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ORIGINAL RESEARCH

Implementation of Lean Manufacturing Principle Towards Improving Firm Performance: Evidence from the Case of Account Book Fabrication Industry

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Abstract

The account book fabrication industry, a sub-sector of the printing and stationery sector, has experienced a steady decline due to the rapid rise of computerized accounting. Despite its economic significance and continued relevance in semi-urban and rural markets, this industry remains unexplored in academic literature. This study addresses this research gap by investigating how lean manufacturing principles can revitalize a declining traditional industry. A case-study approach was adopted at an account book fabrication workshop in Prayagraj, India. Data were gathered through semi-structured interviews with 18 participants, direct shop-floor observations, and time–motion studies. Lean tools, including 5S, Kaizen, Poka-Yoke, and Kanban, were systematically implemented over 6 months. The findings reveal a 20% reduction in fabrication time per unit, a 25% increase in monthly output, improved inventory turnover, higher worker wages, and enhanced owner profits. Beyond operational gains, the study links lean-driven improvements to export competitiveness, demonstrating how enhanced productivity, quality, and cost-efficiency enable traditional firms to meet international standards and participate in global supply chains. The study offers both theoretical and practical contributions for sustaining traditional industries in a globalized economy.

Keywords Lean manufacturing · 5S · Kaizen and Kanban · Productivity

JEL Classification M11 (Production Management) · L60 (Industry Studies: Manufacturing – General) · L67 (Other Consumer Nondurables: Paper, Printing, and Publishing) · O14 (Industrialization; Manufacturing and Service Industries; Choice of Technology) · F14 (Empirical Studies of Trade)

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Introduction

The account book fabrication industry has recently been undergoing drastic changes, leading to increased competition and declining profits (Kumar et al., 2024). As a result, the industry now requires the adoption of lean manufacturing concepts, methods, and ideas to remain competitive (Dennis, 2017; Tetteh et al., 2024). Manufacturing companies are striving to enhance both internal and external performance to gain a competitive edge, as demonstrated by their focus on manufacturing process optimization (Graves et al., 1995; Sundar et al., 2014). Corporations aim to eliminate redundant operations, reduce unnecessary expenditures, and mitigate performance issues caused by rising competition (Karim et al., 2008). The increasing use of computerized accounting has led to a decrease in manual accounting processes, resulting in lower sales of traditional accounting books, such as cash books and ledger books. Therefore, the need for applying lean techniques is growing, as these methods can help increase profits, productivity, and quality. Studies conducted in various workshops identified the primary issues as improper inventory management, less ergonomic working environments, and a lack of diligence among workers at all levels of manufacturing. Consequently, the industry's workshops should deepen their understanding of lean manufacturing methods and tools. The central tenet of the lean concept is to achieve perfection by minimizing waste in every part of the organization (Magnani et al., 2024). The primary objective of lean tools is to eliminate non-value-adding operations and identify waste (Papadopoulou & Özbayrak, 2005; Saraswat et al., 2024). Through technical observation and study, this work aims to develop and implement current lean manufacturing techniques in industry. One workshop was thoroughly examined and observed, and lean methods were subsequently applied to enhance efficiency and productivity.

Manufacturing companies are continually striving to improve efficiency, reduce waste, and enhance product quality to meet customer expectations and stay competitive (Nasseriddine and Wehbe, 2018). The account book fabrication industry is no exception, despite its longstanding presence. The account book fabrication sector is not recognized as a separate industrial category; rather, it functions as a specialized segment within the broader printing and stationery industry. The Indian printing and stationery industry represents a significant component of the manufacturing and MSME ecosystem, with an estimated market size exceeding USD 10 billion and supporting large-scale employment across commercial printing, publishing, packaging, and stationery production. Within this broad structure, the stationery segment alone was valued at approximately USD 2.6–2.9 billion in 2024 and continues to grow steadily due to consistent demand from educational institutions, offices, and small businesses. Despite increasing digitalization, the demand for physical notebooks, registers, and accounting ledgers remains strong, particularly in semi-urban and rural markets where traditional record-keeping practices continue to dominate. Account book fabrication, therefore, represents a focused and functionally important sub-sector that caters specifically to bookkeeping and documentation needs of retailers, educational institutions, and government offices. In this study, the term "account book fabrication industry" is used to denote this specific operational segment for analytical clarity, while conceptually situating it within the wider printing and stationery industry supported by contemporary industry statistics. While technology has advanced, many organizations in this sector still rely on labor-intensive methodologies, resulting in higher manufacturing costs and longer lead times. Lean manufacturing can address these challenges and significantly improve overall performance.

