



“A STUDY ON LEAN MANUFACTURING WITH REFERENCE TO TEXTILE INDUSTRY”

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Abstract: This study investigates how using lean manufacturing techniques like just-in-time, kaizen, value stream mapping, and Six Sigma affects the efficiency of textile companies. We surveyed textile professionals in Surat who practice lean manufacturing to gather data. Using SPSS software, we analyzed the data with multiple regression analysis to understand the relationship between these techniques and operational efficiency. Our research aims to add to the knowledge about lean manufacturing in the textile industry and provide useful insights for companies aiming to improve their efficiency.

Keywords: Textile industry, lean manufacturing, operational efficiency, just-in-time, kaizen, value stream mapping, Six Sigma, Surat, SPSS, multiple regression analysis.

1. Introduction of the study

The textile industry plays a crucial role in the global market, and enhancing operational efficiency has become a key focus for companies in this sector. One approach that has gained significant attention is lean manufacturing. Lean manufacturing emphasizes the elimination of waste, continuous improvement, and the optimization of processes to achieve higher operational efficiency. The objective of this study is to investigate the impact of lean manufacturing practices on operational efficiency in textile companies. Specifically, we aim to examine the relationship between the implementation of lean manufacturing techniques, such as just-in-time, kaizen, value stream mapping, and Six Sigma, and the operational efficiency of textile companies.

To gather primary data for this study, a structured questionnaire was developed based on the identified independent variables (just-in-time, kaizen, value stream mapping, and Six Sigma) and the dependent variable (operational efficiency). The questionnaire was administered to textile industry professionals in Surat who have implemented lean manufacturing practices. This approach ensures the accuracy and reliability of the data collected. To analyze the data, we utilized the SPSS software and employed multiple regression analysis. This statistical technique allows us to examine the relationship between the dependent and independent variables, providing insights into the impact of lean manufacturing practices on operational efficiency in the textile industry.

By conducting this research, we aim to contribute to the existing body of knowledge on lean manufacturing and its implications for the textile industry. The findings of this study will provide valuable insights for textile companies seeking to enhance their operational efficiency through the implementation of lean manufacturing practices.

1.1 Literature Review

1. Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid (June 2021): "Impact of lean manufacturing on the operational performance: evidence from textile industry"

From this study, we found that implementing lean manufacturing techniques has a significant positive impact on operational efficiency in Pakistan's textile sector. Traditional methods remain common, but lean practices effectively reduce waste and stimulate innovation. Engaging employees and fostering a culture of ongoing enhancement are crucial for optimal outcomes. Policymakers are urged to encourage smaller textile enterprises to embrace lean manufacturing methods for improved performance.

2. Graziela dos Santos Bento, Klaus Siegmund Schuldt, Luciano Castro de Carvalho (2020) Title – "The influence of supplier integration and lean practices adoption on operational performance"

This study reveals that close collaboration with suppliers and implementing lean practices positively affects the introduction of new products in medium-sized Brazilian textile businesses. Working closely with suppliers helps introduce new products faster, while lean practices optimize resources and operational efficiency, particularly in cost management. However, close supplier relationships may not universally support lean practices across all performance areas.

3. Leandro L. Lorente Leyva, Edwin P. Curillo Perugachi, Ramiro V. Saraguro Piarpuezan, Carlos A. Machado Orges and Edwin P. Ortega Montenegro (2018): Title – "Lean Manufacturing Application in Textile Industry"

This study emphasizes the importance of adopting Lean Manufacturing principles in the textile industry to address inefficiencies and reduce waste. By implementing tools like 5S's and Manufacturing Cells, operations can be optimized, leading to quicker production times and improved working environments. Lean Manufacturing is crucial for achieving speedy deliveries, cost-efficiency, and meeting customer expectations while minimizing wastage.

4. Rajat Ajmera, Prabhuling Umarani, K.G.Valase (2017): Title - "Lean Six Sigma Implementation in Textile Industry"

This study underscores the value of Lean Six Sigma (LSS) in enhancing efficiency and quality in textile manufacturing. LSS combines Lean Manufacturing principles with Six Sigma methodologies to minimize defects and boost productivity. The incorporation of Lean tools into the Six Sigma approach shows promising outcomes in reducing defects and elevating Sigma levels, particularly benefiting small and medium-sized textile businesses in India.

5. S. Karthi, S.R. Devadasan, K. Selvaraju, N.M. Sivaram, & C.G. Sreenivasa (2013): Title - "Implementation of Lean Six Sigma through ISO 9001:2008 based QMS: A case study in a Textile Mill"

This study showcases the successful integration of ISO 9001-based Quality Management Systems (QMS) with Lean Six Sigma (LSS) methodologies in a South Indian spinning mill. The collaborative efforts between the shop floor team and top management led to significant cost savings, demonstrating the efficacy of integrated approaches in achieving desired outcomes in industrial contexts.

