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A Lean Kaizen Approach using Value Stream Mapping for Quality Improvement in SMEs

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***Abstract*— Lean-Kaizen is made up of two sayings the LEAN and the KAIZEN; Lean means getting rid of meaningless exercises and Kaizen means continuous improvement; lean-kaizen aims at getting rid of the waste by suggesting little better improvements. Lean-kaizen is a technique of improvement handles wide range of inadequacies in the manufacturing plants. It gives a superior opportunity to everyone in the organization to participate in continual improvement processes in achieving the goals or targets decided by the organizations in an economic manner.**

VSM a lean tool which has been implemented in this study gives a conceptual vision by creating a future state map of a sequence of processes of product by examining the current state map. The processes that add more in generation of waste are identified by measuring takt time. The emphasis is placed on solving the daily routine issues like quality rejections by implementing lean principles and Kaizen philosophy by undertaking the effective and efficient case study in Indian small and medium scale enterprises (SME) manufacturing predominantly auto parts used in four and two wheelers. The process of identifying root causes of daily basis problems has achieved through why-why analysis that provided pertinent and fertile evidences in finding and applying Kaizen in targeted areas. The results achieved were compared pre- and post-implementation of VSM and it is concluded that Lean-Kaizen is an effective and economical approach to attaining gradual enhancement in SMEs. Lean–Kaizen combines the principles of Lean (waste elimination) and Kaizen (continuous improvement). This study applies Lean–Kaizen methodology using Value Stream Mapping (VSM) to XYZ Industries, an SME in India's NCR region manufacturing automobile components. The case focuses on the Shaft (SHAFT) process. VSM was used to visualize material and information flow, identify bottlenecks, and propose Kaizen improvements. Root cause analysis and brainstorming was made possible by videography of real-time operations. The outcomes were also positive: the production level grew by 6 percent, customer satisfaction rates went up by 12 percent, the time to deliver a product on time was improved by 6 percent, the cost of rejection decreased by 235 000 rupees each year, the production lead time was reduced by 93.95 percent, and the cycle time was made shorter by 13.66. The results affirm Lean-Kaizen and VSM as an affordable and flexible approach to SMEs.

Keywords — Lean Manufacturing, Kaizen, Value Stream Mapping, SMEs, Automobile Components, Continuous Improvement

I. INTRODUCTION TO LEAN–KAIZEN FOR SMES

Lean-Kaizen has become a well-known and viable strategy in attaining operational excellence, especially in the small and medium-sized enterprises (SMEs). Lean and Kaizen synergy offers a sustainable model of competitiveness in resource-limited environments. Lean is concerned with the removal of wasteful processes whereas Kaizen is concerned with continuous and gradual improvement. Collectively they promote efficiency, employee involvement, and extended flexibility.

- Lean: It is focused on the identification and removal of non-value addition processes and hence streamlining operations and cutting cost.
- Kaizen: Promotes smaller-scale changes that are employee-led at every level that foster a culture of continuous improvement.
- Combined Impact: Kaizen unites both systematic waste removal and participatory enhancement to form a cost efficient channel to operational perfection.

Relevance for SMEs

Some common challenges that SMEs experience are lack of resources, large competition and manufacturing process inefficiencies. Lean- Kaizen can resolve these problems by:

- Reducing inefficiencies in production systems.
- Enhancing competitiveness through cost-effective strategies.
- Encouraging employee involvement in problem-solving and innovation.

Value Stream Mapping (VSM) is one of the Lean tools that form the basis of Lean-Kaizen application to SMEs since it offers a detailed visual representation of the whole flow of materials and information in the production process. This is an effective tool that helps organizations to:

- Map current state processes to uncover bottlenecks, waste, and inefficiencies.
- Design optimized future state maps that enhance flow, reduce lead times, and improve overall process efficiency.

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- Align cross-functional teams through clear visual communication, fostering collaboration and shared understanding.
- Serve as a basis for continuous improvement by distinguishing value-adding from non-value-adding activities.

