
ENHANCING OPERATIONAL EFFICIENCY THROUGH THE IMPLEMENTATION OF VALUE STREAM MAPPING: INSIGHTS FROM THE FOOTWEAR INDUSTRY

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ABSTRACT

In today's highly competitive manufacturing environment, industries are under constant pressure to enhance efficiency, reduce waste, and deliver higher value to the customers. Lean manufacture has emerged as a strategic approach to achieving these goals, with Value Stream Mapping (VSM) being one of its most impactful tools. This study focuses on the application of VSM within the footwear manufacturing sector, specifically at BILING Leather Products Ltd., to identify inefficiencies and improve overall productivity by visualizing and analyzing the flow of materials and information, it also highlights non-value-added activities and suggests targeted improvements. The study explores how aligning cycle times with takt times can effectively reduce the production bottlenecks and eliminated waste, contributing to more informed and agile decision-making. The findings demonstrate the VSM is not only a tool for process enhancement but a critical driver for

operational excellence and sustainable profitability in the manufacturing industry.

Keywords: *Lean manufacturing; Value Stream Mapping; Waste Reduction; Takt Time; Cycle time.*

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1. INTRODUCTION

The global manufacturing landscape is undergoing a transformative shift, driven by heightened customer expectations rapid technological advancements, and increasing economic and environmental pressures. Manufacturers across sectors are compelled to deliver greater product variety, faster turnaround times, and higher quality- all while minimizing costs and maximizing efficiency. To navigate these challenges, many industries have turned to lean manufacturing, a philosophy that prioritizes the elimination of waste, continuous improvement and value creation throughout the production process.

Rooted in the Toyota Production System (TPS), Lean Manufacturing emphasizes the streamlining operation by systematically identifying and removing non-value-added activities. Over the years, it has evolved into a globally recognized framework with a diverse range of tools aimed to improving productivity, reducing lead times, and enhancing process reliability (Womack & Jones, 1996; Shah and Ward, 2003). Tools such as 5S for workplace organization, Total Productive Maintenance (TPM) for equipment efficiency, Just-in-Time (JIT), for demand-driven production, and Value Stream

Mapping (VSM) for process visualization have become central to lean implementations across industries (Nordin et al., 2012).

Among these tools, VSM plays a particularly strategic role. It provides a visual and analytical method to map the current flow of materials and information, identify bottlenecks, uncover various forms of waste, and design a future state that enhances overall process performance. VSM's ability to bridge operational realities with improvement planning makes it invaluable for manufacturing organizations seeking to gain a competitive edge through data-driven decision-making and sustainable practices.

While lean principles have been widely applied in sectors such as automotive, electronics, and aerospace, their adoption in labor-intensive industries like footwear manufacturing remains limited and underexplored. The footwear industry, characterized by complex production process, high customization, and manual operations, presents a unique challenge and opportunity for Lean application. Identifies in workflow, resource allocation, and inventory management, often hinder productivity and profitability in this sector.

Recognizing these challenges, this study investigates how Lean Manufacturing- specifically Value Stream Mapping- can be effectively utilized in the footwear manufacturing sector, using BLING Leather Products Ltd. as a case study. The core research problem addressed is the presence of process inefficiencies and waste in the production system that negatively impact productivity, cost-effectiveness, and market responsiveness.

This study explores how VSM can help visualize and analyze current production conditions, identify forms of waste, and propose actionable strategies to enhance workflow efficiency. The case study setting provides a real-world context to demonstrate the practical benefits and implementation process of Lean tools in a labor-intensive environment.

The study is guided by the few key objectives: to critically assess current production practice and identify performance gaps; to detect and categories waste within the manufacturing process; to utilize VSM to analyze production flow and highlight areas for improvement; and to propose lean-based strategies and a future state road map aimed at enhancing productivity and minimizing waste. The core objective is to offer practical insights and guidance to footwear manufacturers, helping them minimize waste, streamline operations, and enhance overall performance and marketing competitiveness.

This research contributes by applying Lean principles to the underexplored footwear industry and introducing a structured method to reduce waste in labor-intensive production. It highlights the effectiveness of VSM in aligning processes with market and operational goals, offering practical insights for manufacturers seeking to boost efficiency, quality, and competitiveness.

2. REVIEW OF LITERATURE

Value Stream Mapping (VSM) is a vital tool in lean manufacturing which assists in visualization, analysis and enhancement of production processes by eliminating wastes and optimizing the value adding processes. VSM which is a

concept within the scope of lean manufacturing enables organizations to carry out the work in a simplified order. Lean manufacturing originated from the Toyota Production System (TPS), focuses on continual improvement and waste reduction to better meet customer requirements.

