Global Journal of Engineering and Technology [GJET].
ISSN: 2583-3359 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjet-home/

IMPLEMENTATION OF LEAN MANUFACTURING TECHNIQUE IN AN AUTOMOBILE INDUSTRY: A REVIEW

BY

Mr. Ajay jatwa[1*], Mr.Kamlesh Gurjar[2]

[1]M. Tech Scholar in Dept. of Mechanical Engineering, SAIT, Indore (M.P).
[2]Professor in Dept. of Mechanical Engineering, SAIT, Indore (M.P), India.

Article History

Received: 24/01/2023
Accepted: 28/01/2023
Published: 30/01/2022

Vol – 2 Issue – 1

PP: - 13-17

ABSTRACT

Lean manufacturing was established to maximise resource utilisation through waste minimization; however, lean was later formulated in response to the dynamic and competitive business environment. Organizations are obliged to face problems and complexities as a result of the quickly changing business environment. To thrive, every business, whether manufacturing or service-oriented, must be able to adjust to these changes methodically and continually in order to increase product value. To reach this perfection, a value-adding process is required; thus, building a lean manufacturing system is becoming a basic capability for any sort of firm to sustain. This document attempts to design a lean route map for the organization's implementation of the lean manufacturing system. This study summarises the analyses of the exploratory survey results to show the implementation sequence of lean components in a dynamic business environment, and the findings of this review were synthesised to build a coherent theory for lean element implementation.

KEYWORDS: *Lean Manufacturing, Multi-Criteria Decision Analysis Technique, Production Control Mechanisms, Value Stream Mapping Method,*

INTRODUCTION

The lean manufacturing concept was first used in Toyota production system, Japan. In traditional manufacturing, inventory is made in manufacturing, but lean manufacturing there is no inventory. Now the markets are more competitive, so lean manufacturing is an important principle to satisfy the customer, worker and improve the productivity and efficiency of the industry. Lean is defined in 5 ways, define customer value, define value stream, make it flow, establish pull, strive for excellence [1]. The various industries are surveyed and improvement programmes are followed in process and equipment, human resources, product design, supplier relationships, and customer relationships [2]. The lean sigma concept (DMAIC) and kaizen is used to reduce wastage and increase the industries productivity. The various automobile tool industries are identified and surveys are made. The tool was validated and faced, content and reliability test, and involvement in reliability is calculated. Only 31% of the industries are implementing lean concepts. Remaining industries are not aware the lean concept and make awareness of lean concept in workers, supervisors, and all levels [3]. The rotary switch manufacturing organisation is implemented lean six sigma methodology, cause and effect diagram are drawn to invent the faulty switches. The various process parameters with design of experiment were conducted to improve in defects are made. The overall equipment effectiveness (OEE) is calculated and overall defects are reduced [4]. The value stream mapping method is used to identify the current status of the industry. The welding and grinding operations are made separately and man-machine chart is prepared for indicating the current position. The combined working of welding and grinding operations are made then future state man machine chart is drawn. Overall performance of industry is improved. The manufacturing industry is identified and value stream mapping is drawn. The wasted area is identified and 5 why method is implemented to know the reason for wastage. The cause-and-effect diagram is drawn to calculate the root causes of the wastage. The various lean techniques are followed to reduce the lead time and wastage.

LITERATURE REVIEW

According to Fatima Ezahra Touriki et al. in [5] manufacturers are under pressure to manage their activities and resources more efficiently while optimising profitability. At the same time, they must minimise the negative consequences on the environment. Manufacturers are implementing lean and green strategies to improve environmental performance. This equation, however, has been severely disrupted by the coronavirus outbreak. Many firms

*Corresponding Author: Mr. Ajay jatwa

throughout the world have been compelled to reconsider the resilience of their old manufacturing techniques and recognise the significance of incorporating new paradigms based on smart green and lean concepts. Nonetheless, there is a paucity of writing on the integration of these paradigms and their interdependence. This research seeks to present an insightful compilation on recent evolutions in this subject, combining the four paradigms of smart, green, resilient, and lean in the manufacturing domain through a literature survey. The research highlights the developing gaps and untapped topics in this discipline. Finally, we offered two research frameworks to help practitioners and academics.