Alongside VSM, complementary Lean tools such as Poka-Yoke (error-proofing), Visual Control (process monitoring), and One-piece Flow (batch size reduction) support the Lean–Kaizen journey toward operational excellence and non-value-adding activities.

Lean-Kaizen is an evolutional and holistic operational excellence route. SMEs can be sustainably competitive by integrating waste removal with continual enhancement. Kaizen is further updated with modern technologies, which makes it even more relevant, and Lean-Kaizen remains one of the foundations of efficiency and versatility in various industries.

II. LITERATURE REVIEW

Kaizen has been recognized as the overall philosophy to lean thinking, which provides both cultural and process-based underpinnings to waste removal (Singh and Sharma, 2009; Buehlmann and Fricke, 2016). Lean-Kaizen has been operationalized in small and medium-sized enterprises (SMEs) with the help of the following tools: Poka-Yoke, Visual Control, One-piece Flow, Value Stream Mapping (VSM), and workplace organization (Arya and Choudhary, 2015; Villarreal et al., 2016; Thanki and Thakkar, 2016). Of these, VSM has become one of the most critical tools, as they allow companies to visualize material and information flows, pinpoint the bottlenecks, and develop new and better future state maps (Singh et al., 2010). Additional practices like root causes, the use of the why-why method enhance the problem-solving skills of the shop-floor and inculcate the Kaizen culture in the daily routine (Singh and Singh, 2012).

Recent academia has broadened the application of Kaizen to other areas besides manufacturing. Sahmi and El Abbadi (2024) highlighted its flexibility in the healthcare sector, services, and digital sector, connecting continuous improvement with sustainability goals. Syaputra and Aisyah (2022) showed that VSM with Kaizen enhanced efficiency, time management, and organization at the workplace, but issues like employee resistance and management commitment still exist. Continuing these changes, Gomaa (2025) presented Kaizen 4.0 that incorporates Industry 4.0 technologies, such as IoT and AI, into the lean practices, thus allowing real-time monitoring of waste and performance indicators and remaining competitive in the smart manufacturing landscape.

The literature demonstrates how Lean-Kaizen has developed into a digitally-integrated system compared with a conventional waste removal system. Though classical research focused on the tools such as VSM, Poka-Yoke, and One-piece Flow to achieve operational efficiency, the recent input is on the flexibility of Kaizen to sustainability and digital transformation. The introduction of Kaizen 4.0 highlights its applicability in intelligent manufacturing, making Lean-Kaizen a pillar of operational excellence of SMEs in various industries.

Key Outcomes from Literature

- Waste Elimination: Established as the central pillar of Lean–Kaizen, reducing non-value-adding activities (Singh & Sharma, 2009; Arya & Choudhary, 2015).
- Continuous Improvement: Embedded through Kaizen culture, supported by root cause analysis and employee-driven initiatives (Singh & Singh, 2012; Syaputra & Aisyah, 2022).
- Value Stream Mapping (VSM): Proven as a strategic tool for process visualization, bottleneck identification, and sustainability alignment (Singh et al., 2010; Sahmi & El Abbadi, 2024).
- Error-proofing and Flow Tools: Poka-Yoke, Visual Control, and One-piece Flow enhance quality, transparency, and responsiveness (Villarreal et al., 2016; Thanki & Thakkar, 2016).
- Kaizen Beyond Manufacturing: Demonstrated adaptability in healthcare, services, and digital industries, linking improvement to sustainability (Sahmi & El Abbadi, 2024).
- Kaizen 4.0: Integration of IoT and AI into lean practices enables digital VSM and real-time monitoring, ensuring competitiveness in Industry 4.0 environments (Gomaa, 2025).

The literature demonstrates how Lean-Kaizen has developed over the years to become a digitally combined model of waste removal. As classical literature focused on tools such as VSM, Poka-Yoke and One-piece Flow as the means of operational efficiency, newer literature focuses on the flexibility of Kaizen to sustainability and digital transformation. The introduction of Kaizen 4.0 highlights its applicability in intelligent production, making Lean-Kaizen one of the foundations of operational excellence in SMEs operating in a variety of industries.