According to Taiichi Ohno's theory of "DOWNTIME", eight major types of waste exist: Defects, Overproduction, Waiting, Non-utilized talent, Transportation, Inventory, Motion, and Extra processing (Zakir Hossain et al., 2017). These foundational principles have transcended national and industrial boundaries, as they are now applied not only in manufacturing but also in sectors such as healthcare, logistics, and services (Lander and Liker, 2007). Furthermore, tools like Value Stream Mapping (VSM), 5S, and Total Productive Maintenance (TPM) are considered critical instruments for initiating process changes and mobilizing employee engagement. Over time, Lean principles have evolved from their origins in the Toyota Production System into a dynamic, multi-sectoral philosophy. This evolution has been characterized by mechanisms of expansion, transfer, targeting, and combination, enabling Lean to adapt to diverse organizational contexts (Gil-Vilda et al., 2021). In the transport sector, for example, Lean thinking emerged from the scientific management practices of the Ford Motor Company and was later refined through Toyota's post-war innovations. By the 1980s, the term "Lean" gained global prominence, particularly in optimizing cargo flows and reserves through tools like value stream analysis (Kurganov et al., 2021). Similarly, in healthcare, Lean is transitioning from its conventional eight-step methodology to a more flexible, context-sensitive approach.

This shift reflects the need to adapt Lean strategies to the unique complexities of healthcare systems (Wackerbarth et al., 2021). Most recently, Lean has entered a new phase Lean 4.0 by incorporating Industry 4.0 technologies such as IoT, Big Data, and Artificial Intelligence. As a result, traditional Lean tools are being transformed into intelligent, real-time systems that not only reduce waste but also empower workers and significantly enhance digital process performance (Rossi et al., 2022).

Despite the growing body of literature on Lean's evolution and multi-sectoral applications, there remains a notable research gap in understanding how Lean 4.0 principles are being practically implemented across different sectors particularly in terms of real-time waste identification, digital integration challenges, and workforce adaptation. Furthermore, empirical studies examining the measurable impact of Lean 4.0 tools in comparison to traditional Lean approaches remain limited.

The 5S methodology of visual management offers a systematic approach that incorporates tools such as floor tape and operations manual, aiming to go beyond mere tidiness to significantly enhance productivity and profitability. At its core, 5S fosters a specific mindset supported by a toolkit designed to drive efficiency and add value (Filip and Marascu-Klein, 2015). The methodology involves a series of activities – waste elimination, monitoring, evaluation, collaboration and waste identifications – structure around five key principles. The first Short (seiri), entails a thorough examination of the workplace to eliminate unnecessary items, retaining only what is essential to streamline operations. Next, set in order (seiton) focus on the

logical and ergonomic organization of the remaining tools and materials, often supported by visual cues like labels and signage to promote consistency and reduce time wasted. Shine (Seiso) emphasizes daily cleaning and maintenance, ensuring a safe and orderly environment while helping to detect potential issues early. Standardize (Seiketsu) involves establishing policies, procedures, and visual controls to maintain the first three principles consistently across teams and shifts. Finally, Sustain (Shitsuke) ensure the longevity of improvements through continuous education, employee engagement, and regular audits. Together, these principles create a workplace, that prioritize efficiency, safety, and continuous improvement. By minimizing the time spent searching for tools or materials, 5S not only boost the productivity but also reduces the errors and accidents, contributing to a healthier, more motivated to workforce. Originally developed for industrial environments, the 5S methodology has since been successfully adapted across a wide range of sectors, including office, healthcare, and service industries to promote better organization and operational excellence.

Kanban is a visual system designed to manage and control the flow of work within a process, providing a clear visualization of both the workflow and the specific tasks progressing through it. Its primary goal is to identify potential bottleneck and eliminate them, ensuring that work moves efficiently, cost effectively, and with high throughput. Central to Kanban is the visual representation of tasks, often through card or sticky notes, organized on a board that maps out the stages of work flow (Wakode et al., 2015). Typically, the board is divided into columns corresponding to different phases such as “To Do”, “In

Progress”, “Done”. The key principles of Kanban include the visualizing of work through a dedicated board, limiting work in progress (WIP) to prevent team overload and encourage focus, managing flow by monitoring and improving task progression, making process policies explicitly to ensure clarity and team alignment, and fostering continuous improvement through regular process reviews and incremental changes. By applying these principles, Kanban enhance team collaboration and communication and enables teams to quickly adopt to shifting prioritise and requirements.

Line balancing in manufacturing is a strategy aimed at evenly distributing work across operators and machines to ensure the production rate matches the takt time – the speed at which the product must be made to meet the customer demands. A production line is considered perfectly balanced when the time taken to complete tasks matches the takt time exactly. If the production time is either slower or faster than the takt time, adjustment is needed. This may involve reallocating the workers, rearranging the machines, or modifying the tasks to eliminate bottlenecks, and avoid wasted capacity. The goal of line balancing is to create a smooth, efficient production flow, where resources are used optimally, helping manufacturer meet demand consistently and cost effectively.

Elimination of manufacturing wastes requires a multifaceted approach, and tools like Value Stream Mapping (VSM) play a crucial role in this process by clearly mapping out wasteful operations and identifying strategies to address them. By distinguishing between value-adding and non-value-adding activities, VSM enables the removal of costly and inefficient

processes, which in turn reduces lead times and improves customer service (Oakley et al., 2021; Singh et al., 2011). Furthermore, VSM visually exposes inefficiencies such as over-processing, unnecessary motion, and excessive transportation, thereby supporting targeted improvements that streamline operations, minimize time and space usage, reduce labor requirements, and boost overall efficiency (Fauziah et al., 2022). In addition, VSM facilitates significant improvements in both efficiency and productivity by pinpointing non-value-adding activities throughout the production process (Reda et al., 2022). Moreover, in industries such as footwear manufacturing, VSM proves essential by helping eliminate waste and reduce costs while enhancing overall equipment effectiveness (Ahmed et al., 2023). Specifically, as demonstrated in the shoemaking case study, VSM plays a pivotal role in identifying and eliminating inefficiencies in non-bottleneck areas, ultimately enhancing the value-added rate and fostering a more responsive, waste-free, and customer-driven production system (Jing Li et al., 2020).