6. Sundareshan S D, Dr Swamy D R, Dr T S Nanjundeswara Swamy (2015): Title - "A Literature Review on Lean Implementations"

In the literature review common lean tools like kanban and continuous flow are highlighted for their effectiveness in waste reduction and improved productivity. Challenges in managing employee involvement are noted, suggesting further exploration into the relationship between quality of work life (QWL) dimensions and Lean implementation for deeper insights into organizational effectiveness.

7. Mohammad Rashid, Dr.R.B.L Shrivastav, Subhash (2022): Title - "An Analysis of Indian Textile Industry: A Literature Review Approach"

This study delves into India's textile industry, highlighting challenges such as unfavorable tax laws and government policies. Despite obstacles, India's textile sector remains competitive, necessitating continuous enhancements in product quality and manufacturing techniques. The paper advocates for investing in social and human capital to drive growth and societal transformation, foreseeing a promising future for the industry.

8. Anurag Shanu (2019): Title - "Processes of Manufacturing in the Textile Industry"

This research explores advanced technologies revolutionizing production processes in the textile industry, emphasizing the importance of decentralized management methods and producing versatile textiles to meet evolving consumer preferences.

9. Dr. Bharati Rathore (2023): Title - "Textile Industry 4.0: A Review of Sustainability in Manufacturing"

This Study examines sustainability in manufacturing and the textile industry, emphasizing the importance of eco-friendly practices, responsible material sourcing, and assessing product life cycles. Collaboration

among industry stakeholders and incentives for sustainable practices are advocated to enhance sustainability levels within the sector.

1.2 Background of the Study

The textile industry plays a vital role in the global market, contributing significantly to economic growth and employment opportunities. However, in order to remain competitive, textile companies need to continuously improve their operational efficiency. Lean manufacturing, a methodology focused on waste reduction and process optimization, has emerged as a popular approach in various industries, including textiles. By implementing lean practices such as just-in-time, kaizen, value stream mapping, and Six Sigma, companies aim to streamline their operations, reduce costs, and enhance overall efficiency.

Surat, a prominent textile hub in India, is home to numerous textile companies that have embraced lean manufacturing practices. However, there is a need to explore the impact of these practices on operational efficiency specifically in the textile sector. By conducting a comprehensive study in Surat, we aim to investigate the relationship between lean manufacturing practices and operational efficiency in textile companies. This study will contribute to the existing body of knowledge on lean manufacturing and provide valuable insights for textile companies seeking to enhance their operational efficiency and maintain a competitive edge in the global market.

1.3 Problem Statement /Rationale /of the Study

In the textile industry, there is a need to explore the impact of lean manufacturing strategies on operational efficiency. Currently, it's not quite clear how these strategies specifically affect the textile sector. To address this gap in knowledge, conducting a comprehensive study becomes crucial. By doing so, we can gain a deeper understanding of the relationship between lean manufacturing practices and operational efficiency in textile companies.

This study aims to provide valuable insights that will help companies make informed decisions, enhance their operational efficiency, and maintain a competitive edge in the market. By examining the effectiveness of lean manufacturing practices in the context of the textile industry, we can fill the existing knowledge gap. This research will shed light on the best ways for textile companies to streamline their operations, reduce costs, and enhance overall efficiency. With a clearer understanding of how these strategies impact operational efficiency, textile companies can make informed decisions about implementing lean practices such as just-in-time, kaizen, value stream mapping, and Six Sigma. Ultimately, this study will contribute to the growth and success of the textile industry by providing actionable insights that can drive positive change.

1.4 Objectives of the Study

➤ Following are the objectives of our study on lean manufacturing in the textile industry:

- ✓ Assess current use of lean manufacturing in textile companies.
- ✓ Evaluate impact of lean manufacturing on operational efficiency in textiles.
- ✓ Contribute to knowledge on lean manufacturing in the textile sector.

These objectives will guide our research and help us to understand lean manufacturing in the textile industry.

1.5 Hypothesis

➤ Null hypothesis (H_0):

- There is no significant relationship between lean manufacturing practices and operational efficiency in textile industry.

➤ Alternative hypothesis (H_1):

- There is a significant relationship between lean manufacturing practices and operational efficiency in textile companies.

2. Research Methodology

The research methodology for this study on lean manufacturing in the textile industry involves the collection and analysis of primary data. The primary objective is to examine the impact of lean manufacturing practices on operational efficiency. The study aims to test the hypothesis that “there is a significant relationship between lean manufacturing practices and operational efficiency in textile industries or not”.

To gather the required data, a structured questionnaire was developed. The questionnaire focuses on various aspects of lean manufacturing, including just-in-time, kaizen, value stream mapping, and Six Sigma. These techniques are considered as independent variables, while operational efficiency is the dependent

variable. By analyzing the data collected through the questionnaire, the study aims to establish the relationship between these variables.