III. CASE STUDY

Lean-Kaizen methodology was purposely implemented in XYZ Industries, a small and medium-sized enterprise (SME) in the non-capital region (NCR) of India which produces automobile parts (sprockets, collars, shafts, spindles, gears) and selectors in two-wheelers, as well as four-wheelers. The narrow case study of the shaft production line showed lack of efficiency in flow of materials and information which was mainly caused by volatile clamping procedures, no standardized practices and inventory control issues. The research was conducted based on Lean Manufacturing principles (Rother and Shook, 1999; Seth and Gupta, 2005) and Value Stream Mapping (VSM) was applied with standard process symbols (pencil-and-paper mapping) to visualize the whole production stream (Singh et al., 2010). The major issue found out was that during the grinding process there were steps on the outer side of the shaft due to the variation in slot width and instability due to clamping on the slot side. One of the Kaizen interventions suggested was the relocation of the clamping bush to the serration side that would enhance the stability and minimize vibration. Standardization came in terms of requiring the replacement of the clamping bush after every 25,000 pieces as well as the introduction of electronic

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information system and Kanban in order to ease communication and decrease inventories. All these activities, together, have made production more efficient, increased quality, delivered on time and at lower costs, which have made the XYZ Industries more competitive in the Indian automotive supply chain. SHAFT was used in Bike as a case study.

- Problem Identification: Grinding defects on shaft outer diameter due to slot width variation.
- Root Cause: Instability caused by clamping on the slot side.
- Kaizen Solution: Shift clamping bush to serration side → improved stability and reduced vibration.
- Standardization: Replace clamping bush after every 25,000 pieces to maintain process consistency.
- Lean Tools Applied: Value Stream Mapping (VSM) with standardized symbols; pencil-and-paper mapping for material and information flow visualization.
- Additional Improvements: Electronic information system and Kanban introduced to reduce inventory levels and improve communication.
- Impact: Enhanced efficiency, reduced defects, improved delivery timelines, lowered costs, and strengthened SME competitiveness in the automotive sector.

A. *Methodology*

The Lean–Kaizen methodology was implemented at XYZ Industries, an SME automobile component manufacturer located in India's non-capital region (NCR). The study focused on the shaft production line, applying Lean Manufacturing principles and Value Stream Mapping (VSM) to identify inefficiencies and propose targeted improvements. The methodology followed a structured sequence of steps (refer fig. 1) to ensure systematic problem-solving and sustainable process enhancement:

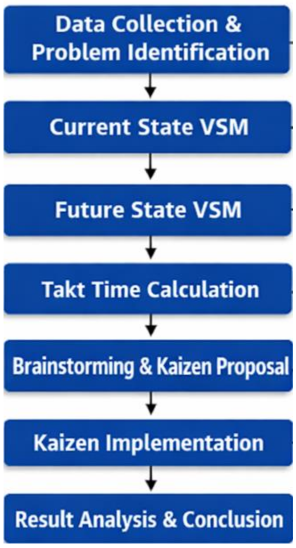

Fig.1: methodology adopted

B. *Case Study - Problem Analysis*

- Data Collection and Problem Identification: Detailed production data were gathered from the shaft line, including cycle times, defect records, and material flow observations. The primary problem identified was the occurrence of steps on the shaft's outer diameter during grinding, traced to slot width variation and unstable clamping practices.

- Preparation of Current Value Stream Map (VSM) : Using standardized process symbols (Singh et al., 2010), a pencil-and-paper VSM was developed to visualize the existing material and information flows. Fig.2 maps the highlighted bottlenecks, delays, and sources of waste across the production line.