Value Stream Mapping (VSM) is a vital tool for identifying and eliminating waste in manufacturing processes, enhancing efficiency, productivity, and customer responsiveness across various industries.

Value Stream Mapping (VSM) serves as a vital lean tool that visually represents and analyses all value-added and non-value-added activities in construction processes, thereby enabling the strategic identification and elimination of waste, enhancement of workflow efficiency, and informed decision-making for continuous performance improvement (Zahraee et al., 2021). Furthermore, VSM proves to be highly effective when

integrated with computer simulation, as it allows for the identification and elimination of waste through visual and analytical representation of production processes, significantly improving lead time, cycle time, and overall productivity (Seyed Moji Zahraee et al., 2020).

In the context of the footwear industry, the significance of VSM lies in its dynamic capacity to identify and prioritize lean improvements such as reducing defects, inventory levels, and lead time—by employing simulation and decision-making methods to enhance production efficiency and customer satisfaction (Qingqi Liu et al., 2020). Moreover, it plays a crucial role in visually representing and analyzing lean production practices and implementation paths, which assists in identifying key strategic resources including operational workforce, management, machinery, culture, and training elements essential for sustaining lean initiatives and achieving competitive advantage (Silva et al., 2019).

Additionally, VSM supports the improvement of process flows and productivity in the footwear industry through informed reengineering and simulation-based decision-making, which contributes to more efficient operations (Calderón-Andrade et al., 2020). Its application is particularly valuable for small and medium-sized enterprises (SMEs), as it aids in identifying sustainability performance gaps, optimizing resource utilization, and aligning economic, environmental, and social goals through measurable and manageable indicators (Mengistu et al., 2021).

Finally, VSM diagrams can be readily generated to illustrate the flow of material and information across the different stages thereby giving a broad array of information covering the current

inefficiencies. This enables the generation of “current state” and “future state” maps which are effective in developing strategies to decrease the cycle time and balance the load. (Chen et al., 2010). It encourages collaboration across departments, fostering a data-driven culture for decision-making.

Despite the widespread application of VSM in various industries, there remains a research gap concerning its integration with advanced simulation and decision-support technologies, particularly in the context of small and medium-sized enterprises within the footwear industry. Empirical studies exploring how VSM can drive holistic, sustainable performance including environmental, economic, and social dimensions are still limited. Moreover, there is a lack of comparative analysis on the effectiveness of VSM across different production environments and organizational sizes. Addressing this gap is crucial to developing tailored, data-driven Lean strategies that enhance competitiveness while supporting long-term sustainability goals.

The primary objectives of this study are:

- To critically examine the current production practices and identify performance gaps;
- To categorize and quantify different forms of manufacturing waste;
- To apply VSM for analyzing material and information flow, takt time, and cycle time alignment;

- To propose an optimized future state map using Lean tools, aimed at improving productivity and operational efficiency.

In the footwear sector, VSM has emerged to be effective for solving problems related to production losses. Research indicates that if business cycle times are harmonized with takt times and if Lean measures are instituted, there is a positive impact on lead time and productivity. Cutting, skiving, sewing and packaging departments will be able to have integrated operations with effective utilization of resources and hence improving production flow.

By applying VSM and other Lean tools, the Indian Manufacturing (IM) industries practice can be significantly enhanced on a more long-term basis which is crucial for staying afloat in competitive markets. The existing gap enables the appraisal of the application of VSM in the context of the footwear industry which is the focus of this study.

3. RESEARCH METHODOLOGY

The process describes the strategies utilized to identify the systematic, critical and focused of BLING Leather Products Ltd. and the ways used to change the production processes by utilizing VSM in the figure 1. Among the processes that were conducted in this study as shown in figure 1 include selection of the particular industry, selection of the particular departments within the industry, data collection and usage of appropriate lean tools for elimination of wastes and value enhancement. (Chen and Meng, 2010).

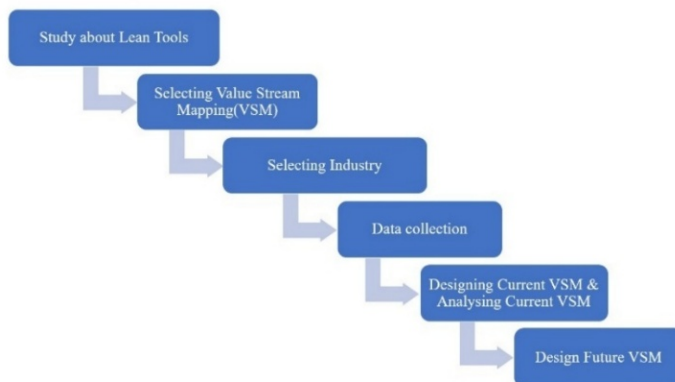


Figure 1. Research Design

3.1 Industry Selection

The footwear sector in Bangladesh was selected because it has a huge potential for business and meets the increasing global appetite for quality leather products. With a focus on footwear exports, BSCI Certified BLING Leather Products Ltd was picked as the case study. The firm was registered in 2019 in Rangpur Economic Zone, and the company executes well organized production activities, backed up by teams in the US, China and Bangladesh.