In the mid-twentieth century, Toyota developed lean manufacturing as a method to improve production and quality by minimizing waste. Lean methodologies are characterized by a focus on customer value, Just-In-Time (JIT) production, and continuous improvement (Kaizen) (Hia et al., 2025; Ohno, 1997). By eliminating non-value-added activities, lean methodologies enhance operational efficiency, reduce lead times, and improve customer satisfaction. Over the years, lean practices have revolutionized production operations in industries such as aerospace, electronics, and automotive manufacturing (Li et al., 2018; Sarhan et al., 2017; Siegel et al., 2024). However, the account book fabrication industry has not widely adopted lean methods. This sector faces unique challenges, including shifting client demands, numerous product standards, and labor-intensive production processes. Therefore, exploring the potential application of lean principles to address these challenges effectively is essential.

This investigation examines the extent to which lean practices enhance performance in the account book fabrication industry. Specifically, the research explores the integration of 5S, Kaizen, Poka-Yoke and Kanban into the production systems of this sector (Bakri et al., 2012; Kumar et al., 2020; Shahin et al., 2024). Furthermore, the study evaluates the impact of lean implementation on waste reduction, manufacturing efficiency, cost reduction, and customer satisfaction. The aim is to contribute to the limited understanding of lean adoption in the account book fabrication sector and to provide practical guidance for industry professionals seeking to implement lean methodologies. The paper assesses the effectiveness of key lean strategies in improving the operational performance of this industry.

The study addresses the following research questions:

RQ1:*What are the most effective lean methodologies for the fabrication of account books?*

RQ2:*How can the account book fabrication industry implement lean principles to enhance productivity and reduce waste?*

RQ3:*What are the effects of lean implementation on product quality, operational costs, and production lead times?*

This study addresses these concerns by providing a framework for integrating lean principles into the account book fabrication industry, thereby enhancing its competitiveness in a rapidly changing market. The research aims to facilitate the adoption of lean manufacturing across various industries and provide valuable insights for industry professionals. The structure of the study is as follows:

Although lean manufacturing has been widely applied in automotive, aerospace, and electronics industries, there is limited research on its role in transforming traditional industries facing decline. For such industries, operational excellence is not only a survival strategy but also a prerequisite for competing in export markets where quality, cost-efficiency, and timely delivery are decisive. Linking lean-driven improvements to export competitiveness provides a meaningful academic contribution to the discourse on sustaining traditional sectors in a globalized economy. This study addresses this research void by examining how operational excellence achieved through lean practices in the account book fabrication industry can be leveraged to enhance export competitiveness. While extensive research exists on lean manufacturing in automotive, electronics, and large-scale production sectors, there is little empirical evidence on its application in traditional, declining industries such as account book fabrication. The academic need for this study arises from (a) the absence of research on how lean principles can revitalize low-demand, resource-constrained industries, and (b) the necessity to examine how operational improvements in such sectors can sustain competitiveness in the face of technological disruption.

Literature Review reviews past studies on lean techniques. Research Methodology and Problem Identification outlines the research methodology and presents a step-by-step application of lean manufacturing principles. Results' Analysis discusses the findings after the implementation of lean manufacturing and compares them with pre-implementation conditions. Discussions and Implications explore the implications of these findings. Conclusion presents the conclusion of the study. This structured approach ensures a comprehensive understanding of lean implementation and its impact on the account book fabrication industry.

Literature Review

Lean Manufacturing

Lean manufacturing (LM) is defined as a "systematic approach to identifying and eliminating waste through continuous improvement, promoting product pull by the customer in pursuit of perfection" (Fam et al., 2018). The versatility of lean manufacturing and its independence from specific industries enable its application across numerous fields. A well-organized lean implementation can significantly foster a culture of continuous improvement by enhancing productivity and minimizing defects (Kumar et al., 2022; Verrier et al., 2014). Lean thinking is driven by a set of interrelated enablers, requiring total commitment from a broad range of stakeholders within an organization (Kumar et al., 2024; Verrier et al., 2014). At its core, lean manufacturing focuses on eliminating waste to create a more efficient, sustainable, and environmentally friendly working environment. Traditional manufacturing methods are being reconsidered as potential alternatives in the context of lean manufacturing (Bajpai, 2015). As a long-term growth strategy, lean manufacturing integrates multiple principles and practices, requiring adoption and commitment from senior management (Magnani et al., 2024). This approach is not solely about reducing costs through workforce or inventory cuts but also about comprehensive expense management and process improvement (Womack & Jones, 1990).

While most studies focus on a single component of lean methodologies, few researchers examine multiple aspects (Singh et al., 2010). However, successful lean implementation requires organizations to consider all key elements, including cellular manufacturing (CM), U-line, line balancing, inventory control, single-minute exchange of dies (SMED), pull systems, Kanban, and production leveling (Mohammad & Oduoza, 2019). The efficient implementation of these lean tools significantly contributes to a corporation's growth and performance. Many businesses are eager to adopt lean management methods because the lean system offers numerous benefits, particularly through waste elimination (Zahraee et al., 2014). This project employed several lean manufacturing techniques, resulting in improved production processes and a higher production rate. Despite the variety of concepts within the lean manufacturing system, they all share a common goal: eliminating waste and non-value-added operations (Hayes, 1981).