In [6,] Charanjit Singh, Davinder Singh, and J. S. Khamba addressed how performance measurement is an important method for gauging the competitiveness of manufacturing industries. Manufacturing organisations face a variety of issues in this era of global competitiveness and customer expectations.

To address these issues, academic and manufacturing researchers have shown a strong interest in green lean manufacturing approaches. Lean manufacturing was intended to enhance resource utilisation and minimise waste across all manufacturing operations. Green in the industrial sector, on the other hand, refers to environmental and social concerns. Manufacturing companies try to discover and increase output performance by utilising key performance parameters to discover the opportunities in Green-lean concepts in the manufacturing sector. The goal of this research is to define and investigate the numerous key performance parameters (KPPs) of Green-Lean methods in manufacturing. Future research will concentrate on rating these green lean manufacturing KPPs using a suitable Multi-Criteria Decision Analysis (MCDA) technique.

In [7], Bingjie Ding, Xavier Ferràs Hernández, and Nria Agell Jané discussed how lean manufacturing and agile manufacturing have been two prominent manufacturing paradigms over the past decades, with the respective goals of reducing waste to achieve low cost and being flexible in production processes. Industry 4.0 is changing old production systems into intelligent ones. In today's competitive market, manufacturing organisations must improve both cost-efficiency and flexibility through the use of Industry 4.0 technology. This is the first systematic literature review to link Industry 4.0 to both lean and agile production. Concerning their interactions, a conceptual framework is given. It demonstrates that Industry 4.0 supports both manufacturing systems and that both systems, in turn, facilitate Industry 4.0 implementation. Integration of Industry 4.0 with lean manufacturing primarily improves cost-competitiveness in the performance dimension; integration with agile manufacturing primarily improves flexibility. According to the findings, Industry 4.0 is the enabling technology that enables two manufacturing systems to coexist while resolving trade-offs between distinct competitive objectives.

Dara Affydah et al. [8] intend to investigate the feasibility of integrating Lean Manufacturing (LM) and the Industrial Revolutions 4.0. (IR4.0). In the industrial sector, LM is widely known and accepted as a viable method.

However, a new paradigm of IR4.0 has motivated manufacturers to investigate how LM might be used and adopted further. It drives the integration of a smart factory to govern machines, humans, products, and cloud applications along the value chain.

For many years, manufacturers, particularly those in the automobile industry such as Toyota, have used lean principles and practises to eliminate waste, decrease operational costs, and improve production performance. Manufacturers could improve productivity and quality by combining LM with IR4.0 and utilising the implementation chain. Furthermore, it permits self-management of operational processes, which can ensure the quality of output for the customer.

The rise of the automobile industry is important to the Indian economy, according to Naveen Kumar, K. Mathiyazhagan, and Deepak Mathivathanan [9]. Global warming and rising pollution levels urge all governments to reconsider their environmental policies in order to achieve long-term sustainability. According to this viewpoint, the automobile industry is under immense pressure for sustainable development from both customers and the government. As a result, the Indian automobile industry focuses on commercial development through increased profitability as well as environmental development through sustainable lean production. Critical success factors (CSFs) for sustainable lean manufacturing have been identified from existing literature, and expert advice has been taken into account to carry out the inter-relationship between CSFs in sustainable lean manufacturing implementation using Interpretive Structural Modelling (ISM) methodology.

Top management has been identified as the influential CSFs that aid in the implementation of SLM and lead other CSFs. An Indian automobile industry perspective summarises driving and dependent elements. The findings of a study based on data collected from the small, medium, and large-scale vehicle sectors. It has previously been demonstrated that sustainable production (lean and green methods) produces greater results.

The current research claims the direct effects of industry 4.0 technologies (I4 T) on lean manufacturing practises (LMP) and sustainable organisational performance, according to Sachin Kamble, Angappa Gunasekaran, and Neelkanth C. Dhone in [10]. (SOP). LMP have also been discovered to have a favourable effect on SOP. The combined effect of I4 T and LMP on SOP, on the other hand, has not been scientifically studied.