To ensure the accuracy of the data, visits were made to textile industries in Surat that have implemented lean manufacturing practices. This allowed for direct interaction with industry professionals who possess knowledge and experience in lean manufacturing. By engaging with these experts, accurate and reliable data was collected, contributing to the validity of the study's findings.

The collected data will be analyzed using SPSS software, employing multiple regression analysis. This statistical technique will help examine the relationship between the independent variables (just-in-time, kaizen, value stream mapping, and Six Sigma) and the dependent variable (operational efficiency). Through this analysis, the study aims to provide insights into the effectiveness of lean manufacturing practices in improving operational efficiency within the textile industry.

2.1 Research Design

For our research study, we will focus on investigating the impact of lean manufacturing practices on operational efficiency in the textile industry. To achieve this, we will employ a quantitative research design. This design will allow us to gather numerical data and analyze it statistically, providing us with objective insights into the relationship between lean manufacturing practices and operational efficiency.

To collect data, we will select a sample of textile companies in the Surat region that have implemented lean manufacturing practices. These companies will serve as our study group. We will administer a structured questionnaire to employees at different levels within these companies, such as managers, supervisors, and production workers.

The questionnaire will cover various aspects of lean manufacturing, including just-in-time, kaizen, value stream mapping, and Six Sigma. This approach will provide us with a comprehensive understanding of the implementation and effectiveness of lean manufacturing practices in the textile industry.

To ensure the validity and reliability of our data, we will conduct visits to the selected companies and engage in direct interactions with industry professionals. This will allow us to gather accurate and firsthand information about the implementation process and any challenges faced. Through statistical analysis techniques, such as multiple regression analysis, we will determine the extent to which the independent variables (lean manufacturing practices) impact the dependent variable (operational efficiency). By adopting this research design, we aim to contribute to the existing body of knowledge on the effectiveness of lean manufacturing practices in the textile industry.

2.2 Sources of Data

In our study on lean manufacturing in the textile industry, we focused on collecting primary data to investigate the impact of lean manufacturing practices on operational efficiency. To achieve this, we developed a structured questionnaire that included operational efficiency as the dependent variable and just-in-time, kaizen, value stream mapping, and Six Sigma as independent variables. These variables represent key techniques associated with lean manufacturing. We administered the questionnaire to individuals within textile companies who possess knowledge and experience in lean manufacturing.

To ensure the accuracy of our data, we visited textile industries in Surat that have implemented lean manufacturing concepts. By interacting directly with industry professionals and observing their practices, we were able to gather accurate and firsthand data on their experiences, challenges, and opinions regarding lean manufacturing.

To analyze the collected data, we utilized the SPSS software and employed multiple regression analysis. This statistical approach allowed us to examine the relationship between the dependent variable of operational efficiency and the independent variables of just-in-time, kaizen, value stream mapping, and Six Sigma.

By conducting this analysis, we aimed to determine if there is a significant relationship between lean manufacturing practices and operational efficiency in textile companies. Our research approach, which incorporated structured questionnaires and industry visits, ensured the validity and reliability of our findings.

2.3 Data Collection Method

We concentrated on obtaining primary data to examine the effect of lean manufacturing techniques on operational efficiency in our study on lean manufacturing in the textile sector. To do this, we developed the following theory: As an alternative hypothesis, we put forth the following: H_1 -There is a significant relationship between lean manufacturing practices and operational efficiency for these textile industries; H_0 -There is no significant relationship between lean manufacturing practices and operational efficiency in the textile industry

To collect the primary data needed to test our hypothesis, we selected operational efficiency as the dependent variable and identified just-in-time, kaizen, value stream mapping, and Six Sigma as independent variables. These variables represent key techniques associated with lean manufacturing. To gather the

necessary data, we developed a structured questionnaire that covered these variables and administered it to individuals within textile companies who had knowledge and experience in lean manufacturing.

To ensure the accuracy of our data, we visited textile industries in Surat that have implemented lean manufacturing concepts. By directly interacting with industry professionals and observing their practices, we were able to gather accurate and firsthand data. This approach allowed us to validate the responses from our questionnaire and obtain a comprehensive understanding of the impact of lean manufacturing on operational efficiency in the textile industry.

2.4 Population

Our study is centered on textile companies that have implemented lean manufacturing practices. This population includes companies in the textile industry that have embraced techniques such as just-in-time, kaizen, value stream mapping, and Six Sigma as part of their operational processes. By studying this specific population, we can gain insights into the operational efficiency of textile companies that have adopted lean manufacturing practices.

To gather data from this population, we employed a structured questionnaire that was administered to individuals within these textile companies who possess knowledge and experience in lean manufacturing. Additionally, we conducted on-site visits to textile industries in Surat, where we directly interacted with industry professionals and observed their lean manufacturing practices. This ensured that we collected accurate and reliable data from the target population.

By focusing on this specific population, our research aims to shed light on the operational efficiency of textile companies that have embraced lean manufacturing techniques. This will contribute to a deeper understanding of the impact of lean manufacturing in the textile industry and provide valuable insights for both practitioners and researchers in this field.