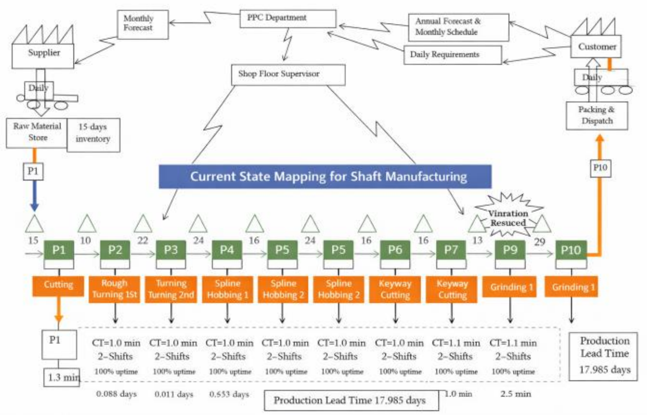

Fig.2: current state VSM

- Design of Future Value Stream Map: A redesigned VSM was created to represent the desired state of operations, incorporating lean practices such as improved clamping methods, standardized replacement intervals, and streamlined communication systems (ref fig.3).

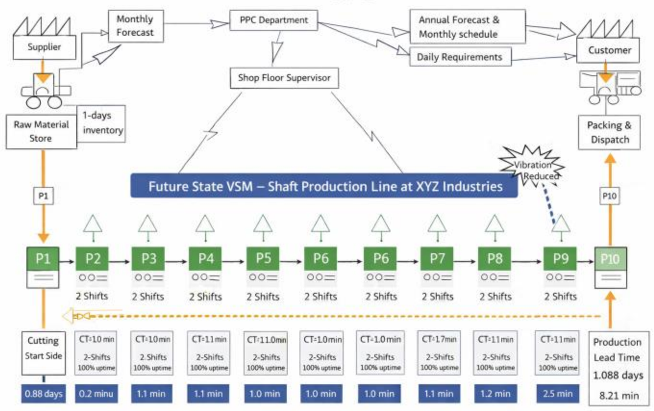

Fig.3: future state VSM

- Takt Time Calculation:

In this study, certain assumptions were made, whereby variations related to labor, machine performance, and shift schedules were excluded from the calculations. The average customer demand for the shaft was determined to be 14,625 units per month, with 25 effective working days, resulting in a daily demand of 585 units. Each shift comprised 7 working

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hours, excluding two lunch breaks of 30 minutes each and two tea breaks of 15 minutes each, giving a total available working time of 840 minutes per day.
The takt time was calculated as the ratio of available working time per day to customer demand per day, yielding:

Takt Time = 840/585 = 1.43 minutes per unit

From the current VSM, the takt time was established at 1.43 minutes per unit. The value-added time for the shaft was found to be 9.51 minutes, while the production lead time was 17.985 days. Using the calculated takt time as a benchmark, a cycle time versus process sequence chart was prepared to identify processes requiring improvement through Kaizen.

Analysis revealed that Process P8 had a cycle time of 1.7 minutes, which exceeded the takt time. Furthermore, P8 was identified as a bottleneck at the Grinding station, primarily due to a high rejection rate. Consequently, this process was selected for improvement. Brainstorming sessions supported by videography were conducted to address issues of elevated cycle time, excessive work-in-progress (WIP), and quality defects, thereby enabling targeted Kaizen interventions.

- Problem Statement & Root Cause Analysis:

During the grinding process, steps are observed on the outer diameter (OD) of components.
Root Cause Analysis:

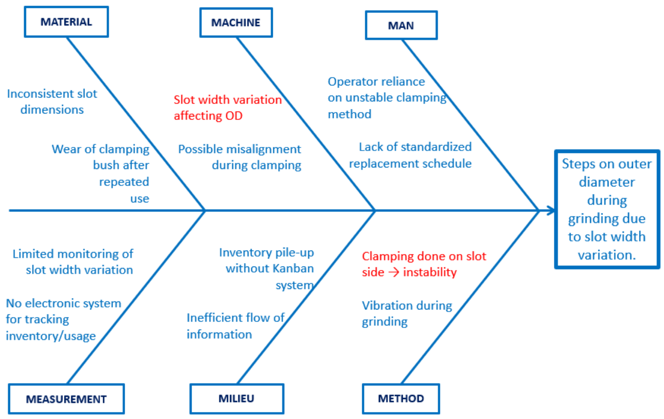

Fig.4: fish bone analysis

- Fish Bone analysis (fig.4) performed to identify the root cause.
- During the grinding operation, clamping the workpiece on the slot side of the Shaft often resulted in wheel dash marks and step formation on the outer diameter.
- This defect arises due to slot width variation, which causes instability when clamping is performed on the slot side.
- The instability leads to vibration during grinding, resulting in dimensional inconsistency and reduced product quality.
- Impact: This recurring issue impacts process reliability, increases rework, and threatens production efficiency.