To fill this void, this study analyses the indirect effects of I4 T on SOP using LMP as the mediating variable; it also seeks to confirm or deny the direct effects of I4 T on LMP and SOP. The study is based on information gathered from 205 managers at 115 manufacturing companies. The results indicate that I4 T has large direct and indirect effects on SOP and validate the presence of LMP as a key mediating variable. The study's findings add to the literature on I4 T by

*Corresponding Author: Mr. Ajay jatwa

identifying I4 T as a facilitator of LMP, which leads to an improvement in the SOP. There are implications and future study directions for academics, practitioners, and consultants.

Masoud Rahiminezhad Galankashi et al. offer a multiobjective mathematical model in [11] to optimise multiperiod aggregate production planning (APP) of multiproduct firms. Despite numerous studies on lean manufacturing (LM), its integration with APP has not been investigated. The purpose of this essay is to merge APP and LM, including an examination of market winners, market qualifiers, and waste. The model's objective functions include cost, lead time, and waste minimization, as well as product quality maximisation. The model is solved using IBM CPLEX 12.4 software, and a solution strategy is proposed. Three independent case studies are used to test the model's applicability and generalizability. According to the results, the suggested model delivers an optimum APP in terms of the primary LM concerns, such as waste, overproduction, time, and sourcing. Furthermore, the sensitivity analysis shows that lean weighting of the goal functions produces better results than equal weighting.

In [12], Leonilde Varela et al. discussed how, nowadays, Lean Manufacturing, Industry 4.0, and Sustainability are important concerns for businesses and society in general, focusing on the impact of the two production philosophies, Lean Manufacturing and Industry 4.0, on the three main pillars of sustainability: economic, environmental, and social.

According to the literature assessment conducted for this paper, these relationships are not widely known and are scattered by many sustainability criteria. To fill this need, this study provides a structural equation model with six assumptions to quantify the effects of Lean Manufacturing and Industry 4.0 on sustainability. To statistically validate such hypotheses, we collected 252 valid surveys from Iberian Peninsula industrial companies (Portugal and Spain). The findings demonstrate that: (1) Lean Manufacturing is not conclusively connected with any of the sustainability pillars, and (2) Industry 4.0 has a substantial correlation with the three sustainability pillars. These results can contribute as an important decision support for the industrial companies and its stakeholders, even because not all the results are in line with other opinions and studies.

In [13], Eva Rother and Armand Baboli explored how the fourth industrial revolution has been anticipated and how industrial manufacturing is ready for transitions related to Industry 4.0. The organisation, which is mostly founded on Lean manufacturing concepts, must consider the most important challenges for its managers. Following a review of Lean manufacturing and industry 4.0 literature, the study will focus on three critical issues for securing the transition in Europe: information exchange, talent development, and progress management. Reflection on technological issues will lead to methodological or administrative solutions to the digitization challenge, taking into account the downsides of the preceding industrial revolution and the ongoing generational change.

The fundamental challenge confronting an electrode manufacturer, according to A. Huarhua-Machuca, V. H. Nuez-Ponce, E. Altamirano, and J. C. Alvarez-Merino in [14], is the high proportion of defective goods. Downtimes due to line changes and disordered workstations during manufacturing operations are two of the issues that have contributed to the defects. A proposal was made to reduce the quantity of production errors utilising the 5S and Single Minute Exchange of Die (SMED) tools to solve this challenge. A simulation will be run to support this research, with the goal of significantly reducing defective items within the production region. The quantity of defective items was reduced by 11.23% after implementing the Lean manufacturing philosophy, enhancing the quality of the production process and delivering economic benefits.

In [15], F. K. De-La-Cruz-Arcela et al. examine the considerable downtimes encountered during the fabrication of metal structures and how to reduce them in order to boost productivity. Welding, bevelling, and transport to the assembly area were recognised as the three most crucial processes since they have the longest downtimes. This downtime is caused by a number of issues, including a lack of order and cleanliness in the various workstations, as well as the absence of production control mechanisms. To reduce downtimes and raise the company's profitability, a plan was prepared to optimise the process of manufacturing brick dryer screens using Lean Manufacturing techniques such as Kanban and 5'S.