2.5 Sampling Method

For our research on lean manufacturing in the textile industry, to ensure the accuracy of our data, we employed a combination of stratified and convenience sampling methods. Stratified sampling allowed us to select participants from different age groups and professions, ensuring a representative sample of the textile industry in Surat. This approach helped us capture a diverse range of perspectives and experiences.

Additionally, we utilized convenience sampling to conveniently access textile companies in Surat that have implemented lean manufacturing practices. By visiting these companies, we were able to collect accurate data directly from individuals who possess knowledge and experience in lean manufacturing.

By employing both stratified and convenience sampling methods, we aimed to gather a comprehensive understanding of the operational efficiency in textile companies implementing lean manufacturing practices. This approach allowed us to capture a wide range of perspectives and ensure the reliability of our findings.

2.6 Sampling Frame

To create an accurate sampling frame for our study on lean manufacturing in the textile industry, we focused on textile companies in Surat that have implemented lean manufacturing practices. This served as our target population. We ensured that our sampling frame was comprehensive and representative by considering factors such as company location, and lean manufacturing implementation. By including a diverse range of textile companies, we aimed to capture a holistic view of operational efficiency in the industry.

In our sampling approach, we used stratified sampling to divide the target population into different groups based on age and profession. This allowed us to create subgroups that were representative of the overall population. Within each group, we randomly selected textile companies to participate in our study. Additionally, we utilized convenience sampling to access textile companies in Surat that have already implemented lean manufacturing practices.

This approach allowed us to gather accurate and firsthand information about their operational efficiency. By combining stratified and convenience sampling methods, we ensured that our sampling frame covered a wide range of perspectives and experiences within the textile industry.

2.7 Data Collection Instrument

To gather primary data for our study on the operational efficiency of textile companies that have implemented lean manufacturing practices, we developed a structured questionnaire as our data collection instrument. The questionnaire was designed to capture information related to the dependent variable, operational efficiency, and the independent variables: just-in-time, kaizen, value stream mapping, and Six Sigma.

The questionnaire consisted of carefully crafted questions that aimed to assess the level of implementation and effectiveness of these lean manufacturing techniques in the textile industry. We ensured that the questions were clear, concise, and easy to understand, considering that not everyone has prior knowledge of lean manufacturing concepts.

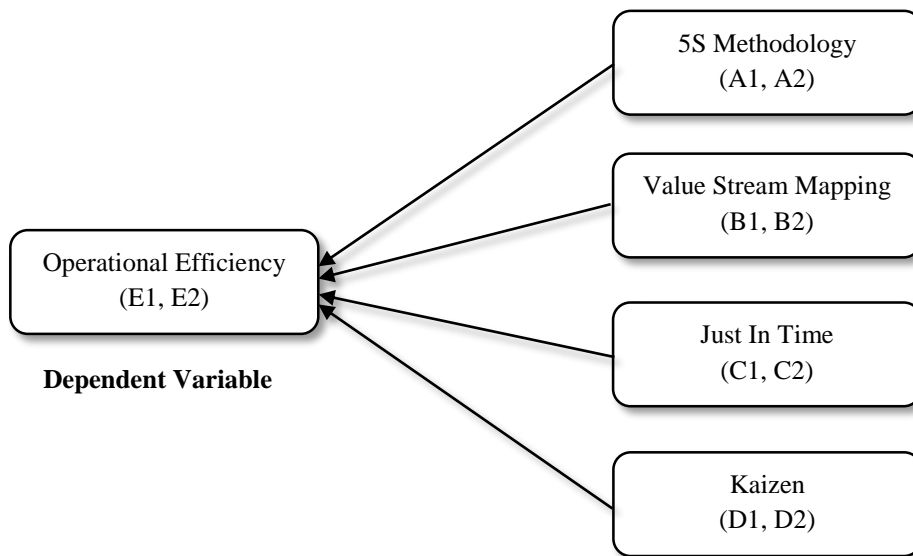
To ensure the accuracy and reliability of the data collected, we personally visited textile companies in Surat that have implemented lean manufacturing practices. By directly interacting with the individuals involved in the implementation, we were able to gather accurate and firsthand insights into the operational efficiency of these companies.

Once the data collection phase was completed, we used the Statistical Package for the Social Sciences (SPSS) software to analyze the collected data. Specifically, we employed multiple regression analysis to examine the relationship between the dependent variable (operational efficiency) and the independent variables (just-in-time, kaizen, value stream mapping, and Six Sigma).

By utilizing this data collection instrument and conducting thorough analysis, we aimed to provide valuable insights into the impact of lean manufacturing techniques on the operational efficiency of textile companies in Surat.