Prior research has largely emphasized lean's internal performance benefits—waste reduction, productivity improvement, and cost minimization. However, fewer studies have linked these operational outcomes with external competitiveness factors such as global market access, export performance, and customer responsiveness. Addressing this

gap, the present study situates lean adoption not only as an operational strategy but also as a pathway to export competitiveness.

The seven waste-reduction concepts of lean manufacturing are overproduction, waiting, transportation, over-processing, excess inventory, unnecessary movement, and defects (Dewi et al., 2021). These techniques provide insights into different working procedures and steps within an industry. To effectively apply these techniques to a project, it is essential to study their processes, expected outcomes, and methods of implementation. Although lean manufacturing tools were initially developed for the manufacturing industry, they present challenges when adapted to the service industry, particularly in preventing work-related accidents and illnesses (Tortorella et al., 2020). However, these tools can be modified to suit the parameters of any business, ensuring effective application (Oyedolapo, 2014). The primary objectives of using lean techniques are to eliminate waste, reduce costs, and improve overall performance. Additionally, implementing these methods leads to greater employee satisfaction and a safer work environment.

Lean Practices, in Printing and Stationery Industry

Previous studies indicate that lean implementation in the printing industry has historically been less successful compared to other manufacturing sectors due to contextual and conceptual barriers. Ainul Azyan et al. (2017) identified a limited understanding of the waste concept as a major obstacle, noting that printing firms often perceive waste only as physical paper scrap rather than including time, transportation, waiting, and other non-value-added activities. However, when lean principles were systematically applied, productivity improvements and elimination of the seven wastes were achieved. Lean Six Sigma (LSS) applications have also demonstrated measurable operational gains. Roth and Franchetti (2010) found that nearly 30% of worker activities in a small printing firm were non-value-added, while Adeodu and Kanakana-Katumba (2021) reported low process efficiency and high lead time in a paper production company before LSS implementation. The printing section was identified as a major contributor to downtime and non-conformance, which improved significantly through 5S, Kaizen, Poka-Yoke and Kanban. Similarly, Chan and Tay (2018) showed that integrating lean tools within Kaizen initiatives led to 10–30% productivity improvement and reductions in cycle time and work-in-process. Tang et al. (2016) demonstrated that implementing one-piece flow increased overall equipment effectiveness (OEE) from 34.3% to 60% in a batch printing environment. Roriz et al. (2017) reported a 47% reduction in setup time using SMED and 5S in a carton company. In newspaper printing, Alif and Bhat (2024) identified that 44.68% of total lead time was non-value-added, while Patil et al. (2022) confirmed that value stream mapping reduced lead time and label wastage. Furthermore, Memari et al. (2024) provided recent evidence that lean implementation significantly reduces waiting time and improves operational performance in a stationery SME.

Research Methodology and Problem Identification

This study adopted a case study-based mixed-method approach to examine lean implementation in an account book fabrication unit located in Prayagraj, Uttar Pradesh, India. The research was conducted over a period of 4 months (June–September 2024) and covered the complete production flow, including paper cutting, ruling/printing, folding, stitching/binding, trimming, and packaging operations. A goal-directed sampling technique was used to select 18 participants directly involved in production activities, comprising one production manager, three supervisors, eight machine operators, four helpers, and two store/dispatch personnel. Semi-structured interviews (30–45 min each) were conducted to understand bottlenecks, waiting time, work-in-process (WIP), machine downtime, and quality issues. Primary data were supplemented with direct shop-floor observations conducted over ten production days, time and motion studies using stopwatch measurements, and analysis of production records, downtime logs, rejection data, and inventory registers. Quantitative performance indicators lead time, cycle time, WIP levels, productivity rate, and defect percentage were analyzed. Data triangulation, member checking with the production manager, and maintenance of an audit trail were employed to enhance the validity and credibility of the findings. For smooth implementation, a workshop has been conducted in the firm where all the 18 participants are trained. The implementation is monitored and results are recorded.

Research Methodology

To achieve first research question based on past literature, this study implemented several lean principles that are most utilized which are 5S', Kaizen, Kanban and the Poka-Yoke. To implement the lean principle in the manufacturing industry, we selected the Account book fabrication Industry for implementing lean principle. Towards answering the second research question, the author visited the industry and

