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Impact of implementation of lean methodologies on SMEs: A study on Allahabad SMEs

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Abstract
The objective of this research is to examine the effects of lean methodology implementation on the operational performance of small and medium enterprises (SMEs) located in the Allahabad region. By employing mathematical modeling and empirical data analysis, a quantitative correlation is established between the implementation of lean practices and enhancements in sustainable operational metrics such as productivity, inventory levels, and defect rates. The study presents an extensive framework that encompasses the synergistic impacts of various lean tools. It provides data-driven insights that enable small and medium-sized enterprises (SMEs) to improve their efficiency, profitability, and growth by implementing lean strategies.

Keywords: Lean methodologies, SMES, operational performance, Allahabad region, empirical analysis, mathematical modeling, sustainability, framework, data-driven insights, efficiency, profitability, growth

Introduction
The world is changing at fast pace and the business organizations are heart of economy and SMEs are the upcoming large business units, they'll only become successful when they adapt to the fast-paced and ever-changing commercial environment, they are thriving for enhanced productivity, quality, and efficiency to outperform their rivals to achieve this one of the ways is Implementation of Lean methodologies in the SMEs like 5S System, Visual Control, Standard Operating Procedures (SOPs), Just in Time (JIT),KANBAN System, Cellular Layout, Value Stream Mapping, Single Minutes Exchange of Dies or Quick Changeover (SMED), TPM (Total Productive Maintenance), and Kaizen Blitz or Rapid Improvement Process. Lean management has become crucial in this context usage of Japanese tools evolved into a management technique and all this originated when the automobile manufacturing giant Toyota developed it's Toyota Production System in Japan and later it spread to the world in the name of Lean methodologies and the usage of this isn't limited to any single industry it has a wider scope and applications (Misha Matharu, March 2019) [7].
The Indian economy has seen substantial growth in the Micro, Small, and Medium Enterprises (MSME) sector over the past fifty years. MSMEs generate substantial employment opportunities at a low capital cost, promoting entrepreneurship and contributing to economic and social development. Second only to agriculture, MSMEs complement large industries, contributing to inclusive industrial development. Expanding into various sectors, MSMEs offer a wide range of products and services to meet domestic and international market needs. MSME, under the MSMED Act, 2006, is categorized into micro, small, and medium enterprises. Micro enterprises invest in plants and machinery or equipment up to one crore rupees, with a turnover of five crore rupees. Small enterprises invest in equipment up to ten crore rupees, with a turnover of fifty crore rupees, and medium enterprises invest up to fifty crore rupees. (Ministry of Micro, Small and Medium Enterprises, 2023) [6], and the contribution of MSMEs to India GDP is 29.15% by 2023 and the through exports is 45.56% by 2023 (PIB Delhi, 2023) [11].
The research gap identified here is how much effective the Lean methodologies implementation in the growth of the SMEs and for this study we've chosen Allahabad region, The main idea of this paper is to explain everyone in detail how the lean methods will be beneficial and bring profits also help the SMEs to grow further and we wanted to prove

that modern challenges require modern solutions and by adapting to new technologies and methodologies, The 3 operational strategies Cost Leadership, Responsive and Distinctive can be achieved by the Lean implementation and the framework also concludes that lean methods implementation can lead to improvement of operational performance which is indirectly beneficial to the SMEs (Saumyaranjan Sahoo, 2017) [15], Although there are lot of factors that contribute to Lean methods and their performance but we limited the factors and the study is performed in every industry so that the scope of this research will be wider and the factors will be suitable to every industry.

Research Problem

The implementation of lean methodologies has gained significant attention as a powerful approach to enhance operational efficiency, reduce waste, and drive continuous improvement in manufacturing and service organizations. However, despite the widespread recognition of lean methodologies' potential benefits, there exists a critical research problem in quantifying and establishing a direct, measurable relationship between lean implementation and operational performance improvements in Small and Medium Enterprises (SMEs), particularly in the Allahabad region.