3. Data Analysis and Interpretation

In our research paper, we conducted a study on the impact of different lean manufacturing practices on operational efficiency in the textile industry. To analyze the data, we utilized multiple regression analysis in SPSS software. In this analysis, we coded the variables as follows: A1 and A2 represented the "5S methodology," B1 and B2 represented "value stream mapping," C1 and C2 represented "just in time," and D1 and D2 represented "kaizen." These were all independent variables that we examined in relation to the dependent variable, which we coded as E1 and E2, representing "operational efficiency." By using multiple



regression analysis, we are able to determine the extent to which each of these lean manufacturing practices influenced operational efficiency. This research provides valuable insights into optimizing production processes in the textile industry.

Independent Variables

Figure 3.1: Conceptual Framework
(Source: Author Analysis)

➤ Frequency Analysis

We used a frequency analysis in our study on lean manufacturing in the textile sector to investigate the demographic traits of our participants. We were able to comprehend their distribution throughout various age groups and response types thanks to this analysis. There were 113 participants in the study, most of whom were from various Surat, Gujarat, and neighborhoods.

Table 3.1 Social and Demographical Information's of Respondents
(Source: Authors Analysis)

Variable	Frequency	Population (%)
Age		
18-24	12	10.6
25 - 34	27	23.9
35 - 44	43	38.1
45 - 60	31	27.4
61 or Older	0	0
Respondent Type		
Student (Engineering)	16	14.2
Professor (Engineering)	25	22.1
Industry Expert / Plant Engineer / Plant Operator	46	40.7
Production Manager / Quality Control Manager	26	23

As shown in table 3.1, out of the 113 people we surveyed, 12 were between 18 and 24 years old (that's about 10.6% of our group), 27 were aged 25 to 34 (23.9%), and 43 were between 35 and 44 (38.1%). There were 31 people aged 45 to 60 (27.4%), but none were 61 or older.

When it comes to respondent type, 16 respondents were engineering students (14.2%), 25 were engineering professors (22.1%), and a big group of 46 were industry experts, plant engineers, or plant operators (40.7%). Finally, 26 respondents were production or quality managers (that's 23%). This detailed breakdown helps us understand the different types of people involved in our study, setting the stage for exploring how lean manufacturing practices affects efficiency in textile companies.

➤ Descriptive Statistics

Table 3.2 Descriptive Statistics (Source: Authors Analysis)

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
How would you rate the overall efficiency of your textile manufacturing operations?	113	3.01	0.102	1.090
How satisfied are you with the level of productivity and performance in your textile manufacturing process?	113	3.31	0.118	1.254
On a scale of 1 to 5, To what extent has the implementation of the 5S methodology improved the organization and cleanliness of your textile manufacturing facility?	113	3.14	0.125	1.329
How would you rate the effectiveness of the 5S methodology in reducing waste and optimizing workflows in your textile manufacturing process?	113	3.19	0.117	1.245
How valuable has the process of value stream mapping been in identifying bottlenecks and improving flow in your textile manufacturing operations?	113	3.13	0.126	1.340
How satisfied are you with the level of visibility and understanding of your textile manufacturing process achieved through value stream mapping?	113	3.31	0.125	1.330
To what extent has the implementation of Just-in-Time (JIT) principles improved inventory management and reduced waste in your textile manufacturing process?	113	3.33	0.111	1.176

How would you rate the effectiveness of Just-in-Time (JIT) in improving production flow and minimizing lead times in your textile manufacturing operations?	113	3.38	0.126	1.332
How successful has the implementation of Kaizen principles been in fostering a culture of continuous improvement in your textile manufacturing organization?	113	3.27	0.122	1.296
How satisfied are you with the level of employee engagement and involvement in Kaizen activities within your textile manufacturing process?	113	3.28	0.122	1.299

According to table 3.2, a mean value of 3 indicates neutrality; a value above 3 indicates agreement; and a value below 3 indicates disagreement. Based on the mean value of 3, it is evident that respondents agree with the questions about operational efficiency, 5S methodology, value stream mapping, just-in-time, and Kaizen. Respondents who disagreed with the questions did so because the scenario/analysis does not apply to them, as indicated by the mean value of less than 3.

Part – 1

❖ Test result by using E2 as dependent variable which represent operational efficiency:

➤ Correlations:

([Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid \(June 2021\)](#)) define multicollinearity as the strong correlation between two, or occasionally more than two, independent variables in multiple regression, which might result in a collinearity problem. Additionally, the Pearson Correlation test was run to determine the degree of correlation between the variables, and the results are shown in Table 3.3. All independent variables (lean management methods) had positive and significant coefficients with operation efficiency at the 0.01 level. It suggests that companies with higher levels of Lean Manufacturing implementation have better operational performance.