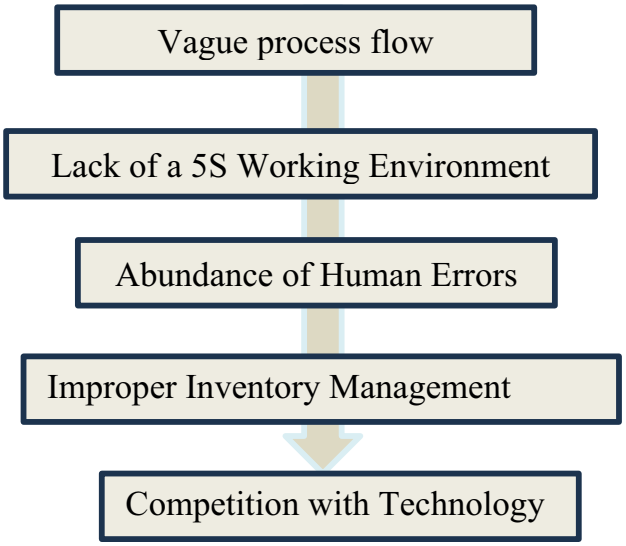

Fig. 1 Outline of case study for problem identification

conducted a thorough case study on waste origination, manufacturing lead time. In this process, problems that have been identified are discussed below. After the identification of problem, suitable lean principle 5S', Kaizen, Kanban and Poka-Yoke have been suggested. Towards answering the third research question, this study applied lean technique to the firm, and several training sessions for the implementation have been conducted; after the greater involvement of management and employees, the lean principle has been implemented. A single-case study approach was employed because the account book fabrication industry is under-researched and fragmented, requiring in-depth engagement with actual shop-floor practices. This qualitative–quantitative blend, involving direct observation, interviews, and before–after performance measures, ensures contextual richness while providing measurable results. Such a methodology is consistent with exploratory studies in lean research when investigating novel industrial contexts. The problems were identified in the five steps discussed as follows and are outlined in Fig. 1.

Problem Identification

The account book fabrication industry that was identified and studied faced several challenges obstructing its overall growth. This process involved visiting the industry, engaging in discussions with managers and employees, and conducting self-diagnosis. This industry operates through three main stages:

- Cutting the paper to the desired size using a cutting machine (Fig. 2a).
- Printing the raw material (i.e., paper) and sectioning it using a sectioning machine (Fig. 2b).
- Fabricating the material into its final form.

Upon examining these processes, both direct and indirect problems were discovered, leading to financial losses, waste, and inefficient workflows.

Five Whys' Analysis for Problem Identification

a. Why is this research significant?

She said: Among the difficulties, the manufacturing sector including the account book building sector faces are inefficiencies, waste, high costs, and uneven quality. Most people agree that lean manufacturing ideas help to increase performance, lower waste, and improve efficiency. This paper adds real data about how lean concepts affect company performance in a particular sector, therefore supporting both scholarly publications and useful applications.

b. Why would one concentrate lean manufacturing ideas?

Lean manufacturing is quite relevant for companies striving operational excellence since it seeks to reduce waste, streamline processes, and raise production.

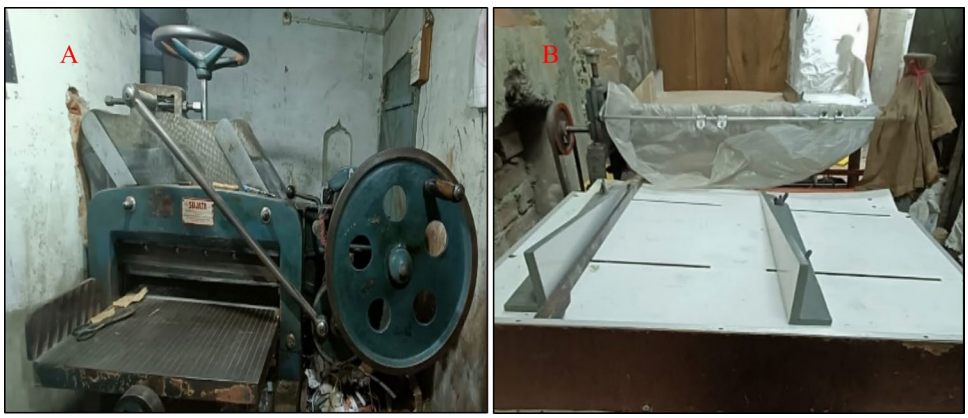

Fig. 2 **a** Cutting machine, **b** sectioning machine. Source: Authors' own compilation based on field visit photographs

Although lean concepts have been used successfully in many sectors, their use in account book construction is yet under investigation. Knowing how lean techniques as 5S, Kaizen, Just-in-Time, and Value Stream Mapping affect performance will let companies in related fields implement best practices.

c. Why should one investigate the manufacturing of account books?

This sector mostly depends on accurate production techniques, material handling, and labor economy. Growing competitiveness and a demand for reasonably priced manufacturing without sacrificing quality call for affordable production. Lean concepts could solve particular inefficiencies in this sector, therefore improving production speed, material usage, and general performance.

d. Why is bettering company performance important?

Companies who increase operational efficiency can boost sustainability, competitiveness, and profitability. Higher customer happiness, greater product quality, and less environmental impact by waste reduction follow from improved performance. This study's insights could let other sectors facing comparable manufacturing difficulties apply lean concepts.

e. Why support current studies?

Although lean manufacturing has been much researched in general manufacturing, its effects in specialized sectors like account book manufacture are still little known. This study contributes empirical data to the corpus of knowledge on lean application in specialized domains. One could say that it offers doable suggestions for companies trying to use lean techniques and boost performance.