3.2 Study Design

The information gathering and analysis for the different parts of the manufacturing process were made through a qualitative and quantitative methods along the lines of the provisions set forth in the requisitions:

(i) Cutting

- (ii) **Skiving and Embossing**
- (iii) **Sewing**
- (iv) **Lasting and Packaging**

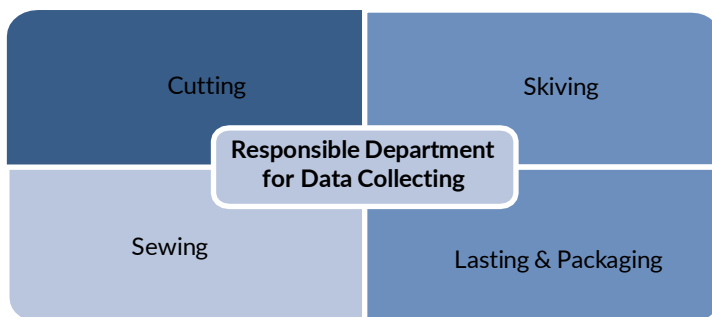


Figure 2. Responsible Department for Data Collecting

Figure 2 shows the standard linear ordering of the different phases in the management of the manufacture of shoes starting from the supply of raw materials. The process of shoe making starts with the cutting and it is done through different cutting processes by different departments. It is pertaining to the need of rearranging the sequence of the operations and the layout of the work centres. Problems do arise due to improper set ups of different type of products which reduces the efficiency of production. Each department was analysed to identify inefficiencies, determine cycle and takt times, and propose actionable improvements.

4. ANALYSIS

4.1 Data Collection

Production processes were observed directly, time study and head of department interviews were done in order to obtain data. The captured information contains: Cycle times for individual tasks within each department.

- (i) **Takt time**, calculated as the available production time divided by customer demand.
- (ii) **Lead time** and **downtime** for each department.
- (iii) **Batch sizes** and resource utilization rates.

4.2 Lean Tools and Techniques Applied

Each of the departments was evaluated to explain the inefficiencies, the cycle and the points of emphasis to provision for corrective measures.

Value Stream Mapping (VSM): With VSM, the Information and materials flow was visualized. While “Current state” useful maps are the “future state” maps which define better methods of achieving workflows.

5S Methodology: Implemented to effectively organize work so as to not cause unnecessary movement and material handling.

Takt Time Analysis: Takt time was determined to synchronize the speed of production to the rate of customer demand, detecting real cycle time and the target cycle time which could be achieved.

Largest Candidate Rule: It was used to equalize the work throughout the workstations so that the tasks were arranged on the basis of the time needed to complete them in decreasing order.

Kaizen Events: Worked on minor operations and rarely occurred but often aimed for the specific loop holes already identified in the VSM to be corrected.

4.3 Data Analysis

The collected data were systematically analyzed using the following steps:

- (i) **Current State Mapping:** Efforts were put into mapping each of the departments and their processes so as to find the processes with high cycle times, long delays and processes that were performing less than optimal.
- (ii) **Performance Metrics:** The main cycle time, the takt time, and balancing efficiency have been some of the key figures as well.
- (iii) **Future State Mapping:** Suggested to structure the ideal flow with the incorporation of lean and job sharing, processes that would then meet the required output.
- (iv) **Improvement Validation:** To confirm that indeed what was being suggested be the most ideal, being implemented were simulations and production managers feedbacks.

5. RESULTS AND DISCUSSION

This section captures their analyses of the present situation, the main problems, and the recommendations for each department in the production process at BLING Leather Products Ltd. The results show how Value Stream Mapping and adoption of Lean concepts are able to transform production processes in terms of efficiency and waste management.

5.1 Cutting Department

5.1.1 Current State Analysis

Table 1. Cutting Cycle Time (C/T), Man Power (M/P) State in Current VSM

SL	Process	C/T(Sec.)	M/P
1	Vamp lining	15.45	2
2	Tung	18.48	2
3	Tung lining	16.42	2
4	Eyelet	9.16	2
5	Eyelet lining	9.85	2
6	Eyelet supporting	9.78	2
7	Mad guard	9.83	1
8	Back quarter	9.82	1
9	Back counter upper	8.84	1
10	Back counter Eva	11.53	2
11	Back quarter under	10.23	2
12	Collar foam	17.88	2
13	Insole Board	11.7	2
14	Counter Stiffener	16.67	2

15	Toe Puff	10.56	2
16	Layer	230	8
Total		416.2	35

Source: The authors' own work.

