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APPLICATION OF VALUE STREAM MAPPING (VSM) IN A SMALL-SCALE FURNITURE MANUFACTURING INDUSTRY

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Abstract
The Indian furniture manufacturing contributes significantly to the country's GDP and employment. This sector faces numerous challenges including waste management, inefficiencies, and resource limitations. Lean Manufacturing, with its focus on waste reduction and efficiency enhancement, provides promising solutions through tools like VSM. Trough systematic literature review Lean Manufacturing adoption has benefits such as productivity improvements, waste reduction, and enhanced quality. However, small-scale industries encounter various barriers to Lean adoption, including a lack of understanding, resources, and infrastructure challenges. The VSM Implementation Framework presented outlines a structured approach involving planning, implementation, and continuous improvement phases. The VSM along with 5S and Kaizen implementation has shown numerous advantages such as reduction in the NVA activities and associated time. The total lead time has been reduced by 4 days.

Keywords:
Value Stream Mapping (VSM), Lean, VSM Framework, 5S, Kaizen, Small Scale Furniture Manufacturing Industry.

I. Introduction

1.1 About furniture manufacturing industries in India.

India is one of the world's fastest developing economies. In India, the plywood manufacturing industry contributes for around 6% of GDP, and its contribution is expected to grow over time. It employs around 50 million people and is India's second largest employer of skilled and semi-skilled labor after agriculture. The Indian plywood business has an annual revenue of almost $100 billion. Green ply, Century ply, Kit ply, Duro ply, Uni ply, and Virgo ply are examples of disorganized ply, while organized ply is just 10%. With significant imports from Malaysia, Indonesia, and New Zealand, India has emerged as one of the world's largest consumers of tropical wood. India accounts for 17.5% of the global population yet only accounts for 2% of the global forest. [18] The overall atmosphere of a company is critical for managers who are faced with the problem of changing the atmosphere. The goal of these industrial enterprises is to grow, become more competitive, and boost their contributions to GDP from 20% to 60%. [2]

Lean Manufacturing is a manufacturing method that focuses on reduction of operational wastage within the production system and from suppliers to customers. Lean aims to increase efficiency and reduce costs. Lean tools such as Value Stream Mapping (VSM) is graphical representation of material flow and information needed to deliver a product or service to the customer. VSM helps identify waste areas and improve opportunities. In 1980, a Toyota assembly facility used Value Stream Mapping (VSM) a Lean Manufacturing tool. Value Stream Mapping was developed as a tool to identify waste areas in the organization and aid in the creation of potential changes to minimize and eliminate waste. As a waste-reduction strategy, businesses are increasingly adopting a "lean" method. The Value Stream

Mapping (VSM) approach ensures an ongoing flow of data and supplies in manufacturing processes. [13]

1.2 Challenges faced by the small scale industries

The majority of small and medium-sized businesses (SMEs) have rejected the concept of implementing Lean. Despite earlier proof of the benefits of lean adoption, there are a number of impediments to it, including perception, a lack of real rewards, and challenges with shop floor staff.[1] The challenges faced by the industries have been identified in the literature and the barriers to lean implementation have been categorized by various researchers. The main lean obstacles is a lack of lean understanding, technical knowledge, training, and resource allocation. Limited adoption of lean tools suggests a need for focused implementation. [1] The primary hurdle for SMEs in Saudi Arabia was altering people's mindset. According to studies, many academics believe that an organizational culture that does not support Lean is a major factor for the failure of successful Lean application. [2] In the industry, there is a lack of trained workers. The inability of small-scale enterprises to recruit and retain competent staff hinders their adoption of sophisticated production techniques. [6].

Small-scale manufacturers frequently struggle due to a lack of access to necessary infrastructure, such as a steady supply of power, efficient transportation systems, and industrial areas. The effectiveness and productivity of manufacturing activities can be negatively impacted by inadequate infrastructure. [7]. Small-scale manufacturers face difficulties as a result of onerous regulations and bureaucratic procedures. The time and money required to comply with different laws, licenses, and permissions can impede small-scale future manufacturing firms' ability to grow and compete. [8] Small-scale manufacturers frequently have trouble getting funding for investments in cutting-edge technology, machinery, and R&D. It is difficult to implement sophisticated manufacturing techniques and modernize production processes due to a lack of funding. [9].