Objectives

1) Quantitatively assess the impact of lean methodologies implementation on the sustainable operational performance of SMEs in the Allahabad region, establishing a mathematical relationship between lean adoption and improvements in key performance metrics.
2) Provide empirical evidence and a comprehensive framework that captures the synergistic effects of multiple lean methodologies, enabling data-driven insights and practical strategies for SMEs to enhance operational efficiency, profitability, and overall business growth

Literature Review

The Indian review of LSS research highlights the significant contributions of researchers in integrating Lean and Six Sigma methodologies, resulting in cost reduction, improved product quality, and waste elimination, offering valuable insights for professionals in manufacturing, service, and processing industries (Yamini, 2021) [22]. Indian MSMEs are implementing Lean Six Sigma to reduce waste and enhance quality. However, challenges like cost and skill limitations persist. Limited research exists on this implementation in Indian MSMEs compared to developed countries, highlighting the need for further studies (Mrigendra Nath Mishra, 2021) [9].

Sigma and Lean Manufacturing are key management practices that significantly enhance organizational performance in Indian Small & Medium Scale Enterprises (SMEs). These practices eliminate waste, improve efficiency, and enhance overall performance. Key success factors include top management commitment, organizational culture, strategy alignment, and process management. The study validates the positive impact of Lean Manufacturing practices on SMEs, highlighting the need for ongoing evaluation and refinement. Lean Manufacturing serves as a benchmark for continuous improvement and quality enhancement in SMEs (Jani., 2020) [2]. Employee involvement, SMED, pull system, 5S, TPM, Statistical process control, Production leveling practices are crucial in India's lean adoption and enhancing operational performance. These practices, along with TPM, have shown significant results in improving cycle time, setup time, inventory, defects reduction, and productivity (Vinod Yadav R. J., 2018) [20]. The study explores the lean implementation in Indian MSMEs, highlighting the importance of balancing hard and soft practices to enhance operational performance. The SAP-LAP framework helps identify gaps and suggest improvements. The adoption of lean in Indian MSMEs is gaining momentum, focusing on operational strategies to meet customer needs and enhance competitiveness (Misha Matharu, March 2019) [7].

Lean practices in India, particularly in Northern India, aim to eliminate waste, improve productivity, and reduce costs. The study evaluated perceptions of lean practices in SMEs, focusing on factors like customer focus, waste elimination, quality maintenance, market research, and continuous improvement (Singh., 2020) [16-17].

In Northern India, lean practices are crucial for SMEs to improve firm performance. These practices include total productive maintenance, supplier management, just-in-time, and five S practices. The workforce plays a crucial role in implementing lean production, addressing manufacturing challenges, cost reduction, and operational enhancement (Singh, 2020) [16-17].

The South Indian SMEs have been assessed using a Sustainable Lean Performance Index (SLPI), a model developed using fuzzy logic to identify potential inhibitors. The study emphasizes the importance of sustainable lean practices in operational performance, highlighting the need for a comprehensive approach to enhancing South Indian SMEs' performance (P.G., 2023) [10].

Indian SMEs face critical barriers in adopting lean manufacturing, including limited financial resources, fear of new technology, lack of top management commitment, and poor leadership quality. This study provided insights to help SMEs focus on these barriers for successful lean manufacturing adoption (Piyush Jaiswal, 2020) [13]. Lean implementation in SMEs faces barriers such as poor communication, lack of management commitment, and inadequate dissemination of benefits. Effective management of these barriers is crucial for successful lean adoption in SMEs (Vinod Yadav R. J., 2019) [21].

From the Literature that we observed a lot of studies are discussing about Lean methodologies implementation and the benefits of implementing them along with the barriers of implementation with different theories and from different methodologies they suggested but after analyzing literature we came to choose a framework and proceed to go with mathematical approaches as most of the literature and studies were either case study or a theoretical based and most of the studies were stating that there will be a significant impact of implementation of lean methodologies in SMEs and to prove that in numbers we’re writing this research paper and the framework, research methodology is discussed in detailed in the following sections and our main objectives is to prove in mathematical representations that lean implementation is having significant impact on the operational performance and that leads to business growth and the questionnaire and the data analysis part is discussed in detail in coming sections.