LEAN MANUFACTURING PRACTICES

The main thrust of LMP is to have a streamlined process flow so that products are manufactured as per the requirements of the customers with little or no waste. Ten dimensions of LMP are shown in Table 1. These ten LMP dimensions are classified into four factors: supplier factors(SF, JIT, and SD), process factors (PS, CF, and STR), control and human factors (TPM, SPC, and EI), and customer factor(CI). In the present study, all ten LMP dimensions were considered for analysis. The supplier factor is concerned with theflow of products and information between the supplier and organisation and is aimed at integrating the existing suppliers with the business processes. The process factors are aimed to develop an efficient lean manufacturing system and are concerned with the smooth flow of the raw materials into the transformation process and their conversion to finished goods. The control and human factors ensure the production of quality goods, which is an outcome of the successful integration of the health of the manufacturing equipment, statistical process control, and human involvement. In an industry 4.0 environment, the employees must be trained and empowered to take corrective action based on real-time information received through various sources, and therefore are included as an important component of this factor. The customer factor ensures that the product and service offerings provide customer satisfaction. The LMP supports the manufacturing organisations in becoming strong contenders in the highly competitive global markets.

Lean implementation in manufacturing organisations is found to improve resource utilisation by 30% to 70% by eliminating

*Corresponding Author: Mr. Ajay jatwa

different types of waste. Many manufacturing companies still struggle to transform themselves into lean organisations. This failure is attributed to an inappropriate implementation environment, a lack of lean tools and techniques meeting the operational requirements, and the inability of the firms to sustain the initial momentum provided by the success of lean implementation.

CONCLUSION

In future, technical developments would often contribute to a future supply-side transformation, including long-term improvements in production and productivity. Costs of shipping and material processing will decline, networks of manufacturing and industrial output will become more competitive and rates of exchange will decline, setting new market opportunities and boosting economic and social development. Scholars also pointed out that the transition leads to greater inequality, particularly in transforming labor markets. Automation will replace jobs in the economy, a complete substitution of workers by robots which will exacerbate the gap between capital gains and labor gains. In the other hand, it is also possible that replacing workers with technology will inevitably contribute to the growth rate in stable, profitable employment.