Figure 1: Challenges faced by Furniture Manufacturing industries

II. Literature Survey

Abu, F. et al. (2019) revealed a scarcity of research on lean manufacturing adoption in the furniture industry. Knowledge-related barriers hinder both lean and non-lean firms, prompting initiatives by the Malaysian Timber Industry Board (MTIB) to enhance awareness. [1] Trubetskaya, A. et al. (2023) explored the integration of Lean principles, specifically Value Stream Mapping (VSM), and simulation techniques to enhance efficiency in the furniture industry. Focusing on waste reduction, the study provides an industrial case example, emphasizing the dynamic capabilities of simulation in assessing proposed improvements. The combination of VSM and simulation offers a comprehensive analysis of both current and future states, facilitating targeted recommendations for process enhancements. [5] Chowdhury, S. et al. (2015) investigated the application of lean strategies, to enhance productivity in a furniture manufacturing company. The study reveals significant improvements, such as reduced setup times, a 59% decrease in worker travel distance, and increased multifactor productivity from 1.85 to 2.26. The implementation of lean techniques resulted in enhanced operational efficiency,

decreased downtime, reduced rejects and material wastage, and an additional daily production value of 148,705 Taka. [6]
Filip, F.C. et al. (2015) discussed the implementation of the 5S methodology to enhance management performance and optimize industrial workplaces. The 5S method, encompassing seiri, seiton, seiso, seiketsu, and shitsuke principles, is explored for its impact on reducing errors, improving efficiency, and creating a quality-conducive working environment. The paper emphasizes the importance of internal audits, specifically the "5S audit," in sustaining and monitoring the process. Results showcase benefits such as waste reduction, enhanced safety, increased productivity, and improved discipline. The study provides insights into the systematic approach of implementing 5S, contributing to the literature on workplace organization and performance optimization.[7] Suhardi, B. et al. (2019) focused on implementing lean manufacturing principles in an Indonesian furniture company to minimize production floor waste. Utilizing Value Stream Mapping (VSM), the research identifies waste by distinguishing between value-added and non-value-added activities. The study employs 5W1H techniques and ECRS principles, integral to kaizen, to address critical waste in motion. Considerations for operator workload aim to prevent bottlenecks and reduce lead time. The findings demonstrate a notable 4.79% reduction in lead time, enhancing production efficiency. The study concludes that VSM, with these improvements, is an effective tool for analyzing and recommending enhancements in the manufacturing process.[8]
Trubetskaya, A et al. (2023) introduced a Lean Six Sigma (LSS) framework. The framework combines Lean value stream mapping (VSM) and Six Sigma problem-solving, demonstrated through an Irish compound feed manufacturer case study. The research contributes to the limited literature on Lean in agriculture, offering a simplified LSS approach for small to medium-sized organizations. [9] The paper explores the application of the '5S' methodology in a leading E-commerce furniture warehouse in Maharashtra. '5S' involves sorting, order, shine, standardize, and maintain principles to enhance workplace management. The study, within the context of the Furniture Industry, demonstrates the effectiveness of '5S' in improving organizational performance, productivity, and hygiene. The benefits of proper material organization, time management through dashboards, and the positive impact on productivity. [10]
Vivaan Mehta et al. (2020) highlighted the efficient implementation of 5S, reducing waste, optimizing quality, and improving workplace conditions. 5S can be effective management method for enhancing environmental conditions and organizational efficiency, promoting self-discipline among employees. [11] Guzel, D. et al. (2022) explored the implementation of lean manufacturing techniques in Small and Medium Enterprises (SMEs), specifically a sofa manufacturing company. Utilizing Pareto analysis and Value Stream Mapping (VSM), the research identifies target areas for improvement. Application of Kaizen, 5S, standard work, layout planning, and single-piece flow techniques leads to notable improvements, including a 29% reduction in total workmanship. [12] Salwin, M. et al. (2021) highlighted VSM's static nature and suggests combining it with simulation models for a more dynamic understanding. [13]
Parihar, S. (2012) discussed VSM provides a visual representation of material and information flows, aiming to eliminate waste, reduce lead time, and enhance throughput in production systems. The study concludes that the current state map reveals non-value activities, and by transitioning from push to pull, the process lead time decreases, and Product Cycle Efficiency improves. [14] Romero, L.F. et al. (2017) explained VSM's potential in enhancing visibility and performance. VSM as an underexplored tool with the capacity to improve outcomes across various industries. [15] ANGIN N. et Al. (2022) highlighted untapped potential within the Turkish furniture industry, urging increased focus on lean practices and exploring synergies with other modern management techniques. [16] Ratnasingam, J. (2022) contributed valuable insights into LM practices, linking them to Industry 4.0 preparedness in the context of Malaysian furniture manufacturing. [17] Mittal, K. et al. (2016) addressed challenges in small-scale plywood manufacturing, emphasizing the impact on profits. Utilizing a Fuzzy TOPSIS MADM approach, it ranks problems, highlighting material wastage as the most influential issue.