Serialization of Problem Identified

The industry lacked a clear, structured process flow. Account book manufacturing was carried out without considering future demands and needs. This lack of a strategic process flow resulted in the unnecessary occupation of space, loss of capital, and wasted time.

Tools and equipment were poorly organized, the workshop lacked cleanliness, and working conditions were not ergonomic due to low lighting and inadequate ventilation. These factors negatively impacted the corporation's finances and employee morale. The disorganized environment led to low confidence and negative body language, hindering overall development.

Observations revealed that workers often exhibited carelessness and did not follow systematic processes. Errors such as dirty handprints on pages during printing and cutting were common. These defects resulted in customer rejections and wasted materials. The root cause was a lack of proper training, as most workers were uneducated and had learned the processes through observation alone, rather than through formal instruction.

Another significant issue identified was inefficient inventory management. Products that were in demand long ago continued to be mass-produced and standardized, leading to unorganized and obsolete inventory. This caused customer disinterest and reduced sales.

The rise of digital solutions and the increasing use of computers for accounting purposes have posed significant challenges to this industry. Many individuals and businesses have shifted to computerized accounting due to its convenience, resulting in a decline in demand for traditional account books.

Addressing these challenges through structured process flows, implementing the 5S technique, reducing human errors through training, optimizing inventory management, and adapting to technological changes can significantly enhance the efficiency and competitiveness of the account book fabrication industry.

Results' Analysis

Applying Lean Principle

The Kaizen

The Kaizen lean tool was implemented by engaging workers across all levels, regardless of their hierarchy or area of expertise, in discussions about lean practices and the importance of continuous improvement. This approach aimed to help the firm remain competitive in an evolving market influenced by technological advancements. The Kaizen sessions enhanced worker efficiency and improved their understanding of market dynamics, ultimately benefiting the organization. Additionally, an awareness camp was conducted to educate employees about various lean tools and their practical applications.

The Kanban

By applying the Kanban technique, changes were introduced to optimize inventory management. Workers were

Fig. 3 **a** Before applying 5S. **b** After applying 5S. Source: Authors' own compilation based on field visit photographs

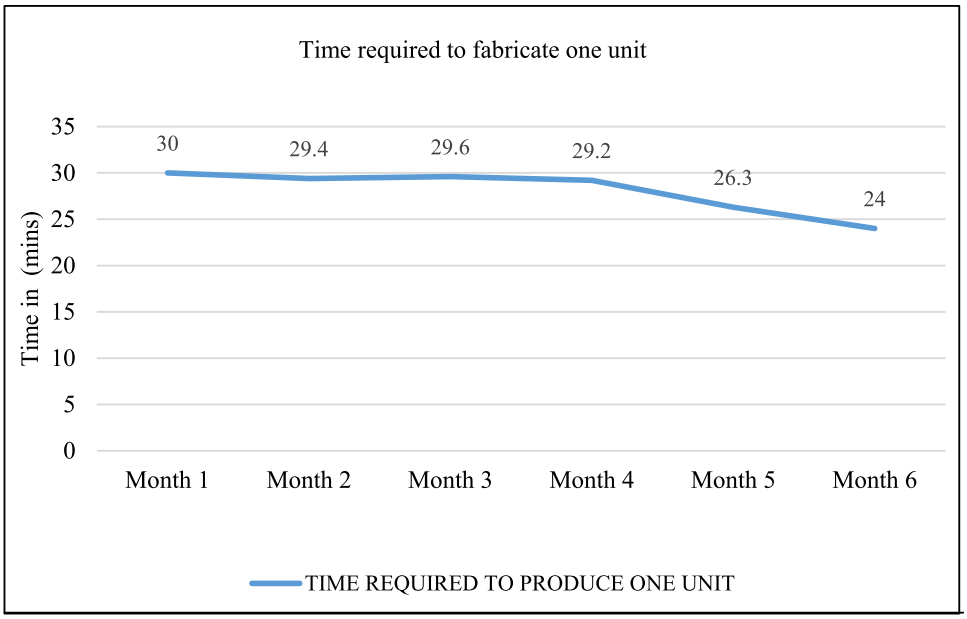

Fig. 4 Time required for fabricating one unit (in minutes). Source: Authors' own compilation based on primary data collected during the case study

directed to produce a higher quantity of products in greater demand and reduce the production of items with lower demand. This adjustment led to improved inventory control and faster product turnover, enhancing the firm's efficiency and profitability. The 5S lean technique was also employed to organize the workspace effectively. Tools were arranged in a systematic manner to ensure easy accessibility, and workers were encouraged to clean and maintain the workshop. During this process, paper litter (depicted in Fig. 3) was collected and sold, providing an additional economic benefit to the firm and contributing to overall sustainability.

