2 shows the problems in the production process and the actions taken to eliminate them.

5 Results and Discussion

The results of the present work obtained from a comparative analysis of the working conditions of the shop floor. The result of the study proves that LM is indeed a superior technique than other process improvement technologies. Figure 3 shows improvements obtained in production on the shop floor.

It has been observed that lean manufacturing implementation in the present case study results in increased productivity which was possible by identifying all types of non-value-added activities (waste). Lean manufacturing has also proved to be helpful in identifying waste and suggesting an effective action for their elimination.

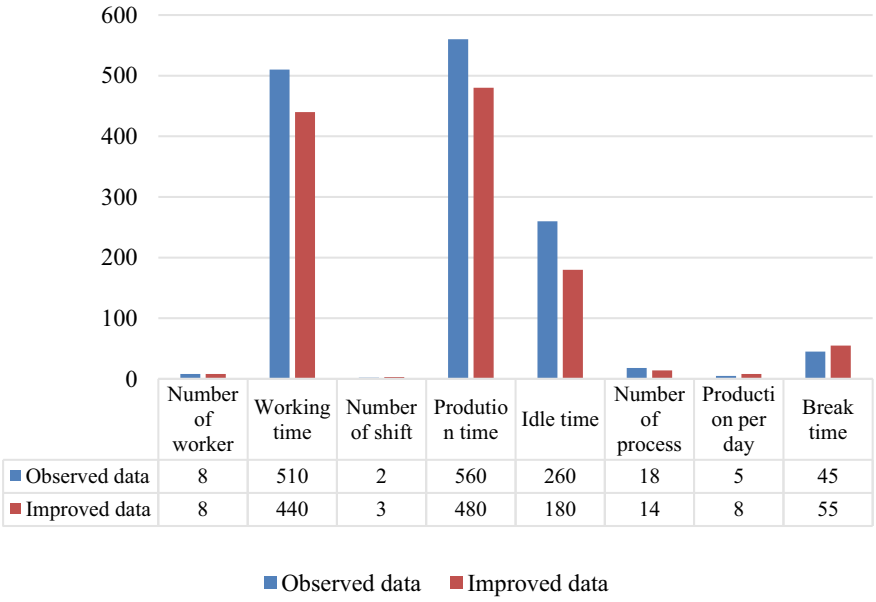
Table 2 Suggested action for the elimination of problems

Process	Problem	Action
Cutting and bending	(i) More workstation (ii) Large distance between station (iii) Lack of workers (iv) Lack of machinery	(i) Design a new shop floor layout (ii) Arrange all machinery
Chassis manufacturing	(i) More workstations (ii) Higher changeover time (iii) Lack of setup (iv) Improper location of equipment	(i) They can arrange a new platform of chassis welding (ii) Decided the location of equipment
Body manufacturing	(i) The higher number of defects (ii) Lack of equipment	(i) Improved planning (ii) Arranged equipment systematically
Chassis and body fabrication	(i) Ineffective production planning (ii) Lack of material handling equipment	Improve production planning
Shaping and grinding	Lack of machinery	Arranged all machinery systematically
Pin marking	Unplanned position of the machine	Fixed the position of pin marking machine
Painting	(i) Lack of shop floor area (ii) Undefined timing	Design a new shop floor layout
Buffing	Lack in number of machineries	Arranged machinery in proper planning
Assembly	Ineffective working plan	Improved planning
Testing	Lack of planning	Improved production planning

6 Conclusions

In present research work, lean manufacturing has been implemented to eliminate waste in the vehicle manufacturing industry. The main conclusion obtained by the present work are discussed below:

1. It has been observed that the process improvement technique can provide effective benefits when applied with lean manufacturing for shop floor management. Because it successfully enhanced productivity and optimize resources.
2. The present research work provided a modified lean manufacturing approach that is capable of improving productivity within limited constraints.
3. The Working time, production time, and idle time have been improved 70 min, 80 min, and 80 min respectively by improvement in production planning.
4. Additional improvements were accrued by shop floor utilization and a reduction of inventory resulting in productivity enhancement.



	Number of worker	Working time	Number of shift	Production time	Idle time	Number of process	Production per day	Break time
Observed data	8	510	2	560	260	18	5	45
Improved data	8	440	3	480	180	14	8	55

Fig. 3 Production improvement on the shop floor (Time unit—Minute)

5. The authors of the present research work strongly believe that the present study could be beneficial for young researchers and industry person for improvement in shop floor management.