Theoretical Framework

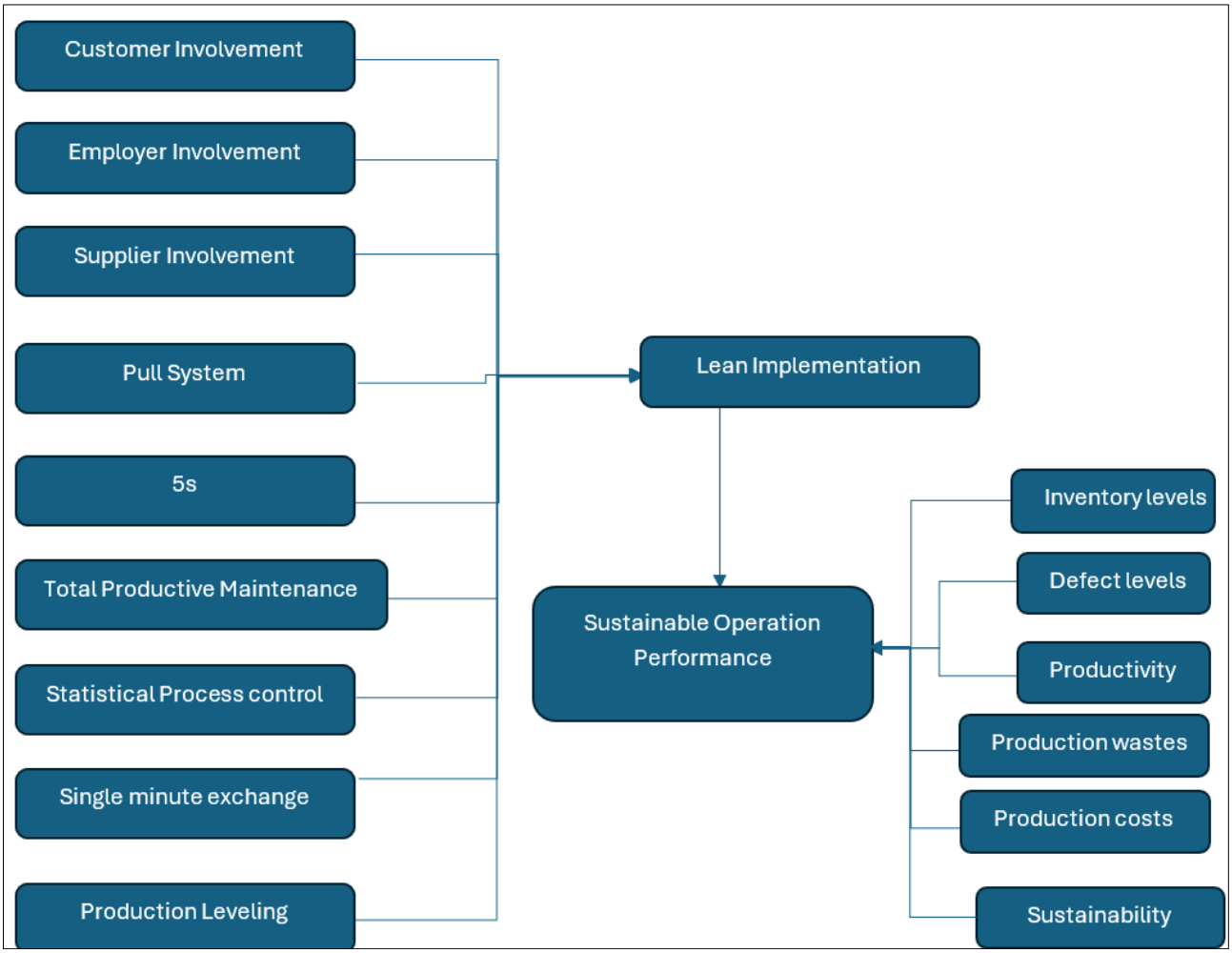

Fig 1: Theoretical Framework

Implementation of lean practices in India significantly improves operational performance, enhancing process improvement, material flow management, and waste reduction, thereby enhancing overall operational efficiency (Saumyaranjan Sahoo, 2017) [15]. The framework which we're using in this paper is an adopted framework from (Vinod Yadav R. J., 2018) [20] where the same kind of analysis is performed and we're adapting the same framework for our research paper and this framework consists of attributes like Customer Involvement, Employer Involvement, Supplier Involvement, Pull system, 5s, TPM, Statistical process control, SMED & Production Leveling as a variables for measurement of lean implementation and next is that for measuring the Sustainable operational performance the variables like Inventory levels, Defect levels, Productivity, Production wastes, Production costs which holistically represents the Sustainable operational performance is included in the framework, the reason for going with this framework is because in most studies theoretically everyone stated that Lean implementation will have some significant effect on operational performance and most of the them are based on theories and the frameworks are limited to a certain and not in depth to perform a mathematical analysis, and this framework is framed by analyzing different research articles and theories and based on them the authors carefully evaluated and prepared the questionnaire and prepared the framework which is a result of the analysis of different articles and our main idea is to state the impact in numbers in order to prove that we've adapted to this framework and questionnaire used in this coming to the variables and all the Lean implantation & Operational performance we need to find any relationship between both of these variables.

Research Methodology

Firstly, we decided to perform the research with primary data and to collect primary data we needed a tool to collect and after selecting a proper research tool and the method to collect the data we've analyzed collected data and performed hypothesis testing and using SPSS and Google. To perform the research, we adapted the questionnaire as a research tool which is adapted from the research paper (Vinod Yadav R. J., 2018) [20] and after extracting the questions from the paper we prepared a google from by adding few demographic question to the existing questionnaire and included the options to the questions according to our convenience to perform online survey so that the survey will become easier and coming to the survey part the google form is classified into 4 sections where section 1 consists of demographic questions and section 2 consists questions relating to Customer Involvement, Employer Involvement, Supplier Involvement and 3rd section consists of lean Methods & Process used by SMEs and the last section is about Operational Performance and