Strategic recommendations include optimizing wooden log purchases to minimize wastage, transitioning to modern hydraulic peeling machines, and implementing a proper process layout for efficient material movement. [18]

This paper focuses on applying Value Stream Mapping (VSM) and simulation to enhance efficiency in a leading furniture plant facing significant waste challenges. The study presents the current state, develops a simulation model, proposes improvement suggestions based on VSM, and validates them through simulation. Results demonstrate improved flow time and reduced non-value-added time. The integration of VSM with simulation proves beneficial, offering a dynamic perspective for continuous improvement in manufacturing processes. [5] The VSM method is used to identify production processes, including those involving materials and informational data, and subsequently 5W1H and ECRS are used to enhance the production process. VSM was created to aid in the identification of waste in a process. The detection of waste can be done by brainstorming and tracking the movement of information and physical objects. [8] This study employs Value Stream Mapping (VSM) for assembly process analysis by collecting data through consultations with shop floor experts and conducting time studies. Total Product Cycle Time is calculated, and opportunities for improvement are identified, leading to suggestions for lean techniques to reduce lead times and enhance throughput in the assembly process. [14]

In this paper, the issue the business is having is with a factory that makes furniture. According to the literature review, there is just one study that specifically addresses the elimination of wastes from a furniture plant utilizing VSM. Based on a map of the present state and a future state, the authors have suggested various improvements for five production lines. [5] Implementing standard operating procedures, instructions or/and check lists, implementing continuous flow, using the Kanban ordering system, fostering improved teamwork, organizing employee cross-training and learning through problem solving, designing factory layout for continuous flow, and creating supplier partnerships are the seven suggestions to address challenges for lean improvement tools and lean measurements.[9].

III. Development and Implementation of VSM Framework

Value stream mapping, is a lean manufacturing technique utilized to scrutinize, design, and regulate the flow of materials and information necessary for delivering a product to a customer. Also recognized as "material and information-flow mapping," it employs a set of standardized symbols (in figure 2) to illustrate various work streams and information exchanges. The mapping process distinguishes between activities that add value from the customer's perspective and those that do not, aiming to identify and eliminate non-value-adding elements. Value Stream Mapping (VSM) is a visual representation or diagram that depicts the steps, activities, and flow of a particular process in order to map the current process. It is beneficial to comprehend the order of steps, spot bottlenecks, and assess the effectiveness of the current process. VSM helps identify waste areas and improve opportunities.

