International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 04 | April - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Implementing Lean Manufacturing Practices to Improve Operational Efficiency in Manufacturing Industry

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ABSTRACT

This study investigates how the application of lean manufacturing principles is influencing operational efficiency in the Indian manufacturing sector. Centred on tools such as 5S, Kaizen, and Total Productive Maintenance (TPM), the research explores the adoption patterns, employee perceptions, and measured impacts of lean initiatives. Using a structured questionnaire administered to 120 employees at and supported by industry benchmarks, the study employs quantitative methods including descriptive statistics, Multiple Linear Regressions, Independent Samples t- tests to derive insights.

The results confirm that lean practices lead to measurable improvements in workplace organization, process cycle times, and defect reduction. 70% of employees report enhanced efficiency, while 54.2% rate 5S implementation as highly effective. However, challenges such as partial TPM rollout and inconsistent training remain. The study emphasizes that a structured lean rollout and strong cultural integration are critical for maximizing long-term operational gains.

INTRODUCTION

Operational efficiency has become a decisive factor for survival in India's increasingly competitive manufacturing landscape. In this context, lean manufacturing—a system rooted in the Toyota Production System (TPS)—has been widely adopted to streamline production, eliminate waste, and enhance value delivery. Indian manufacturers, pressured by cost constraints, global competition, and rising customer expectations, are now transitioning from traditional batch-production approaches to lean systems emphasizing flow, flexibility, and zero waste.

Core lean tools such as 5S (Workplace Organization), Kaizen (Continuous Improvement), and Total Productive Maintenance (TPM) are being integrated to drive improvements in workplace discipline, problem-solving, and equipment reliability. This study investigates the extent of adoption of these practices at Anula Pumps Precision Manufacturing Pvt. Ltd., and evaluates their quantifiable impact on key efficiency metrics, including process time, defect rates, and equipment uptime. The paper also identifies practical constraints in implementation and suggests targeted strategies for lean maturity.

OBJECTIVES

Primary Objective

- To assess the overall impact of lean manufacturing practices—specifically 5S, Kaizen, and TPM—on operational efficiency within Indian manufacturing firms.

Secondary Objectives

- To examine the adoption levels and usage patterns of lean tools across functional departments.
- To evaluate the influence of lean practices on productivity, waste reduction, and equipment reliability.
- To identify key employee perceptions and challenges related to lean implementation.

Review of Literature

Bouhannana and El Korchi (2025) – "A Systematic Literature Review to Measure Lean, Green, and Agile in Manufacturing Organisations"
conducted a systematic literature review focused on evaluating how leanness, greenness, and agility are measured within manufacturing organizations. Their study analyzed over 121 measurement methods, revealing that while numerous tools exist to assess lean performance, many lack clarity in application. This review helps identify strengths, weaknesses, and gaps in current lean measurement frameworks, offering better direction for industrial practitioners aiming to improve operational efficiency.

Virmani et al. (2025) – "Driving Operational Excellence: The Role of Technology-Organization-Environment Framework in Lean Six Sigma Integrated Industry 4.0 Adoption"
explored the integration of Lean Six Sigma with Industry 4.0 technologies through the lens of the Technology-Organization-Environment (TOE) framework. Their findings show that this integration plays a vital role in driving operational excellence, particularly by enhancing real-time monitoring, decision-making, and sustainability. The study emphasizes that adopting such combined frameworks significantly improves process efficiency and competitiveness in modern manufacturing environments.

Bora and Bhangale (2023) – "Bringing Lean Manufacturing Principles and Industry 4.0 Technologies Together: A Comprehensive Review"
offered a comprehensive review on merging lean manufacturing principles with Industry 4.0 technologies in the food processing industry. Their research highlights that integrating tools like IoT, cyber-physical systems, and automation with lean methodologies helps reduce waste, increase flexibility, and improve productivity. However, the study also pointed out challenges such as high initial costs, technical skill requirements, and resistance to change, which must be addressed for successful lean implementation.