Table 1 Current state represents cycle time in cutting for the case under study. This is the formula which is used by Stephen 1993 in calculating cycle time. Cycle Time = Total cycle time/T number of cycle. The cutting department had a metric measuring 416.2 seconds cutting cycle time and had 35 workers involved. Analysis concluded that the operations in this segment turned out to be uncombined with the takt time of the segment of 24 seconds. This meant that there were material flow and workload distribution problems in the segment. The longest operation in the cycle was the "layer" process which lasted 230 seconds while the back counter upper had shortest time of 8.84 seconds.

$$\text{Production rate} = \frac{\text{Customer demand}}{\text{Manpower} \times \text{Working hours} \times 60} = \frac{42000}{35 \times 8 \times 60} \\ = 2.5 \text{ Unite per minute}$$

$$\text{Takt time} = \frac{\text{Avaliable minutes for production}}{\text{Required unit for production}} = \frac{8 \times 3600}{8 \times 2.5 \times 60} \\ = 24 \text{ S}$$

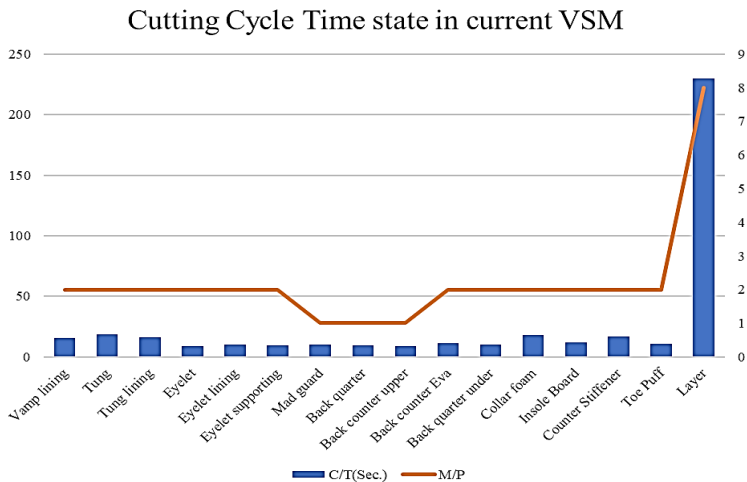


Figure 3. Cutting Cycle Time for Current VSM

Figure 3 illustrate the relationship between cycle time and manpower allocations across different production process. The bar represents the cycle time required for each process, while the line graph indicates the number of workers (M/P) assigned to each stage. This dual representation highlights which process are the most time consuming and whether manpower is appropriately balanced. It helps identify bottlenecks, overstaffed or understaffed areas, and opportunities for improving line balancing and resource optimizations.

Proposed Improvements

(i) Adopting the 5S approach towards improving organization of the workstations to cut down on material movement and handling.

(ii) Utilizing the Largest Candidate Rule to reallocate tasks in a bid to achieve workload balance.

(iii) Decreasing the cycle times of essential activities to reach takt time.

5.2 Skiving and Embossing Department

5.2.1 Current State Analysis

Table 2. Skiving and Embossing Cycle Time State in Current VSM

SL	Process	C/T(Sec.)	M/P
1	Abmosing-1	30.89	4
2	Abmosing-2	27.75	4
3	Tung level	24.84	3
4	Back quoter skiving	23.27	4
5	Quarter supporting skiving	24.47	3
6	Back quarter	26.08	3
7	Quarter box	29.4	4
8	Thermoplastic fusing	55.87	16
Total		242.57	41

Source: The authors' own work.

Table 2 provides the present cycle times for skiving and embossing, which are crucial for the development of the current state map. The total cycle time for skiving and embossing was 242.57 seconds, with 41 workers involved. This exceeded the target takt time of 28.11 seconds, primarily due to inefficiencies in processes such as "thermoplastic fusing," which consumed 55.87 seconds.

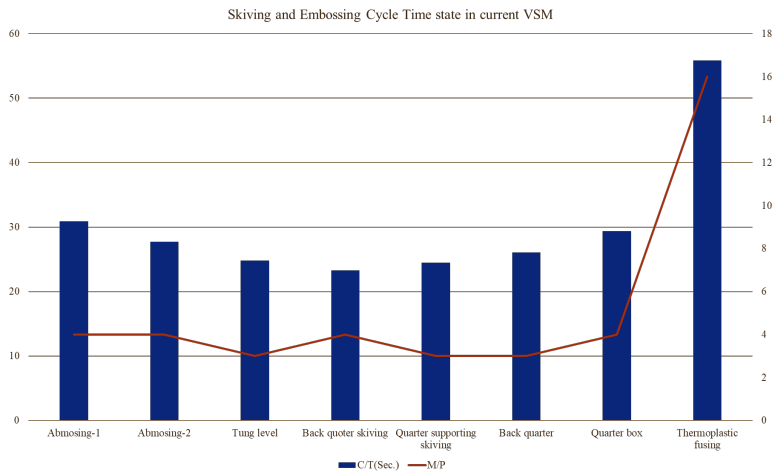


Figure 4. Skiving and Embossing Cycle Time for Current VSM

Figure 4 represent the chart displays the cycle time (C/T in seconds) and manpower (M/P) requirements for skiving and embossing processes in the current Value Stream Map (VSM). While most processes maintain a consistent cycle time and manpower level, "Thermoplastic Fusing" stands out with significantly higher cycle time and manpower, indicating a potential area for process optimization or workload balancing.

Proposed Improvements

- (i) Introducing process automation for time-intensive tasks like thermoplastic fusing.
- (ii) Enhancing worker training to reduce delays during manual operations.

- (iii) Using **Kaizen events** to identify and implement quick wins for efficiency gains.