Sustainability in the SMEs and the answers for these questions are simple most of them we're Yes/No and the Likert scale used in 3rd and 4th sections of the questionnaire and this is an adapted questionnaire from an existing research paper so we didn't performed any pretests because thy framed these questions by performing particular tests, To conduct the survey we've visited to the SMEs in Allahabad region to get the questionnaire filled by explaining each and every terminology and then we've examined the SMEs setups and all to validate that right data is getting or not there are around 75+ SMEs in Allahabad region and we've accessed data from the MSME office in Allahabad region after getting the data we've mailed and visited them to get the questionnaire filled and we've successfully collected 29 SMEs data and we've analyzed the data using the SPSS software to perform different tests all the statistical tests are performed with the 90 percent desired statistical power level and 0.05 probability levels. Hence, our sample was adequate for further analysis. The list of tests conducted was Correlation the sample size is <30 and we analyzed the collected data using these tests and concluded the hypothesis the results are discussed detail in the following sections.

Hypothesis Development

The performance of Indian SMEs in lean-green implementation is significantly improved by addressing the critical success factors (CSFs) identified using MICMAC analysis and Lean manufacturing improves labor productivity, quality, lead-time, and cost efficiency, hence enhancing operational performance. (Thakkar, 2018) [19]. The implementation of Lean manufacturing techniques in Indian MSMEs has yielded significant benefits, including cost reduction, quality improvement, and increased lead time. This highlights the need for up-scaling Lean practices across the MSME sector to invest in sustainable Industry 4.0 tools and maintain competitiveness. (Ramachandranb, 2021) [14]. Lean practices in manufacturing significantly enhance performance, addressing economic, environmental, and social aspects, thus promoting sustainable development, and enhancing resource efficiency in Indian SMEs, thereby enhancing their sustainability. (A multicase study approach in Indian manufacturing SMEs to investigate the effect of Lean manufacturing practices on sustainability performance, 2021)

From the literature we've identified the factors for lean methodologies and operational performance from that we've developed and framed a hypothesis for testing and we're using correlation to test this hypothesis.