References

1. Ohno T (2014) Toyota production system: beyond large-scale production. CRC Press, London
2. Commission E, Leonardo LLP, Transfer V (2017) Process optimization methods, pp 1–45. https://www.scribd.com/document/366521979/R2-en-COSIMA-Process-Optimization-Methods
3. Vinodh S, Arvind KR, Somanaathan M (2010) Application of value stream mapping in an Indian camshaft manufacturing organisation. J Manuf Technol Manag 21(7):888–900
4. Rahani AR, Al-Ashraf M (2012) Production flow analysis through value stream mapping: a lean manufacturing process case study. Proc Eng 41:1727–1734
5. Singh H, Singh A (2013) Application of lean manufacturing using value stream mapping in an autoparts manufacturing unit. J Adv Manag Res 10(1):72–84. https://doi.org/10.1108/09727981311327776
6. Jasti NVK, Sharma A (2011) Lean manufacturing implementation using value stream mapping as a tool: a case study from auto components industry 5(1)
7. Rohani JM, Zahraee SM (2015) Production line analysis via value stream mapping: a lean manufacturing process of color industry. Proc Manuf 2:6–10. https://doi.org/10.1016/j.promfg.2015.07.002

8. Chlebus E, Helman J, Olejarczyk M, Rosienkiewicz M (2015) A new approach on implementing TPM in a mine—a case study. Arch Civ Mech Eng 15. https://doi.org/10.1016/j.acme.2015.07.002
9. Garre P, Nikhil Bharadwaj VVS, Shiva Shashank P, Harish M, SaiDheeraj M (2017) Applying lean in aerospace manufacturing. Mater Today Proc 4(8):8439–8446
10. Diaz IC, Jin Y, Ares E (2017) Cycle time study of wing spar assembly on aircraft factory. Proc Manuf 13:1019–1025
11. Sharma SS, Shukla DD, Sharma BP (2018) Analysis of lean manufacturing implementation in SMEs: a "5S" technique. Springer, Singapore
12. Dadashnejad AA, Valmohammadi C (2019) Investigating the effect of value stream mapping on overall equipment effectiveness: a case study. Total Qual Manag Bus Excell 30(3–4):466–482
13. Gopi S, Suresh A, John Sathya A (2019) Value stream mapping & manufacturing process design for elements in an auto-ancillary unit—a case study. Mater Today Proc 22:2839–2848
14. Esa MM, Rahman NAA, Jamaludin M (2015) Reducing high setup time in assembly line: a case study of automotive manufacturing company in Malaysia. Proc - Soc Behav Sci 211:215–220
15. Boateng-Okrah E, Appiah Fening F (2012) TQM implementation: a case of a mining company in Ghana. Benchmarking An Int J 19(6):743–759
16. Seth D, Seth N, Dhariwal P (2017) The management of operations application of value stream mapping (VSM) for lean and cycle time reduction in complex production environments? a case study. Prod Plan Control 7287:1–22
17. Tripathi V, Gautam GD., Sarswat S (2020) Process optimization methods for shop floor planning? a study 8(10):244–247
18. Tripathi V, Saraswat S (2018) Lean management implementation in mining equipment manufacturing shop floor. National Conference on Mining Equipment New Technologies Challenges & Applications, Dhanbad (India), pp 7–10
19. Tripathi V, Sarswat S (2018) Lean manufacturing for shop floor of automotive industries: a study. J Exp Appl Mech 9(2):58–65
20. VenkatJayanth B, Prathap P, Sivaraman P, Yogesh S, Madhu S (2020) Implementation of lean manufacturing in electronics industry. Mater Today Proc. https://doi.org/10.1016/j.matpr.2020.02.718
21. Shou W, Wang J, Wu P, Wang X (2020) Lean management framework for improving maintenance operation: development and application in the oil and gas industry. Prod Plan Control. https://doi.org/10.1080/09537287.2020.1744762
22. Sivaraman P, Nithyanandhan T, Lakshminarasimhan S, Manikandan S, Saifudheen M (2020) Productivity enhancement in engine assembly using lean tools and techniques. Mater Today Proc. https://doi.org/10.1016/j.matpr.2020.04.010
23. Amrani A, Ducq Y (2020) The management of operations lean practices implementation in aerospace based on sector characteristics: methodology and case study methodology and case study. Prod Plan Control. https://doi.org/10.1080/09537287.2019.1706197
24. Sutharsan SM, Mohan Prasad M, Vijay S (2020) Productivity enhancement and waste management through lean philosophy in Indian manufacturing industry. Mater Today Proc. https://doi.org/10.1016/j.matpr.2020.02.976
25. Mohan Prasad M, Dhiyaneswari JM, Ridzwanul Jamaan J, Mythreyan S, Sutharsan SM (2020) A framework for lean manufacturing implementation in Indian textile industry. Mater Today Proc. https://doi.org/10.1016/j.matpr.2020.02.979
26. Balamurugan R, Kirubagharan R, Ramesh C (2020) Implementation of lean tools and techniques in a connecting rod manufacturing industry. Mater Today Proc. https://doi.org/10.1016/j.matpr.2020.03.702
27. Gopi S, Suresh A, John Sathya A (2019) Value stream mapping & manufacturing process design for elements in an auto-ancillary unit-A case study. Mater Today Proc 22:2839–2848
28. Masuti PM, Dabade UA (2019) Lean manufacturing implementation using value stream mapping at excavator manufacturing company. Mater Today Proc 19:606–610. https://doi.org/10.1016/j.matpr.2019.07.740

29. Mundra N, Mishra RP (2020) Impediments to lean six sigma and agile implementation? An interpretive structural modeling. Mater Today Proc. https://doi.org/10.1016/j.matpr.2020.04.141
30. Suhardi B, Anisa N, Laksono PW (2019) Minimizing waste using lean manufacturing and ECRS principle in Indonesian furniture industry. Cogent Eng 6(1):1–13