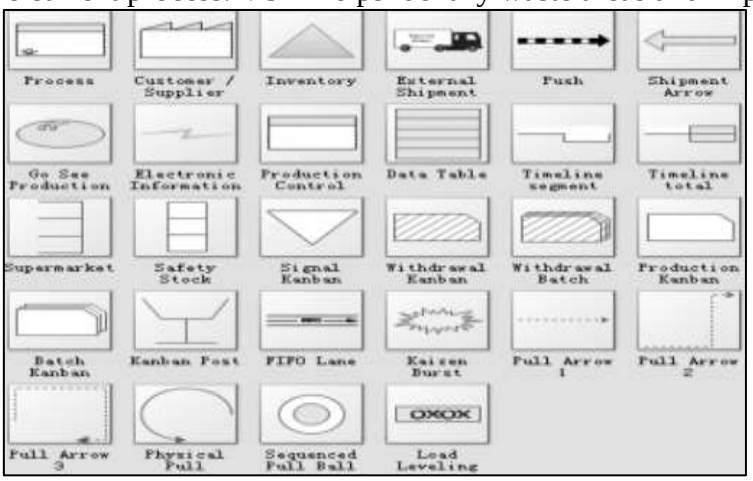

Figure 2: Value Stream mapping symbols [14]

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VSM Implementation Framework

Phase	Planning Phase	Implementation Phase	Improvement Phase
Steps	1. Educate and Train employees about lean 2. Prepare a Kaizen team 3. Process Mapping of all activities 4. Prepare a SIPOC matrix	1. Create the Current State Map (CVSM) 2. Identify VA & NVAs 3. Analyze the CVSM and Do Brainstorming 4. Design the Future State (FVSM) with Kaizen burst	1. Identify the scope of Improvement 2. Prepare an action plan 3. Implement the Improvements 4. Do audit to Continuously Improve

VSM Implementation in the Industry

Process Mapping

The process mapping of all the activities has been observed and mapped. The process of making a product generally follows following process – Cold pressing, Cutting on Beam saw machine, Edge Banding process, Pin routing process and boring/ drilling using Multibore machine. All the details related to the processes, cycle time, changeover time, inventory level has been collected and accordingly CVSM has been developed.

Figure 3: Production Process flow

Create the Current State Map (CVSM)

As per the data, the CVSM has been developed as shown in figure 4. The timeline below the operations shows the VA time and NVA time of the each workstation. The Total VA time observed to the 21 min. The total lead time comes out to be 10 days. The industry has various issues related to the material handling, unorganized workspace, longer searching and setup time etc. The lean tools such as 5S and Kaizen has been selected based on the literature review and implemented in the case industry.

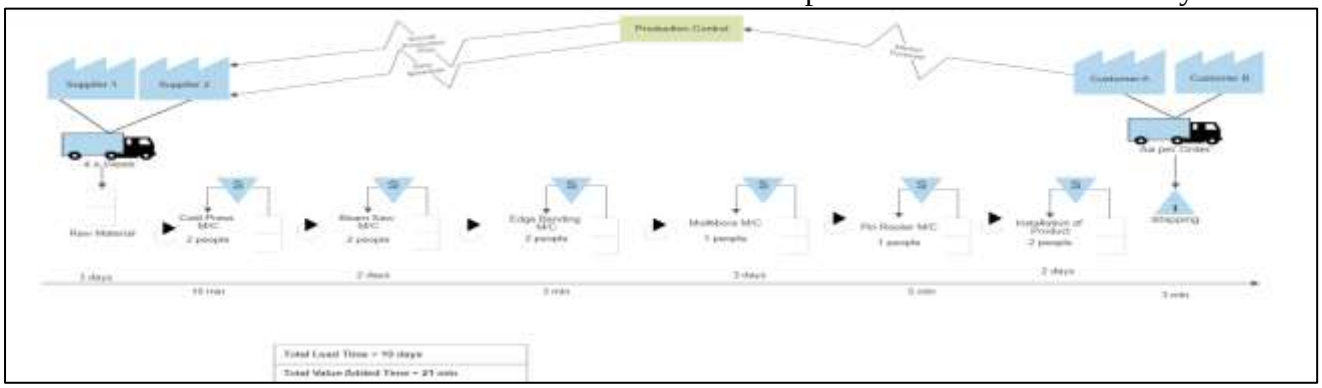

Figure 4: CVSM of the Plant

Design the Future State (FVSM)

Through implementation of the lean tools, The FVSM shows, the total VA time reduced to 13 min and Total lead time reduced to 6 days.