The Poka-Yoke

By applying the Poka-Yoke lean technique, errors in the production process were reduced by promoting greater worker caution and providing proper refreshment breaks to alleviate stress. This approach led to an increase in overall efficiency. Over a 6-month period, the implementation of lean tools such as 5S and Poka-Yoke in the workshop led to a decrease in the average time required to fabricate one unit of an account book—from 30 to 24 min. Initially, progress was slow due to workers' difficulty adapting to the new practices. Consequently, frequent training sessions were conducted to facilitate this transition. During the second and third months, the average fabrication time was 29.4 min/unit and 29.6 min/unit, respectively. After conducting additional training sessions, the average time improved to 29.2 min/unit in the fourth month, 26.3 min/unit in the fifth month, and 24 min/unit by the sixth month. This resulted in a 20% decrease in the average time required to produce one unit after 6 months of implementation and monitoring, as shown in Fig. 4.

Due to the reduction in average production time per unit, a greater number of units were produced within the standard 8-h workday. In the first month, the workshop produced 480 units. Production then increased to 500 units in the second month and 490 units in the third month. Following a training session with the workers, production further improved, resulting in 493 units in the fourth month, 547 units in the fifth month, and 600 units in the sixth month. This represents a 25% increase in monthly production, rising from 480 to 600 units by the end of the 6-month period. These

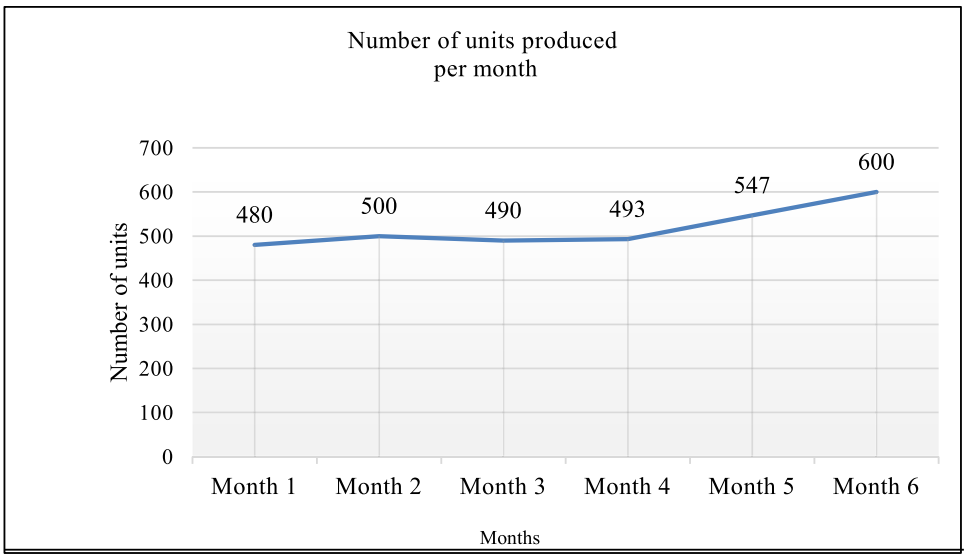

Fig. 5 Number of units produced per month. Source: Authors' own compilation based on primary data collected during the case study

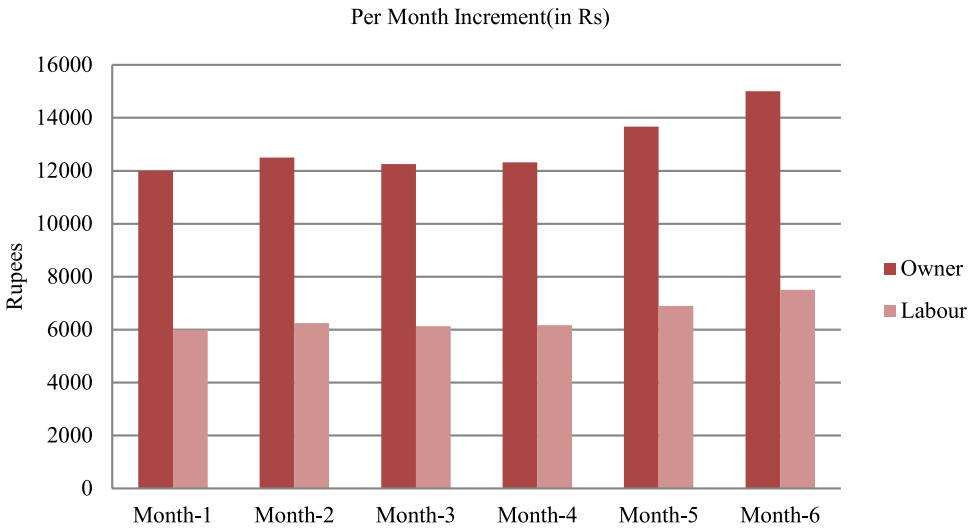

Fig. 6 Monthly increments in profit of the owner and salary of the labor (in Rs.). Source: Authors' own compilation based on primary data collected during the case study

improvements are illustrated in Fig. 5, showing the correlation between reduced production time and increased output over the 6 months.

As a result of the increased monthly production, there was a significant rise in the net profit for the owner and an increment in the salaries of the workers. After 6 months, the owner's net profit increased from Rs. 12,000 to Rs. 15,000 per month. Additionally, the salaries of the two laborers increased from Rs. 6000 to Rs. 7500 per laborer. These improvements are illustrated in Fig. 6.