Songkhwan et al. (2025) – "The Influence of Lean Manufacturing and Green Supply Chain Management on Firm Performance: The Mediating Role of Supply Chain Resilience"
examined the relationship between lean manufacturing, green supply chain management, and firm performance in the context of Thai manufacturing companies. The study found that lean manufacturing practices positively impact green supply chain initiatives and, ultimately, firm performance. It also identified that supply chain resilience acts as a critical mediator, enabling firms to maintain productivity and efficiency in times of disruption.

Rossi et al. (2022) – "Lean Tools in the Context of Industry 4.0: Literature Review, Implementation, and Trends"
reviewed the application of traditional lean tools within Industry 4.0 environments, including tools such as 5S, Value

Stream Mapping (VSM), and Kanban. The study found that digital enhancements to these tools, like digital dashboards and automated tracking systems, significantly improve their effectiveness in identifying and eliminating waste. The research suggests that updating lean tools to align with digital transformation trends can greatly boost operational performance.

RESEARCH METHODOLOGY

This study employed a descriptive research design to quantify the impact of lean manufacturing tools on operational outcomes in a mid-sized Indian manufacturing firm. Primary data was collected through a structured questionnaire consisting of 30 closed-ended and Likert-scale questions, distributed to 120 employees at Anula Pumps Precision Manufacturing Pvt. Ltd., spanning production, quality, and maintenance departments.

A convenience sampling method was adopted to ensure a diverse respondent base across operational roles. The questionnaire covered awareness, training, usage frequency, perceived effectiveness of 5S, Kaizen, and TPM, and the observable impact on process performance.

Data was analysed using SPSS software. Statistical tools included:

Multiple Linear Regressions

- Why To measure the impact of 5S, Kaizen, and TPM(independent variables) on functional effectiveness(dependent variable)

Independent Samples t-Test

- Why: To compare the means of responses from secondary data vs. primary field responses and test for significant differences.

Secondary data was sourced from academic literature, industry reports, and benchmark cases from lean leaders such as Toyota, Bosch, and Maruti Suzuki to contextualize findings and validate impact metrics.

STATISTICAL ANALYSIS OF THE STUDY

1. Multiple Linear Regressions

Hypothesis:

- **H_0(Null Hypothesis):**
There is no significant impact of 5S, Kaizen, and TPM practices on operational efficiency in the manufacturing industry.
- **H_1 (Alternative Hypothesis):**
There is a significant impact of 5S, Kaizen, and TPM practices on operational efficiency in the manufacturing industry.

Spss output:

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.179	.099		-1.813	.072
	Q11_Effectiveness_5S	.821	.025	.948	32.492	<.001

a. Dependent Variable: Q16_Encouragement_Level

Interpretation:

- **B = 0.821**: For every 1-unit increase in 5S effectiveness, encouragement level increases by 0.821 units.
- **Beta = 0.948**: Indicates a very strong positive relationship between 5S effectiveness and encouragement level.
- **t = 32.492**, **Sig. < 0.001**: Statistically significant; 5S effectiveness has a significant impact on encouragement level.
- **p-value < 0.05**: Reject the null hypothesis; there is a significant relationship.
- **Constant = -0.179**, **p = 0.072**: Not statistically significant; the baseline encouragement level without 5S is not meaningful.
- **Conclusion**: 5S effectiveness significantly and positively influences operational efficiency.

2. **Independent Samples t-Test**

Hypothesis:

- **H_0 (Null Hypothesis):**
There is no significant difference between the perceptions from secondary data and primary field responses regarding the effectiveness of lean manufacturing practices.
- **H_1 (Alternative Hypothesis):**
There is a significant difference between the perceptions from secondary data and primary field responses regarding the effectiveness of lean manufacturing practices.

Spss output:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Q12_Kaizen_Impact	2.90[a]	120	.947	.086
	Q16_Operational_Efficiency	2.90[a]	120	.947	.086

a. The correlation and t cannot be computed because the standard error of the difference is 0.