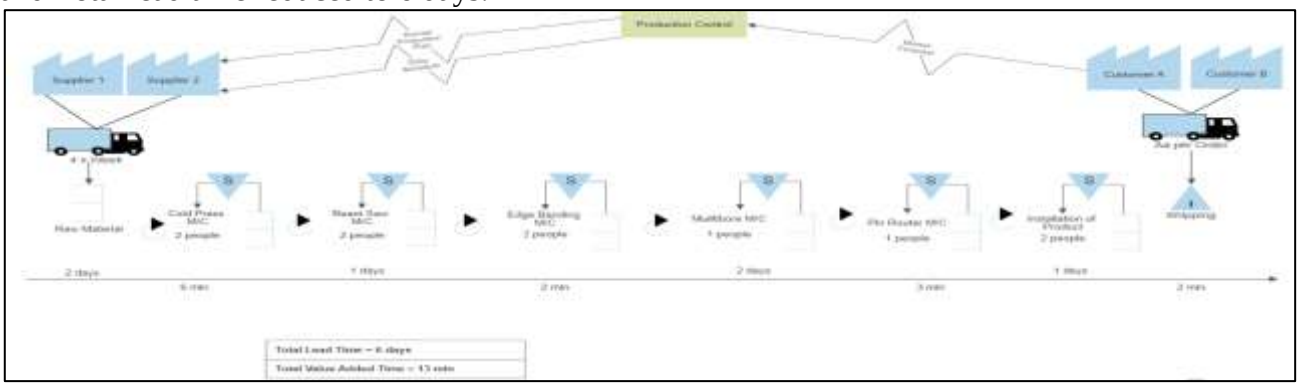

Figure 5: FVSM of the Plant

IV. Result & Discussion

The application of value stream mapping (VSM) in a small-scale furniture manufacturing industry proved to be highly beneficial in identifying non-value-adding activities. By analyzing the entire production process and mapping out the flow of materials, information, and activities, several areas of improvement were identified. The application of Value Stream Mapping (VSM) in small-scale furniture manufacturing yielded substantial benefits by pinpointing inefficiencies and streamlining processes. Through VSM, non-value-adding activities such as material handling inefficiencies and long setup times were identified, leading to targeted improvements. These insights were crucial in implementing lean techniques like 5S and Kaizen, which significantly improved organization, reduced setup times, and enhanced overall efficiency. Despite challenges like limited resources and regulatory hurdles, the study demonstrated the practicality and effectiveness of VSM and lean methodologies in driving operational excellence. Measurable improvements such as faster lead times and increased productivity validated the impact of these strategies.

V. Conclusion

The implementation of a Value Stream Mapping (VSM) in small-scale furniture manufacturing industries has numerous benefits. By using VSM, companies can pinpoint inefficiencies and areas of waste within their production processes. This leads to targeted improvements and improved the operational efficiency. The case study provides improvements resulting from VSM implementation, including reduced lead times, better material handling practices, and overall process efficiency improvement.

References

[1]Abu, F. *et al.* (2019) 'The implementation of Lean Manufacturing in the furniture industry: A review and analysis on the motives, barriers, challenges, and the applications', *Journal of Cleaner Production*, 234, pp. 660–680. doi:10.1016/j.jclepro.2019.06.279.

[2]Alkhoraif, A. and McLaughlin, P. (2018) 'Lean implementation within manufacturing smes in Saudi Arabia: Organizational culture aspects', *Journal of King Saud University - Engineering Sciences*, 30(3), pp. 232–242. doi:10.1016/j.jksues.2018.04.002.

[3]Zsidisin, G.A. and Siferd, S.P. (2001) 'Environmental purchasing: A framework for theory development', *European Journal of Purchasing & Supply Management*, 7(1), pp. 61–73. doi:10.1016/s0969-7012(00)00007-1.