REFERENCES

1. Womack, J., Jones, T. and Roos.D, 1990, The Machine that Changedthe World, Harper Business: New York.
2. Roberto Panizzolo, Patrizia Garengo, Milind Kumar Sharma and AmolGore, 2012, Lean manufacturing in developing countries: evidence from Indian SMEs, production planning and control, Vol. 23, Nos. 10–11, 769–788.
3. M. Eswaramoorthi, G. R. Kathiresan, P. S. S. Prasad , P. V. Mohanram, 2011, A survey on lean practices in Indian machine tool industries, International Journal of Advanced Manufacturing Technology 52:1091–1101.
4. S. Vinodh , S. Vasanth Kumar and K.E.K Vimal, 2014, Implementinglean sigma in an Indian rotary switches manufacturing organization, Production Planning and Control, Vol. 25, No. 4, 288–302.
5. F. E. Touriki, I. Benkhati, S. S. Kamble, A. Belhadi, and S. El fezazi, “An integrated smart, green, resilient, and lean manufacturing framework: A literature review and future research directions,” *Journal of Cleaner Production*, vol. 319, p. 128691, Oct. 2021, doi: 10.1016/j.jclepro.2021.128691.
6. C. Singh, D. Singh, and J. S. Khamba, “Understanding the key performance parameters of green lean performance in manufacturing industries,” *Materials Today: Proceedings*, vol. 46, pp. 111–115, Jan. 2021, doi: 10.1016/j.matpr.2020.06.328.
7. B. Ding, X. Ferràs Hernández, and N. Agell Jané, “Combining lean and agile manufacturing competitive advantages through Industry 4.0 technologies: an integrative approach,” *Production Planning & Control*, vol. 0, no. 0, pp. 1–17, Jun. 2021, doi: 10.1080/09537287.2021.1934587.
8. D. Affydah, A. N. M. Rose, M. A. Rashid, and N. N. Mohamed, “Review of Lean Manufacturing with IR4.0 in Automotive Industry,” *J. Phys.: Conf. Ser.*, vol. 1874, no. 1, p. 012050, May 2021, doi: 10.1088/1742-6596/1874/1/012050.
9. N. Kumar, K. Mathiyazhagan, and D. Mathivathanan, “Modelling the interrelationship between factors for adoption of sustainable lean manufacturing: a business case from the Indian automobile industry,” *International Journal of Sustainable Engineering*, vol. 13, no. 2, pp. 93–107, Mar. 2020, doi: 10.1080/19397038.2019.1706662.
10. S. Kamble, A. Gunasekaran, and N. C. Dhone, “Industry 4.0 and lean manufacturing practices for sustainable organisational performance in Indian manufacturing companies,” *International Journal of Production Research*, vol. 58, no. 5, pp. 1319–1337, Mar. 2020, doi: 10.1080/00207543.2019.1630772.
11. M. R. Galankashi, N. Madadi, S. A. Helmi, Abd. R. A. Rahim, and F. M. Rafiei, “A Multiobjective Aggregate Production Planning Model for Lean Manufacturing: Insights From Three Case Studies,” *IEEE Transactions on Engineering Management*, pp. 1–15, 2020, doi: 10.1109/TEM.2020.2995301.
12. L. Varela, A. Araújo, P. Ávila, H. Castro, and G. Putnik, “Evaluation of the Relation between Lean Manufacturing, Industry 4.0, and Sustainability,” *Sustainability*, vol. 11, no. 5, Art. no. 5, Jan. 2019, doi: 10.3390/su11051439.
13. E. Rother and A. Baboli, “Lean Manager in the Factory of the Future : Case study in automotive industry,” in *2019 IEEE 6th International Conference on Industrial Engineering and Applications (ICIEA)*, Apr. 2019, pp. 218–224. doi: 10.1109/IEA.2019.8714779.
14. Huarhua-Machuca, V. H. Nuñez-Ponce, E. Altamirano, and J. C. Alvarez-Merino, “Applying Lean Techniques to Reduce Defective Products: A Case Study of an Electrode Manufacturing Company,” in *2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, Dec. 2019, pp. 541–545. doi: 10.1109/IEEM44572.2019.8978865.
15. F. K. De-La-Cruz-Arcela, J. S. Martinez-Castillo, E. Altamirano-Flores, and J. C. Alvarez-Merino, “Application of Lean Manufacturing Tools to Reduce Downtime in a Small Metalworking Facility,” in *2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM)*, Dec. 2019, pp. 551–555. doi: 10.1109/IEEM44572.2019.8978711.
16. Mayr *et al.*, “Electric Motor Production 4.0 – Application Potentials of Industry 4.0 Technologies in the Manufacturing of Electric Motors,” in *2018 8th International Electric Drives Production*

*Corresponding Author: Mr. Ajay jatwa

Conference (EDPC), Dec. 2018, pp. 1–13. doi: 10.1109/EDPC.2018.8658294.

17. Beifert, L. Gerlitz, and G. Prause, "Industry 4.0 – For Sustainable Development of Lean Manufacturing Companies in the Shipbuilding Sector," in *Reliability and Statistics in Transportation and Communication*, Cham, 2018, pp. 563–573. doi: 10.1007/978-3-319-74454-4_54.
18. K. Alvarez, D. Aldas, and J. Reyes, "Towards Lean Manufacturing from Theory of Constraints: A Case Study in Footwear Industry," in *2017 International Conference on Industrial Engineering, Management Science and Application (ICIMSA)*, Jun. 2017, pp. 1–8. doi: 10.1109/ICIMSA.2017.7985615.
19. "Lean Manufacturing and Industry 4.0: A Holistic Integration Perspective in the Industrial Context." https://ieeexplore.ieee.org/document/9080393/
20. "Lean Management 4.0 Proposition for the Evolution of Managerial Criteria." https://ieeexplore.ieee.org/document/9309877/
21. "Lean Manufacturing Implementation through DMAIC Approach: A Case Study in the Automotive Industry | Quality Innovation Prosperity," Jul. 31, 2021. https://www.qip-journal.eu/index.php/QIP/article/view/1576

*Corresponding Author: Mr. Ajay jatwa