Discussions and Implications

Discussions

This study addresses the three questions raised earlier in the manuscript. The first question focuses on developing a suitable lean technique for the account book fabrication industry to reduce waste and increase productivity. Based on the identified problems, three lean principles 5S, Kaizen, Poka-Yoke and Kanban were implemented. The second research question examines how lean principles can be applied in the account book fabrication industry to achieve success. In the Account Book Fabrication Industry, the implementation of lean manufacturing principles has significantly enhanced overall firm performance. Lean manufacturing is a methodology applied across various sectors with the objectives of reducing waste, increasing efficiency, and boosting productivity. This study demonstrates the potential of lean practices in a specialized industry characterized by challenging mass production requirements, customization, and variable demand. Key lean principles—waste minimization, continuous improvement, and process standardization—were found to improve both operational and financial performance within this industry. The third

research question explores the effect of lean principles on operational costs and product quality in the industry. The main findings of the study highlight the benefits of waste reduction and efficiency gains. These findings align with several studies (such as Mohammad et al., 2019), which have shown that lean principles are effective in enhancing profit, improving product quality, and reducing inventory levels. Lean manufacturing promotes continuous refinement and standardized work procedures while minimizing defects and enhancing product quality. These techniques have a direct impact on the financial performance of account book fabrication enterprises. By reducing defects, improving operational efficiency, and minimizing waste, firms can cut costs and increase profits. Furthermore, optimizing resource use and productivity allows organizations to increase production capacity without raising costs. The reduction in setup time achieved through lean tools enhances production capacity; however, its strategic importance lies in how it strengthens export competitiveness. Export competitiveness in manufacturing sectors is fundamentally determined by cost-efficiency, quality consistency, delivery reliability, and responsiveness to buyer requirements. Lean techniques implemented in this study 5S, Kaizen, Poka-Yoke and Kanban systematically improve these core performance dimensions. Reduced setup time and waste elimination lower unit production costs, strengthening price competitiveness in export markets. Improved process discipline through 5S and continuous improvement via Kaizen enhance quality consistency, while Kanban improves flow reliability and delivery performance. Poka-Yoke reduces defect rates, minimizing the risk of shipment rejection or non-compliance with buyer specifications. From a theoretical standpoint, the study positions operational excellence as a capability-building mechanism that directly influences export competitiveness by improving cost structure, standard compliance, and supply reliability. In global markets, firms compete not only on price but also on their ability to consistently meet international standards, adhere to strict delivery schedules, and fulfill bulk institutional orders with minimal variability. Lean-driven improvements reduce operational uncertainty and enhance production stability, thereby increasing credibility with international buyers. In the context of the account book fabrication industry, these improvements enable firms to serve institutional buyers in developing economies where traditional accounting formats remain relevant. By offering competitively priced products with reliable quality and timely delivery, lean implementation transforms internal operational gains into external market advantages. Therefore, operational excellence achieved through lean practices is not merely an efficiency improvement initiative but a strategic pathway to strengthening export competitiveness and facilitating participation in global value chains.

Implications

Theoretical Implication

This study aligns with the market competitiveness by empirically demonstrating how the structured implementation of lean techniques 5S, Kaizen, Poka-Yoke and Kanban drives measurable operational improvements in the account book fabrication industry. Theoretically, the study contributes by linking specific lean practices to competitiveness outcomes through process stabilization, waste reduction, and continuous improvement mechanisms. The findings show that workplace organization (5S) enhances workflow efficiency, Kaizen fosters incremental productivity gains through employee involvement, Kanban improves inventory control and flow synchronization, and Poka-Yoke minimizes defects and rework. Together, these techniques create a more responsive, cost-efficient, and quality-focused production system, which strengthens firm-level competitiveness in low-margin, demand-sensitive markets. From a managerial perspective, the study provides practical evidence that systematic lean deployment can reduce lead time, lower work-in-process inventory, minimize errors, and improve on-time delivery, thereby enhancing customer satisfaction and market positioning. Managers in small and medium fabrication units can adopt these lean tools not only for operational excellence but as a strategic pathway to sustain competitiveness in highly price-competitive environments. Additionally, lean tools like Kanban and Total Productive Maintenance (TPM) require significant investments in infrastructure and training. These requirements can be particularly challenging for smaller firms with limited resources, making full implementation difficult. Despite these challenges, the account book fabrication industry can achieve substantial performance improvements by adopting lean manufacturing principles. By focusing on employee engagement, continuous improvement, and waste reduction, firms can enhance their competitive advantage and increase profitability.

Managerial Implications

Lean principles are among the most effective strategies for reducing inventory, increasing operational efficiency, and improving product quality. The enhancement in product quality leads to higher customer satisfaction. Findings also indicate a reduction in lead time, allowing firms to produce more defect-free products. Consequently, lean manufacturing is a proven technique for achieving success and facilitating a transition toward sustainability. Unlike large-scale automated printing facilities, account book fabrication units operate in a semi-mechanized, labor-intensive environment.