5.3 Sewing Department

5.3.1 Current State Analysis

Table 3. Sewing Cycle Time State in Current VSM

SL	Process	C/T(Sec.)	M/P
1	Marking	23.41	4
2	Lining Jig-jag	18.43	2
3	Supporting	40.22	1
4	Upper Jig-jag	104.42	2
5	Lining PU Joint	212.11	3
6	Vamp Supporting Joint	48.23	2
7	Vamp Supporting Sewing	27.41	1
8	Quarter Joint	18.44	1
9	Quarter Sewing	46.15	1
10	Quarter supporting Joint	22.51	2
11	Quarter supporting Sewing	30.03	1
12	Eyelet Joint	27.55	2
13	Eyelet Sewing	76.3	2
14	Vamp decoration joint	61.22	1
15	Vamp decoration sewing	46.32	2
16	Eyelet supporting joint	63.41	2
17	Eyelet supporting sewing	45.21	2
18	Eyelet trimming	32.86	1
19	Upper and lining jig-jag	35.44	2
20	Tongue jig-jag	32.43	1
21	Back seam	106.32	3
22	Hammering	26.12	1
23	Toe cap sewing	21.43	1

24	Back loop sewing	23.29	2
25	collar seam	20.48	2
26	foam glue attaches	24.52	1
27	Counter setting	48.41	2
28	Lining gluing	44.23	3
29	Round sewing	34.45	2
30	Eyelet punching	25.43	1
31	Tongue attach	45.56	2
32	Cleaning	39.55	3
	Total	1471.89	58
		46.00	

Source: The authors' own work.

The sewing department had the most complex workflow, with a total cycle time of 1,471.89 seconds and 58 workers. The process with the longest duration was "lining PU joint", which took 212.11 seconds, while the shortest was "quarter joint" at 18.44 seconds are presented in Table 4.3. The department's takt time was 41 seconds, but the observed cycle time was 46 seconds, indicating room for improvement.

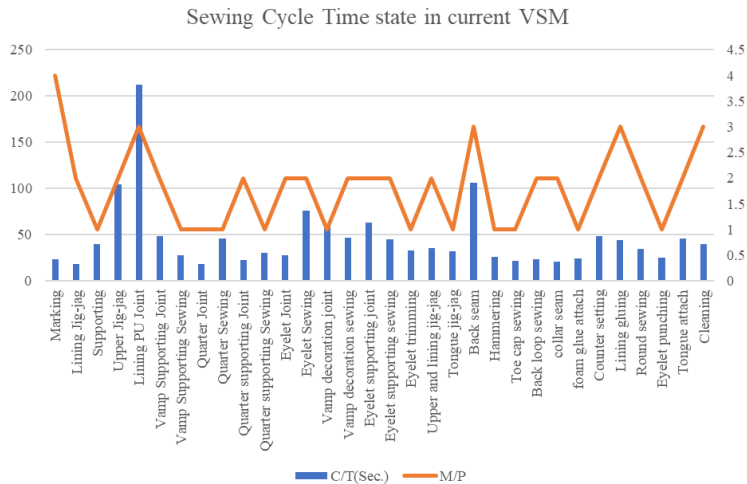


Figure 5. Sewing Cycle Time for Current VSM

Figure 5 illustrate this chart the cycle time (C/T) and manpower (M/P) distribution across 32 production processes. Blue bars represent the time (in seconds) each task takes, while the orange line indicates the number of workers involved per process. The data highlights high-time processes like “Lining PU Joint” and “Back Seam,” which may benefit from efficiency improvements or resource reallocation.

Proposed Improvements

- (i) Reallocating tasks to balance workloads across workstations using **task precedence diagrams**.
- (ii) Introducing specialized machinery for tasks requiring high precision, such as decorative stitching.

- (iii) Establishing a robust quality control system to minimize rework time.

5.4 Lasting and Packaging Department

5.4.1 Current State Analysis

Table 4. Cycle Time State in Current VSM in Lasting and Packaging Department

S/L	Process	C/T(Sec.)	M/P
1	Lace input	139	6
2	Toe parting steam	31	2
3	Foot lasting	30	2
4	Heel lasting	27	2
5	Lace tight	78	4
6	Repairing	30	2
7	Back counter measuring	22.5	2
8	Toe measuring	39	2
9	Toe marking	33	2
10	Round marking	34	1
11	Mesh primal	37	4
12	Outsole primal	37.5	1
13	First upper glue	50	2
14	First outsole glue	40	2
15	Second upper glue	51	2
16	Second outsole glue	35.5	2
17	Sole attached	65.5	4
18	First pressure	38.5	2
19	Glue injecting	30	2
20	Second pressure	25	1
21	Upper cleaning	28	2

22	Lace opening	117.5	1
23	De-lasting	27	2
24	Chocks-in	35	2
25	Filler tissue	30.5	1
26	Lace-in	171.5	2
27	Blowing	30	2
28	Toe coloring	25	1
29	Hand ironing	48	2
30	Repairing	28	2
31	Outsole cleaning	34	2
32	Inner box price	34	2
33	Inner box making	162	2
34	Hand tag price	55	1
35	Rapping and micro tapping	58	1
	Total	50.2	72

Source: The authors' own work.