Addressing the root cause is essential to ensure stable clamping, consistent grinding performance, and long-term standardization of the process. Root causes analyzed as below:

- Instability caused by clamping on the slot side.
- Wear and misalignment of clamping bush.
- Lack of standardized replacement schedule.
- Inefficient monitoring of slot width variation.
- Poor inventory flow without Kanban system.

C. *Brainstorming and Kaizen Proposal*

A two-hour real-time record of the process of interest (P8) was recorded continuously. All important aspects of the operation such as man, material, method and machine involved in the completion of the process cycle were recorded. This visual data was used as the main input to further analytical processes.

The video was thoroughly screened through organized brainstorming sessions to determine the deviations, inefficiencies and areas of improvement. The group was a team of 4-6 members who were domain-relevant and a focused review meeting was held. The potential measures that could be used to improve the quality and productivity of the processes were recorded individually by each participant. The team used the technique of why–why analysis to explore the underlying cause of issues, which allows systematic search of the root causes.

Modification: To deal with this, the clamping method was changed: the clamping bush on the slot side was relocated on the serration side. This modification offered a superior stability, reduced vibration and effectively eliminated the step defects of the outer diameter.
Lean Tools Applied: Value Stream Mapping (VSM), Takt time calculation, Kaizen events.

Any ideas that were proposed were discussed as a team to see their viability and suitability with operations goals. Shortlisting of the most viable and effective recommendations was done as Kaizen improvement actions. Each team member was then allocated specific shafts in order to be accountable and implement the recommended improvements successfully.

D. *Kaizen Improvement: Clamping on Serration Side*

When grinding, holding the workpiece on the slot side of the Shaft (SHAFT) could frequently cause the development of wheel dash marks and development of steps on the outside diameter. This problem was a cause of an increased in-house rejection.

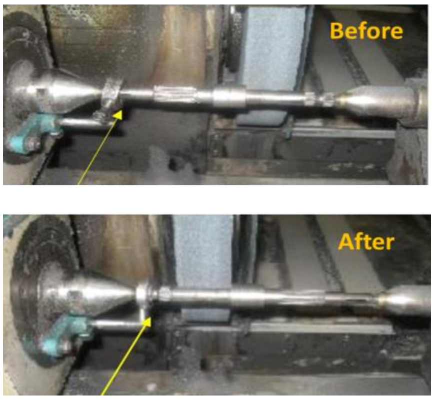

Fig.5: before and after clamping

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To address this, the clamping method was modified (fig.5): the clamping bush previously positioned on the slot side was shifted to the serration side. This adjustment provided better stability, minimized vibration, and effectively eliminated the step defects on the outer diameter. For consistent performance, the clamping bush on the serration side is recommended to be replaced after every standardized production batch of 25,000 pieces.

IV. RESULT ANALYSIS (BEFORE VS. AFTER VSM IMPLEMENTATION)

Based on data collected before and after applying VSM and Kaizen events (refer fig 3 & 4), the following improvements were achieved within 45 days in the selected SMEs as shown in table 1:

TABLE:1 RESULT ANALYSIS (BEFORE VS. AFTER VSM IMPLEMENTATION)