H0: Lean methodologies and Sustainable operational performance have no relation.

H1: Lean methodologies and Sustainable operational performance have a positive relation.

From this we can find out that by implementing lean methodologies does have a positive effect in operational performance or not in a mathematical expression not by theories

Results

After collecting the primary data by visiting each SME in Allahabad region after collection of data, cleaning of data is performed to get the correct data set later the data analysis is performed using SPSS by IBM software for testing the hypothesis in this analysis data coding and data cleaning is performed.

The questions are grouped into a single construct by computing the averages of same variables simply we computed averages of questions which represent a single construct and repeating the process again for Lean implementation and Sustainable operational performance as well later we computed the descriptive statistics of each construct and then we performed correlation to test the hypothesis the results are mentioned in the below tables, and they are discussed In detail further.

Table 1: Descriptive Statistics

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
CI	1.3621	.29570	29
EI	1.8046	.73202	29
SI	2.3333	.00000	29
PS	1.7241	.70186	29
S5	1.2759	1.01406	29
TPM	1.2586	.43549	29
SPC	.8793	.68992	29
SMED	1.2931	.41225	29
PL	2.4224	1.03748	29
SU	5.2644	.70923	29
OP	6.0621	1.50533	29
LM	12.2002	3.14359	29
SOP	8.2954	1.23448	29

The above table demonstrates the descriptive statistics of the primary data where the averages / transformation / computation of variables is performed using SPSS and we can see that Lean Methodologies (LM) has a deviation of 3.14359 and Sustainable operational performance (SOP) with 1.23448 which represents that the LM has a irregularities or the deviation is more in implementation of LM compared to the SOP and the rest of the variables like CI, EI, SI etc. having a very less deviations all these collected from a sample of 29 SMEs and the hypothesis test which we used correlation to test is described further with the results obtained while data analysis, The correlation test is performed between SOP and LM.

Table 2: Correlations

Correlations			
		LM	**SOP**
LM	Pearson Correlation	1	.695**
	Sig. (2-tailed)		.000
	N	29	29
SOP	Pearson Correlation	.695**	1
	Sig. (2-tailed)	.000	
	N	29	29

The above table describes the correlation test between LM (lean methodologies implementation) and SOP (sustainable operational performance) where we used to test our hypothesis from the above results, we came to conclusion that we successfully accepts the H1 / Alternative Hypothesis because at a confidence level 95% and significance level 5% or ($\dot{\alpha}$ = 0.05), by observing the data from the table we got the 'P' value = .000 i.e., P(.000) < 0.05 based on this we accept H1 and the test results Pearson coefficient of correlation (r) = .695, which lies in between the range of +0.5< 0.695 < +0.9 which shows that there is a significant

positive relation in between SOP and LM, from the Pearson coefficient of correlation when the computed value greater than +0.5 then there is a strong relationship between them and depending on the sign the relationship is positive or negative we can decide, from our findings we got a value of +0.695 from these we can conclude that there is a strong positive relationship between Lean implementation and Sustainable operational performance and that is confirmed by the Pearson correlation coefficient(r) using this results we can validate our hypothesis as well which states that.

"**H1:** Lean methodologies and Sustainable operational performance positive relation."
We can accept the alternative hypothesis from our findings, and this proves that in Allahabad SMEs have been benefited from implementing lean methodologies implementation and their Operational performance is increasing by using lean methodologies in further sections the findings are explained in detail.