This department recorded a total cycle time of 1,757 seconds and involved 72 workers. The takt time was 49.4 seconds, while the observed cycle time was slightly higher at 50.2 seconds as shown in Table 4. Time-consuming processes included "lace-in" (171.5 seconds) and "inner box making" (162 seconds).

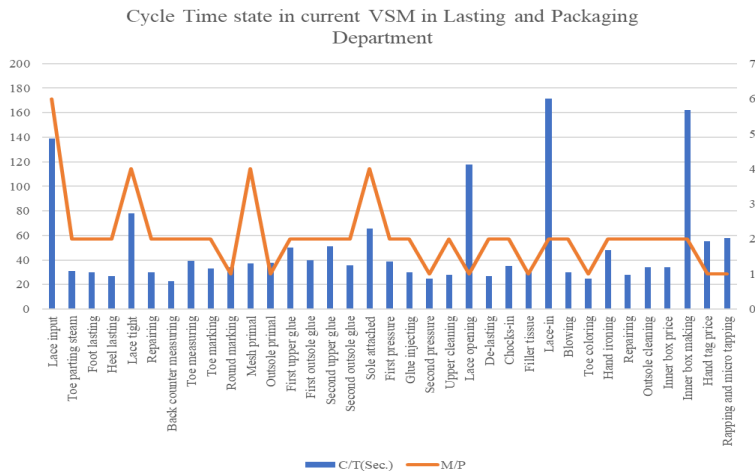


Figure 6. Lasting and Packaging Departments Cycle Time for Current VSM

Figure 6 demonstrate the chart is visualizes the cycle time (C/T in seconds) and manpower (M/P) allocation across various processes in the Lasting and Packaging Department's current Value Stream Map (VSM). The blue bars represent cycle times for each task, while the orange line tracks the number of workers involved. Notably, tasks such as "Lace input," "Back counter," "De-lasting," and "Inner box making" exhibit significantly higher cycle times, indicating key areas where process delays or workload imbalances may be occurring.

Proposed Improvements

- (i) Implementing **pull systems** to optimize the flow between lasting and packaging processes.

- (ii) Reducing setup times for tasks like "inner box making" through **Total Productive Maintenance (TPM)** and operator multitasking.
- (iii) Consolidating tasks where feasible to reduce the number of manual interventions.

5.5 Value Stream Mapping for State in Current VSM

The Lean methodology introduced VSM in 1995 as a tool to identify and address waste within a specific value stream (Womack and Jones, 1997). VSM facilitates the mapping and analysis of process chains to identify areas for enhancement (Mia et al., 2017). VSM are a structured way to find and get rid of trash (Krolczyk et al., 2017).

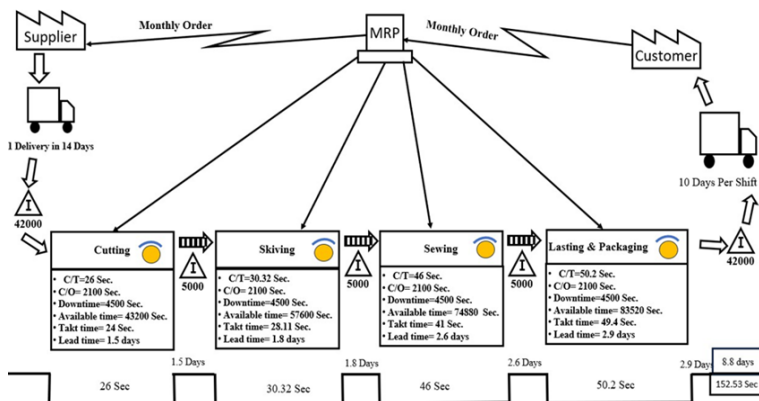


Figure 7. State in Current VSM

Figure 7 depicts the present state map, highlighting the important components of the system:

Demand: Customers place purchases monthly with no firm commitment, resulting in significant monthly volume changes. Customers place orders every day, but Maier only selects specific items and amounts from available stock the day before shipping.

Physical Systems: The manufacturing process entails the creation of several shoe varieties and low-volume pieces using flexible machinery. Because of shared resources and remote processes, large transfer batches are required, which increases in-process inventory accumulation and impedes flow.

Information System: The Production Control Department manages the complex scheduling process, which involves multiple individuals using both technical and manual technologies.

The existing system has an average advance time of 8.8 days and a high volume of work content per part. The upgrade goal was to reduce the cycle time from 152.53 seconds to 138 seconds, as per the authorized redesign.

Some important ways to make the current process better are to lower stress at work, improve line balance, and allow more job sharing. Some of the identified problems include poor ergonomics, backwards flows, and excessive movement. Experts suggest enhancing the visibility of defects and reducing the number of quality checkpoints. Other changes that could be made include replacing old tools, like tape measures, with laser markings and lowering the temperature at which work is done.

5.6 Overall Process Improvements Using VSM

5.6.1 Future State Mapping

Based on the current state analysis, a future state value stream map was developed to address inefficiencies across departments. Key elements of the improvement plan included:

- (i) **Cycle Time Reduction:** Targeted reductions in processing times, particularly for bottleneck tasks, to align with takt time.
- (ii) **5S Implementation:** Workplace organization to enhance efficiency and reduce worker fatigue.
- (iii) **Pull Systems:** Transitioning to a demand-driven production flow to minimize in-process inventory.
- (iv) **Automation and Process Consolidation:** Introducing machinery and integrating low-value-added tasks to improve overall productivity.