Issue	Before Implementation	After Implementation	Improvement
Wheel dash marks & steps on outer diameter	Frequent defects, high rejection rate	Completely eliminated; no rejection for 20 days	Defect-free production
Customer satisfaction	Baseline level	Increased by 12%	Higher satisfaction
On-time delivery	Baseline level	Improved by 6%	Better delivery performance
Quality (PPM level)	Defects present	Achieved Zero PPM	World-class quality
Customer complaints	Reported due to poor quality	None reported	Complaints eliminated
Rejection cost	₹2.35 lakhs per year	Saved annually	Cost savings
Clamping process	Difficult, unstable	Easier, stable clamping	Process reliability
Production lead time	17.985 days	1.088 days	Reduced by 93.95%
Cycle time	9.51 minutes	8.21 minutes	Reduced by 13.66%

Defect Elimination:

- Wheel dash marks on the face and step defects on the outer diameter were completely eliminated.
- No rejection reported in each shift for 20 consecutive days.

Customer Benefits:

- Customer satisfaction improved by 12%.
- On-time delivery performance increased by 6%.
- Achieved zero PPM (Parts per Million) defect level (fig.6)
- No customer complaints recorded.
- Annual rejection cost savings of ₹2.35 lakhs due to improved quality.

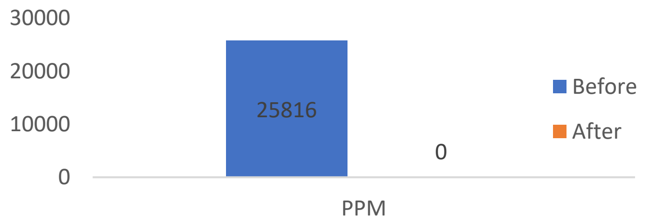
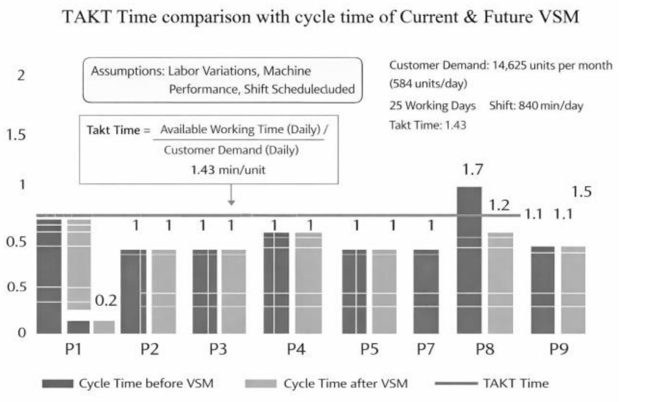


Fig.6: Before and after PPM

Process Improvements:

- Easier and more stable clamping of workpieces.
- Production lead time reduced by 93.95% (from 17.985 days to 1.088 days).
- Cycle time reduced by 13.66% (from 9.51 minutes to 8.21 minutes).(fig 7)

Fig.7: Takt comparison with cycle time



V. CONCLUSIONS:

The application of Lean-Kaizen with Value Stream Mapping (VSM) resulted in the quantifiable changes in the chosen SME. SHAFT (Process 8) production grew by 6% and the on-time delivery performance and quality ratings improved. The research supports the fact that, with VSM, Lean Kaizen is specifically applicable to SMEs because it is simple to implement and can provide quick and concrete outcomes. The method also exhibits high levels of continuous improvement whereby systematic improvement can be done in products, processes and procedures. Additionally, the methodology can be widely applied to different manufacturing settings and helps to simplify the working processes and shorten the time of training due to the standardization of practices.

Production Gains:

- SHAFT (Process 8) production has increased by 6 percent, and there was a significant improvement in the on-time delivery and overall quality ratings of the SME.

Suitability of Lean–Kaizen with VSM:

- Especially efficient in the case of SMEs, where it is possible to detect improvement opportunities within a short time.
- Kaizen recommendations are easy to apply and give quick, quantifiable outcomes.

Continuous Improvement Potential:

- Provides continuous improvement of real-time shop floor operations whenever used.
- Promotes procedural, product and process enhancement.

Broader Applicability:

- The approach can be used in a variety of manufacturing settings.
- Facilitates enhancement of systems and processes and lessens employee training span due to standardized practices.

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