Table 3.3 Correlation by Using E2 as Dependent variable (Source: Authors Analysis)

Pearson Correlation	E2	A1	A2	B1	B2	C1	C2	D1	D2
E2	1.000	.429	.521	.640	.622	.621	.554	.520	.614
A1	.429	1.000	.420	.556	.505	.473	.580	.465	.566
A2	.521	.420	1.000	.503	.562	.602	.558	.560	.595
B1	.640	.556	.503	1.000	.568	.601	.657	.628	.635
B2	.622	.505	.562	.568	1.000	.557	.623	.610	.693
C1	.621	.473	.602	.601	.557	1.000	.530	.569	.658
C2	.554	.580	.558	.657	.623	.530	1.000	.624	.660
D1	.520	.465	.560	.628	.610	.569	.624	1.000	.661
D2	.614	.566	.595	.635	.693	.658	.660	.661	1.000
Significance	E2	A1	A2	B1	B2	C1	C2	D1	D2
E2	.	.000	.000	.000	.000	.000	.000	.000	.000
A1	.000	.	.000	.000	.000	.000	.000	.000	.000
A2	.000	.000	.	.000	.000	.000	.000	.000	.000
B1	.000	.000	.000	.	.000	.000	.000	.000	.000
B2	.000	.000	.000	.000	.	.000	.000	.000	.000
C1	.000	.000	.000	.000	.000	.	.000	.000	.000
C2	.000	.000	.000	.000	.000	.000	.	.000	.000
D1	.000	.000	.000	.000	.000	.000	.000	.	.000
D2	.000	.000	.000	.000	.000	.000	.000	.000	.
N	E2	A1	A2	B1	B2	C1	C2	D1	D2
E2	113	113	113	113	113	113	113	113	113
A1	113	113	113	113	113	113	113	113	113
A2	113	113	113	113	113	113	113	113	113

B1	113	113	113	113	113	113	113	113	113
B2	113	113	113	113	113	113	113	113	113
C1	113	113	113	113	113	113	113	113	113
C2	113	113	113	113	113	113	113	113	113
D1	113	113	113	113	113	113	113	113	113
D2	113	113	113	113	113	113	113	113	113

➤ Multiple linear regression:

Table 3.4 Multiple Linear Regression (Source: Authors Analysis)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	dF1	dF2	Sig. F. Change
1	.747 ^a	.558	.524	.866	.558	16.386	8	104	.000

a. Predictors: (Constant), D2, A1, A2, B1, D1, C1, B2, C2

b. Dependent Variable: E2

As stated by ([Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid \(June 2021\)](#)). The R-square value is significant based on the values listed in Table 3.4. The degree to which Lean Manufacturing methods (independent variables) have an impact on operational efficiency (dependent variables) can be determined using the R-square (coefficient of determination). This figure indicates that lean practices used in the study had a 55.8% influence; the remaining 44.2% was attributable to other factors that an error term explained. It demonstrates that a moderate amount of improved operational performance is influenced by particular lean methods that were analyzed. When the R-Square score falls between 50% and 60%, it indicates a satisfactory fit for the model.

➤ ANOVA (Analysis of Variance):

Table 3.5 ANNOVA (Source: Authors Analysis)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	98.228	8	12.278	16.386	.000 ^b
Residual	77.931	104	.749		
Total	176.159	112			

a. Dependent Variable: E2

b. Predictors: (Constant), D2, A1, A2, B1, D1, C1, B2, C2

([Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid \(June 2021\)](#)) state that the operational efficiency model is significant at the 5% significance level based on the ANOVA Table 3.5, which shows a p-value of 0.000, which is less than 0.05. 16.386 was the F-statistic, and the P-value was 0.000, or less than 0.05. It demonstrates that the operational efficiency of textile companies is significantly impacted by the Lean Manufacturing techniques that were investigated for this study. **As a result, we agree with Alternative Hypothesis (H₁).**

Part – 2

❖ Test result by using E1 as dependent variable which represent operational efficiency:

➤ Correlations:

([Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid \(June 2021\)](#)) define multicollinearity as the strong correlation between two, or occasionally more than two, independent variables in multiple regression, which might result in a collinearity problem. Additionally, the Pearson Correlation test was run to determine the degree of correlation between the variables, and the results are shown in Table 3.6. All independent variables (lean management methods) had positive and significant coefficients with operation efficiency at the 0.01 level. It suggests that companies with higher levels of Lean Manufacturing implementation have better operational performance.

Table 3.6 Correlation by Using E1 as Dependent variable (Source: Authors Analysis)