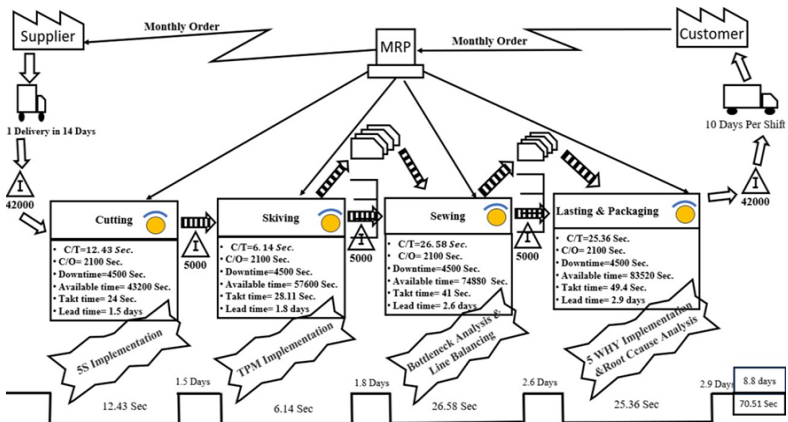


Figure 8. Value Stream Mapping for Future State

Figure 8 illustrates the Future State Value Stream Map, emphasizing prolonged cycle durations among departments as a major source of waste. To address this issue, three methods were employed: the Largest Candidate Rule. These algorithms generated comparable results due to the production line's simplicity. The algorithms indicated substantial delays in balancing, resulting in diminished process efficiency. To improve balance and augment production, lean methodologies including 5S, Kanban, Kaizen, and TPM were incorporated into the future state map, anticipating enhancements in balancing efficiency.

5.6.2 Efficiency Metrics

The balancing efficiency across departments was recalculated post-implementation:

- (i) Cutting Department: Improved from 48.2% to 72%.
- (ii) Skiving and Embossing Department: Enhanced from 21.8% to 65%.
- (iii) Sewing Department: Increased from 35.31% to 64.68%.
- (iv) Lasting and Packaging Department: Improved from 48.43% to 70%.

5.7 Discussion

The two figures (Figure 7 and Figure 8) represent the current state and future state VSM for the production process of BLING Leather Product Ltd., clearly demonstrating the impact of Lean interventions. The current state map identifies significant

inefficiencies across the cutting, skiving, sewing, lasting and packaging departments, where cumulative cycle time reached 152.53 seconds and the overall production lead time was 8.8 days. Critical problems include misaligned cycle and Takt time, high down time, bottlenecks in key process, and excessive work-in-process (WIP) inventory, all of which hindered the ability to meet customer demand effectively.

In the future state map, the application of VSM alongside targeted Lean tools such as 5S, Total Productive Maintenance (TPM), bottleneck analysis and line balancing, and 5 WHY Root Cause Analysis directly addressed in these inefficiencies. These Lean methodologies were the primary drivers of improvement, reducing the total cycle time by over 53%, from 152.53 seconds to 70.51 seconds. Each department achieved significant cycle time reductions: cutting decreased from 26 to 12.43 seconds, skiving from 30.32 to 6.14 seconds, sewing from 46 to 26.58 seconds, and lasting and packaging from 50.2 to 25.36 seconds. Importantly, in the future state, all department cycle times are now lower than their respective Takt time, ensuring a smooth, demand-driven production flow.

Although, the overall production lead time remained approximately 8.8 days, the drastic reduction in cycle time indicates much higher process efficiency, flexibility, and throughput capability. The VSM not only visualized the current bottlenecks and waste, but also systematically guided the applications of Lean tools to create a structured roadmap for improvement. Thus, the findings affirm that the structured use of VSM combined with appropriate Lean techniques was the key factor in transforming the production system. This case

demonstrates that even traditional, labor-intensive industries in emerging economies can achieve substantial operational excellence by adopting a data-driven Lean approach.

6. CONCLUSION

This study demonstrated the significant impact of applying Lean manufacturing principles, particularly Value Stream Mapping (VSM), in enhancing efficiency and reducing waste at BLING Leather Products Ltd. A systematic analysis of operations across four departments- cutting, skiving and embossing, swing, and lasting and packaging- revealed major inefficiencies, including mismatch cycle time and takt time, bottlenecks, and imbalanced workloads. Through the integration of Lean tools such as 5S, Takt time analysis, Kaizen, and Largest Candidate Rule, the proposed future state map achieved notable improvements: reduced cycle times aligned with customer demand, balancing efficiency gains ranging from 21.8% to 70%, and streamlined workflows eliminating non-value -adding-activities. These finding underscore the transformative potential of VSM and Lean principles for operational excellence in the footwear sector.

However, the study's scope was limited to production efficiency within a single factory, suggesting the need for future research to explore areas such as environmental sustainability, supply chain optimization, and customer satisfaction. Further validation across diverse manufacturing context would also strengthen the generalizability of these methods. Overall, the successful adoption of Lean strategies positions BLING Leather Product Ltd. for enhanced competitiveness in the global footwear market.

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