Therefore, improvements were more behavior and layout-driven rather than technology-intensive. The study confirms that even in small-scale printing environments, structured lean tools such as 5S and Kaizen can yield measurable operational benefits without heavy capital investment.

Overall, the integration of 5S and Kaizen contributed to improved process discipline, reduced non-value-added activities, and enhanced operational efficiency in the account book fabrication units studied. These findings align with prior research in the broader printing industry, demonstrating that lean principles are adaptable to SME-scale production environments when contextualized appropriately.

Conclusion

The account book fabrication industry that operates without lean manufacturing principles faces numerous challenges, such as improper inventory management, an untidy workplace, and an unskilled workforce, all of which hinder the delivery of quality products to customers. Lean manufacturing offers a solution to these challenges by improving productivity, enhancing quality, and reducing capital investment. Lean principles aim to eliminate waste, boost productivity, and respect human effort, enabling individuals and organizations to achieve their goals. Several lean tools were utilized in this study to identify and address specific problems in the account book fabrication industry. The implementation of 5S and Poka-Yoke resulted in improvements across various levels. These tools helped to reduce production time by 20% by maintaining a tidy workspace, organizing tools properly, and encouraging workers to be more cautious. These changes led to an increase in the monthly profits of the owner and provided incentives for the laborers. Additionally, the use of the Kanban technique improved inventory management, ensuring quicker turnover of products and a faster return on capital. The Kaizen approach facilitated the identification of errors and promoted a culture of continuous improvement. Overall, the application of these lean tools significantly enhanced operational efficiency, quality, and profitability within the account book fabrication industry. More importantly, the study aligns with the Special Issue theme by establishing that operational excellence achieved through lean manufacturing serves as a foundation for export competitiveness. By meeting global benchmarks for quality, cost, and delivery, traditional industries can enhance their market access and competitiveness in export-oriented supply chains. The findings provide a way forward for small and medium enterprises in resource-constrained industries to integrate lean principles as a strategy for export growth.

Limitations and Future Research Direction

This study is limited to the lean tool implementation in account book fabrication industry which is not generalized for other types of industry. However, lean tool applicability in account book industry is verified. Based on the outcome in future we recommend deeper insight on the account book fabrication industry as we did not apply the single minute of exchange of die technique which is a very good lean tool for reducing tool and die setup time. While lean has been extensively studied in modern sectors, little attention has been given to declining industries that face existential threats due to digital disruption. By empirically showing how lean principles can revitalize such a sector, the paper fills a dual void: (1) extending the theoretical application of lean to non-mainstream industries, and (2) linking operational excellence with competitiveness in globalized supply chains.

Future research can expand this work by (a) investigating multi-case settings across similar traditional industries, (b) examining how operational excellence translates into measurable export performance, and (c) integrating advanced approaches such as Industry 4.0–Lean synergies to explore modernization pathways for traditional sectors.

Key Questions Reflecting Applicability in Real Life

1. How can small and medium enterprises (SMEs) in traditional, declining industries integrate Lean tools (5S, Kaizen, Kanban, and Poka-Yoke) with emerging Industry 4.0 technologies suchas IoT, AI, and data analytics to build resilience against technological disruption and reposition themselves in global value chains?
2. As a practitioner or policy-maker, what context-specific framework would you design to measure and monitor how operational excellence achieved through Lean implementation translates into export competitiveness, delivery reliability, and buyer-satisfaction metrics in resource constrained MSMEs of emerging economies?
3. How can Lean-driven operational improvements be combined with green and sustainability practices to help traditional labour-intensive sectors, such as account book fabrication, meet evolving global sustainability standards, ESG expectations, and circular-economy requirements of international buyers?

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Data, Material and/or Code Availability The primary data used in this study (interview transcripts, shop-floor observation notes, time and motion measurements, production logs, downtime records, and rejection/defect data) were collected from a single workshop and contain commercially sensitive and participant-identifying information. They are therefore not publicly archived, but anonymized extracts can be made available from the corresponding author upon reasonable request, subject to the continued consent of the participating firm. No proprietary code was developed for this study.

Declarations

Conflict of Interest The authors declare that they have no known conflicts of interest or competing interests (financial or non-financial) that could have appeared to influence the work reported in this paper.

Ethical Approval This study did not involve any clinical trials, invasive procedures, or vulnerable populations. As the research was based on shop-floor observations and semi-structured interviews with consenting adult employees of the participating firm, formal ethics committee approval was not required under the institutional guidelines applicable to the authors. All the procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments.

Informed Consent Informed consent was obtained from all individual participants (the production manager, supervisors, machine operators, helpers, and dispatch personnel) prior to their involvement in interviews, observations, and training sessions. The owner of the workshop also provided written consent for the conduct of the case study and for the publication of anonymized findings. No personally identifying information is reported in the manuscript.

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