Pearson Correlation	E1	A1	A2	B1	B2	C1	C2	D1	D2
E1	1.000	.480	.466	.452	.423	.381	.502	.422	.465
A1	.480	1.000	.420	.556	.505	.473	.580	.465	.566
A2	.466	.420	1.000	.503	.562	.602	.558	.560	.595
B1	.452	.556	.503	1.000	.568	.601	.657	.628	.635
B2	.423	.505	.562	.568	1.000	.557	.623	.610	.693
C1	.381	.473	.602	.601	.557	1.000	.530	.569	.658
C2	.502	.580	.558	.657	.623	.530	1.000	.624	.660
D1	.422	.465	.560	.628	.610	.569	.624	1.000	.661
D2	.465	.566	.595	.635	.693	.658	.660	.661	1.000
Significance	E1	A1	A2	B1	B2	C1	C2	D1	D2
E1	.	.000	.000	.000	.000	.000	.000	.000	.000
A1	.000	.	.000	.000	.000	.000	.000	.000	.000
A2	.000	.000	.	.000	.000	.000	.000	.000	.000
B1	.000	.000	.000	.	.000	.000	.000	.000	.000
B2	.000	.000	.000	.000	.	.000	.000	.000	.000
C1	.000	.000	.000	.000	.000	.	.000	.000	.000
C2	.000	.000	.000	.000	.000	.000	.	.000	.000
D1	.000	.000	.000	.000	.000	.000	.000	.	.000
D2	.000	.000	.000	.000	.000	.000	.000	.000	.
N	E1	A1	A2	B1	B2	C1	C2	D1	D2
E1	113	113	113	113	113	113	113	113	113
A1	113	113	113	113	113	113	113	113	113
A2	113	113	113	113	113	113	113	113	113
B1	113	113	113	113	113	113	113	113	113
B2	113	113	113	113	113	113	113	113	113
C1	113	113	113	113	113	113	113	113	113
C2	113	113	113	113	113	113	113	113	113
D1	113	113	113	113	113	113	113	113	113
D2	113	113	113	113	113	113	113	113	113

➤ Multiple linear regression:

Table 3.7 Multiple Linear Regression (Source: Authors Analysis)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	dF1	dF2	Sig. F. Change
1	.592 ^a	.350	.300	.912	.350	6.999	8	104	.000

a. Predictors: (Constant), D2, A1, A2, B1, D1, C1, B2, C2

b. Dependent Variable: E1

As stated by ([Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid \(June 2021\)](#)) Based on the data shown in Table 3.7, the R-square value holds significant weight. The degree to which Lean Manufacturing techniques (independent variables) have an impact on operational efficiency (dependent variables) can be ascertained using the R-square (coefficient of determination). This number indicates that lean practices used in the study had a 35% influence; the remaining 65% was attributable to other factors that an error term stated. It demonstrates that a moderate amount of improvement in operational performance can be achieved by analyzing particular lean approaches. A model with an R-Square score between 35% and 50% is said to be averagely fitted.

➤ ANOVA (Analysis of Variance):

Table 3.8 ANNOVA (Source: Authors Analysis)

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	46.544	8	5.818	6.999	.000 ^b
Residual	86.447	104	0.831		
Total	132.991	112			

a. Dependent Variable: E1

b. Predictors: (Constant), D2, A1, A2, B1, D1, C1, B2, C2

([Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid \(June 2021\)](#)) state that the operational efficiency model is significant at the 5% significance level based on the ANOVA Table 3.8, which shows a p-value of 0.000, which is less than 0.05. 6.999 was the F-statistic, and the P-value was 0.000, or less than 0.05. It demonstrates that the operational efficiency of textile companies is significantly impacted by the Lean Manufacturing techniques that were investigated for this study. **As a result, we agree with Alternative Hypothesis (H₁).**

4. Results and Findings

- The study reveals a significant positive correlation between lean manufacturing practices and operational efficiency in the textile industry, with all independent variables showing significance at the 0.01 level.
- Multiple regression analysis indicates that lean manufacturing practices account for 55.8% of the variance in operational efficiency, demonstrating their substantial influence on enhancing performance.
- The R-squared value was 55.8% for the model with E2 as the dependent variable, suggesting that 55.8% of the variation in operational efficiency can be explained by lean manufacturing practices.
- The R-squared value was 35% for the model with E1 as the dependent variable, suggesting that 35% of the variation in operational efficiency can be explained by lean manufacturing practices.
- ANOVA results confirm the statistical significance of lean manufacturing practices on operational efficiency, with a p-value of 0.000 which is less than 0.05, for both model indicating a robust impact at the 5% significance level, which is supporting alternative hypothesis (H₁)
- Age distribution among the 113 participants showed that 10.6% were aged 18-24, 23.9% were 25-34, and 38.1% were 35-44.
- Engineering students comprised 14.2% of respondents, professors 22.1%, and industry experts 40.7%.
- Production or quality managers accounted for 23% of respondents.
- The mean values for operational efficiency, 5S methodology, value stream mapping, just-in-time, and kaizen all exceed the neutral value of 3, indicating widespread agreement on the effectiveness of these practices in enhancing operational efficiency.
- The R-square values suggest a substantial influence of lean practices on operational efficiency, with a model fit ranging from average to good, reinforcing the importance of implementing lean manufacturing techniques in textile companies.
- The study underscores the importance of lean manufacturing as a strategy for optimizing production processes and improving operational efficiency in the textile industry, offering valuable insights for practitioners and policymakers alike.