Discussion
The framework we used consists of factors like Customer Involvement, Employer Involvement, Supplier Involvement, Pull system, 5s, TPM, Statistical process control, SMED & Production Leveling as a variables for measurement of lean implementation and next is that for measuring the Sustainable operational performance the variables like Inventory levels, Defect levels, Productivity, Production wastes, Sustainability, Production costs which holistically represents the Sustainable operational performance, as this is a verified framework and the hypothesis testing is done using correlation from the results we got positive results from all this we can say from our findings that in Allahabad region the implementation of Lean methodologies has a positive effect on operational performance which finally results in the growth and profitability of the SMEs and extending the scope to expand the business to them from the descriptive statistics we computed upon the constructs are also giving us a valuable information that, still lean implementation have difficulties and differentiation that is the reason why we have higher standard deviation compared to Operational performance. Lean manufacturing is a process that aims to improve manufacturing processes by focusing on preventive maintenance and cost reduction. It is primarily implemented in an Electronics and Electrical Manufacturing Company in India, with continuous improvement programs driving its implementation. (M.Yogesh, 2012) [5].

Conclusion
The main objective of this research paper is to find out that is there any benefit causing by implementing the lean methodologies in the SMEs by measuring the operational performance for that we've reviewed literature from different articles and studies and found theories regarding this same problem and based on the studies we identified the research gap that present in all studies is that they are all theoretical and no mathematical proof the whole idea of this research paper is to prove the theories of different researchers as mathematically correct for that we've adapted a verified framework and prepared questionnaire using google forms and collected the primary data by visiting the SMEs in Allahabad region. After collecting primary data, the data analyzed, and hypothesis tested found out that lean implementation have a positive impact on operational performance which makes beneficial for SMEs in Allahabad region and the findings of this research aligns exactly with the literature of the existing studies and theories of the researchers.

Limitations
Although implementation of lean methodologies shows a positive results in increasing operational performance but there are lot of limitations in implanting the lean practices whether it's from human side or from the machinery also, Indian SMEs face critical barriers in manufacturing, including limited financial resources, fear of new technology, lack of top management commitment, and poor leadership quality, identified using Grey-DEMATEL (Piyush Jaiswal and Amit Singh, 2021) [12]. SEM analysis revealed structural process barriers in lean manufacturing, including high rejection rates and frequent breakdowns, highlighting the need for effective supply chain management strategies. (K.P, 2021) so, in this research paper the constructs used for research are implemented and widely used in the Allahabad SMEs although there are lot of variations in the data from different SMEs in the LM we can conclude this from the descriptive statistics we computed in the results section and the reason behind this is the barriers like poor management, lacking of knowledge, limited financial resources and fear of new technology etc. When it comes to Larger firms their approaches and methods are completely different the barriers are more for SMEs compared to larger firms, Indian SMEs and large firms exhibit different adoption practices and barriers, with large firms showing higher awareness and resource constraints, emphasizing the need for education on strategic benefits (Mishra, 2016) [8] and in order to achieve sustainability the need of identifying critical success factors related to projects is crucial, The CSF in manufacturing is crucial for sustainability, as highlighted by the ISM and its implementation through lean methodologies (Karishma M. Qureshi, 2022) [4], Lean implementation in Medium Enterprises faces barriers such as resistance to change, high costs, lack of training, and organizational culture, requiring effective training and support (Soni, 2018) [18].

Future scope and research
The research highlights the challenges faced by small and medium-sized enterprises (SMEs) in implementing lean methodologies. These challenges include the need to address specific obstacles and challenges encountered in the Allahabad area. By identifying and addressing these obstacles, enhanced approaches and support systems can be developed to facilitate seamless transformations. Further investigation is needed to analyze the specific contributions of each lean tool and technique, determining the most effective combinations or sequences for operational performance enhancements. Investigating the effects of lean methodologies on supply chain management, customer satisfaction, and sustainability practices can provide a comprehensive understanding of the advantages of adopting lean. Future research may explore the potential of integrating lean methodologies with digital technologies, such as Industry 4.0 solutions, to enhance operational efficiency and competitiveness in the dynamic business environment.