[4]Wulan, P.N. and Adhiutama, A. (2023) *Product defect reduction using quality planning in Furniture Manufacturing*, *Journal of Economics and Business UBS*. Available at: https://jurnal.ubs-usg.ac.id/index.php/joeb/article/view/144.

[5]Guner Goren, H. (2017) 'Value stream mapping and simulation for Lean Manufacturing: A case study in furniture industry', *Pamukkale University Journal of Engineering Sciences*, 23(4), pp. 462–469. doi:10.5505/pajes.2016.59251.
[6]Chowdhury, S., Haque, K.A. and Sumon, M. (2015) *Implementation of Lean Strategies in a furniture manufacturing factory*, *IOSR Journal of Mechanical and Civil Engineering*. Available at: https://www.iosrjournals.org/iosr-jmce/papers/vol12-issue1/Version-3/H012134550.pdf.
[7]Filip, F.C. and Marascu-Klein, V. (2015) 'The 5s lean method as a tool of industrial management performances', *IOP Conference Series: Materials Science and Engineering*, 95, p. 012127. doi:10.1088/1757-899x/95/1/012127.
[8]Suhardi, B., Anisa, N. and Laksono, P.W. (2019) 'Minimizing waste using lean manufacturing and ECRS principle in Indonesian furniture industry', *Cogent Engineering*, 6(1). doi:10.1080/23311916.2019.1567019.
[9]Trubetskaya, A., McDermott, O. and Brophy, P. (2023) 'Implementing a customised lean Six sigma methodology at a compound animal feed manufacturer in Ireland', *International Journal of Lean Six Sigma* [Preprint]. doi:10.1108/ijlss-08-2022-0169.
[10]*Study and implementation of '5S' methodology in the furniture industry ...* Available at: https://www.ijert.org/research/study-and-implementation-of-5s-methodology-in-the-furniture-industry-warehouse-for-productivity-improvement-IJERTV10IS080114.pdf (Accessed: 10 August 2023).
[11]Vivaan Mehta, Pawan Dave (Aug 2020) Impact of 5S and lean manufacturing technique in various organization to enhance the productivity doi:10.35629/5252-0204421436.
[12]Guzel, D. and Shahbazpour Asiabi, A. (2022) 'Increasing productivity of furniture factory with lean manufacturing techniques (Case study)', *Tehnički glasnik*, 16(1), pp. 82–92. doi:10.31803/tg-20211010121240.
[13]Salwin, M. *et al.* (2021) 'Using value stream mapping to eliminate waste: A case study of a steel pipe manufacturer', *Energies*, 14(12), p. 3527. doi:10.3390/en14123527.
[14]Parihar, S., Jain, S. and Bajpai, Dr.L. (2012) *Value stream mapping: A case study of assembly process*, *International Journal of Engineering Research & Technology*. Available at: https://www.ijert.org/value-stream-mapping-a-case-study-of-assembly-process (Accessed: 10 August 2023).
[15]Romero, L.F. and Arce, A. (2017) 'Applying value stream mapping in manufacturing: A Systematic Literature Review', *IFAC-PapersOnLine*, 50(1), pp. 1075–1086. doi:10.1016/j.ifacol.2017.08.385.
[16]ANGIN, N. and TAŞDEMİR, Ç. (2022) 'Identification of internal dynamics of Türkiye's furniture industry in the context of Lean Manufacturing Integration Maturity', *Business & Management Studies: An International Journal*, 10(2), pp. 483–501. doi:10.15295/bmij.v10i2.2034.
[17]Ratnasingam, J. (2022) 'Status of lean manufacturing practices and its influence on the adoption of Industry 4.0 in the Malaysian Furniture Industry', *Annals of WULS, Forestry and Wood Technology*, 119, pp. 5–23. doi:10.5604/01.3001.0016.0764.
[18]Mittal, K. et al. (2016) 'Application of fuzzy topsis MADM approach in ranking & underlining the problems of plywood industry in India', Cogent Engineering, 3(1), p.1155839. doi:10.1080/23311916.2016.1155839.