Interpretation:

- **Mean of Q12_Kaizen_Impact = 2.90**, **Mean of Q16_Operational_Efficiency = 2.90**: Both variables have the **same average score**.
- **Standard Deviation = 0.947**: Variation in responses is the same for both questions.
- **Standard Error Mean = 0.086**: The standard error of the mean is the same for both variables.

- **Note**: The test could not compute **t-value or correlation** because the **standard error of the difference is 0**, indicating **no difference between the two means**.
- **Conclusion**: There is **no significant difference** between the perceived impact of Kaizen and the overall operational efficiency—they are perceived **equally by respondents**.

FINDINGS AND SUGGESTIONS

Key Findings

- **Adoption Trends**: 70% of respondents indicated awareness of lean principles, and 65% reported having received formal training. However, only 40% were consistently involved in lean activities, indicating a gap between awareness and participation.
- **Tool Effectiveness**:**5S** was perceived as highly effective by 54.2% of employees, particularly for improving workplace organization and reducing search times.**Kaizen** received a 70% approval rate for enhancing shop-floor problem-solving and employee engagement.**TPM**, while recognized by 50% for improving machine reliability, showed partial implementation, with 30% marking it 'Not Applicable'.
- **Operational Impact**:70% of respondents reported reduced process or cycle times after lean implementation.60% observed waste reduction (e.g., material scrap, motion waste).
- **Statistical Validation**:
  - ANOVA revealed significant departmental differences in perceptions of lean impact. Chi-square tests showed no strong correlation between awareness and active participation, suggesting implementation is not yet institutionalized.
- **Barriers**:
  - Lack of training (35%)
  - Resistance to change (30%)
  - Time constraints due to production pressure (20%)
  - Limited managerial support (15%)

Suggestions

- **Enhance Training**: Establish structured multi-level training programs to bridge the gap between awareness and application.
- **Promote Involvement**: Institutionalize participation through Kaizen circles, suggestion systems, and cross-functional lean teams.
- **Scale TPM**: Roll out plant-wide TPM with operator involvement and track performance through OEE, MTBF, and MTTR metrics.
- **Change Management**: Address resistance through targeted communication, pilot projects, and employee-led improvement ownership.

CONCLUSION

This study confirms that lean manufacturing practices—particularly 5S, Kaizen, and Total Productive Maintenance—have a measurable and positive influence on operational efficiency in the Indian manufacturing sector. Based on primary data from 120 employees at Anula Pumps Precision Manufacturing Pvt. Ltd., and supported by secondary benchmarking data, the research highlights notable improvements in process times, workplace organization, and waste reduction following lean implementation.

REFERENCES

Ahuja, I.P.S. and Khamba, J.S., 2008. *An evaluation of TPM initiatives in Indian industry for enhanced manufacturing performance*. Journal of Quality in Maintenance Engineering, 14(4), pp.388–412.

Dhingra, A.K., Kumar, S. and Singh, B., 2019. *Cost reduction and quality improvement through Lean-Kaizen concept using value stream map in Indian manufacturing firms*. International Journal of Systems Assurance Engineering and Management, 10(2), pp.243–258.

Ghosh, M., 2012. *Lean manufacturing performance in Indian manufacturing plants*. Journal of Manufacturing Technology Management, 23(1), pp.56–75.

Kadam, P.H., Rohit, K. and Balsara, S., 2023. *Practical implications of lean manufacturing implementation based on Kaizen suggestions: A case study*. In: Advances in Industrial Engineering and Management Science. Singapore: Springer, pp.217–229.

Makwana, A.D. and Makwana, D.K., 2019. *Strategic implementation of 5S and its effect on productivity of plastic machinery manufacturing company*. Australian Journal of Mechanical Engineering, 17(3), pp.207–215.

Panizzolo, R., Garengo, P., Sharma, M.K. and Gore, A., 2012. *Lean manufacturing in developing countries: evidence from Indian SMEs*. Production Planning & Control, 23(10–11), pp.769–788.

Sahoo, S. and Yadav, S., 2018. *Lean production practices and bundles: A comparative analysis*. International Journal of Lean Six Sigma, 9(2), pp.148–170.