References

1. A multicase study approach in Indian manufacturing SMEs to investigate the effect of Lean manufacturing practices on sustainability performance. International Journal of Lean Six Sigma; c2021. p. 579-606.
2. Jani SY. Validating Lean Manufacturing (LM) Practice Model for Productivity Growth in an Indian Small & Medium Scale (SMEs). Journal of Engineering Sciences; c2020. p. 155-168.
3. KPRT. Identification and modeling of process barriers implementing lean manufacturing in small and medium-size enterprises. International Journal of Lean Six Sigma; c2021. p. 61-77.
4. Qureshi KM, Karishma, Bhatia BG. Accomplishing sustainability in manufacturing system for SMEs through lean implementation. MDPI Sustainability; c2022. p. 1-22. Available from: https://www.mdpi.com/journal/sustainability
5. Yogesh M, Rao D. Application of Lean in a Small and Medium Enterprise (SME) Segment - A Case Study of Electronics and Electrical Manufacturing Industry in India. International Journal of Scientific & Engineering Research; c2012.
6. Ministry of Micro, Small and Medium Enterprises. Annual Report 2022-23. Ministry of Micro, Small and Medium Enterprises; c2023.
7. Matharu M, Misha, Singh NS. Lean Implementation in Indian Manufacturing MSMEs: A SAP-LAP Analysis. Management and Production Engineering Review; c2019 Mar. p. 68-78.
8. Mishra R. A comparative evaluation of manufacturing flexibility adoption in SMEs and large firms in India. Journal of Manufacturing Technology Management; c2016. p. 730-762.
9. Mishra MN, Mishra AM. Role of Lean Six Sigma in the Indian MSMEs during COVID-19. International Journal of Lean Six Sigma; c2021. p. 697-717.
10. PGVG. Modelling the inhibitors of integrated sustainable lean manufacturing system in the South Indian SMEs using fuzzy logic. Journal of Modelling in Management; c2023. p. 1746-5664.
11. PIB Delhi. Contribution of MSMES to the country's GDP. PIB; c2023 Dec 11. Available from: https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1985020
12. Jaiswal P, Singh AS. Barriers in implementing lean manufacturing in Indian SMEs: a multi-criteria decision-making approach. Journal of Modelling in Management; c2021. p. 339-356.
13. Jaiswal P, Singh AS. Barriers in implementing lean manufacturing in Indian SMEs: a multi-criteria decision-making approach. Journal of Modelling in Management; c2020. p. 339-356.
14. Ramachandranb IB. Lean manufacturing techniques – Implementation in Indian MSMEs and benefits realized thereof. Indian Journal of Engineering & Materials Sciences; c2021. p. 89-101.
15. Sahoo SS, Saumyaranjan Y. Analyzing the Effectiveness of Lean Manufacturing Practices in Indian Small and Medium Sized Businesses. IEEE; c2017.
16. Singh SS. Impact of implementing lean practices on firm performance: a study of Northern India SMEs. International Journal of Lean Six Sigma; c2020. p. 1005-1034.
17. Singh SS. Investigating the Perceptions of Lean Manufacturing Practices in Northern India SMEs: An Empirical Study." Industrial Engineering Journal; c2020.
18. Soni AK. Interpretive Structural Modeling of identified Barriers to Lean Implementation in SMEs. MATEC Web of Conferences; c2018.
19. Thakkar SJ. Interdependence analysis of lean-green implementation challenges: a case of Indian SMEs. Journal of Manufacturing Technology Management; c2018. p. 295-328.
20. Yadav V, Jain RJ. The impact of lean practices on the operational performance of SMEs in India. Emerald Insight; c2018. p. 317.
21. Yadav V, Jain RJ. An appraisal on barriers to implement lean in SMEs. Journal of Manufacturing Technology Management; c2019. p. 195-212.
22. Garg YC. The implementation of Lean Six Sigma framework in the Indian context: a review and suggestions for future research. The TQM Journal; c2021. p. 1823-1859. Available from: https://www.emerald.com/insight/1754-2731.htm