5. Limitations of the Study

- The findings of this study may be specific to the textile industry in Surat and may not be applicable to other regions or industries.
- The sample size used in this study may not fully represent the entire population of textile companies implementing lean manufacturing practices.
- The study was conducted within a specific time frame, which may have limited the depth and breadth of data collection.
- The data collected relied on self-reported information from participants, which may introduce bias and affect the validity of the findings.
- Participants' responses may be influenced by personal opinions or biases, potentially impacting the objectivity of the data collected.
- The study focused on operational efficiency and may not have considered other important variables that could impact lean manufacturing practices.
- There is a possibility of measurement errors in data collection methods, which could affect the accuracy and reliability of the study's findings.

- The study did not account for external factors such as economic conditions or technological advancements that could impact lean manufacturing practices.

6. Conclusion/Suggestions

➤ Conclusion

The findings of this study present compelling evidence regarding the impact of lean manufacturing practices on operational efficiency within the textile industry. Through an in-depth analysis, several key conclusions emerge:

- Lean Manufacturing Practices Significantly Impact Operational Efficiency: The ANOVA analysis revealed a statistically significant effect of lean manufacturing practices on operational efficiency in the textile industry. The p-value of 0.000 which is less than 0.05 indicates a robust impact at the 5% significance level, supporting the alternative hypothesis. This suggests that implementing lean manufacturing practices can lead to tangible improvements in operational efficiency within textile firms.
- High Variance in Operational Efficiency Explained by lean practices: With E2 as the dependent variable, the model explained 55.8% of the variance in operational efficiency. Similarly, for E1, the explained variance was 35%. This indicates that a substantial portion of the variation in operational efficiency can be attributed to the adoption of lean manufacturing practices.
- Positive Perception of Lean Practices among Respondents: Mean values above 3 for questions regarding operational efficiency, 5S methodology, value stream mapping, just in time, and kaizen suggest a general agreement among respondents regarding the effectiveness of these lean practices. This reflects a positive perception of lean manufacturing's potential to enhance operational performance.
- Diverse Demographic Representation in the Study: The demographic breakdown of respondents showcased a diverse sample, including various age groups and respondent types such as engineering students, professors, industry experts, and production or quality managers. This ensures a comprehensive understanding of the impact of lean manufacturing practices across different segments of the textile industry workforce.
- Implications for Textile Industry Optimization: The findings underscore the importance of integrating lean manufacturing principles into textile industry processes to optimize operational efficiency. By embracing practices like 5S methodology, value stream mapping, just in time, and kaizen, textile firms can streamline operations and enhance overall performance, leading to increased competitiveness and sustainability in the market.
- Positive and Significant Correlation: The Pearson correlation test revealed positive and significant correlations between all independent variables representing lean manufacturing practices (5S methodology, value stream mapping, just in time, and kaizen) and operational efficiency, indicating their relevance in improving operational efficiency and driving performance improvements.

In conclusion, the results of this study provide valuable insights into the critical role of lean manufacturing practices in driving operational efficiency within textile firms. By understanding and leveraging the principles of lean management, organizations can position themselves for sustained success and performance excellence in today's dynamic business landscape.

➤ Suggestions

- Acknowledge potential biases in sample selection, such as the exclusive focus on Surat's textile companies, limiting broader industry representation.
- Investigate additional variables influencing operational efficiency in lean manufacturing, like organizational culture or leadership style, to expand research scope.
- Provide actionable insights on specific findings related to the effectiveness of individual lean manufacturing techniques for practitioners.
- Explore the conceptual framework's applicability beyond textiles, potentially in other manufacturing or service sectors.
- Enhance research depth by integrating qualitative methods like interviews or case studies to understand contextual factors influencing lean manufacturing effectiveness.

7. References

- Muhammad Naeem, Nisar Ahmad, Sarfraz Hussain, Bilal Nafees and Aatir Hamid (June 2021) "Impact of lean manufacturing on the operational performance: evidence from textile industry" <https://doi.org/10.18510/hssr.2021.9393>
- Graziela dos Santos Bento , Klaus Siegmair Schuldt, Luciano Castro de Carvalho (2020)"Title - The influence of supplier integration and lean practices adoption on operational performance" <https://doi.org/10.1590/0104-530X3339-20>
- Leandro L. Lorente Leyva, Edwin P. Curillo Perugachi, Ramiro V. Saraguro Piarpuezan, Carlos A. Machado Orges and Edwin P. Ortega Montenegro (2018) "Lean Manufacturing Application in Textile Industry" https://www.researchgate.net/publication/328861132_Lean_Manufacturing_Application_in_Textile_Industry
- Rajat Ajmera, Prabhuling Umarani, K.G.Valase (2017) "Lean Six Sigma Implementation in Textile Industry" <https://www.irjet.net/archives/V4/i4/IRJET-V4I4340.pdf>
- S. Karthi, S.R. Devadasan, K. Selvaraju, N.M. Sivaram, & C.G. Sreenivasa (2013) "Implementation of Lean Six Sigma through ISO 9001:2008 based QMS: A case study in a Textile Mill" <https://doi.org/10.1080/00405000.2013.774945>
- Sundareshan S D, Dr Swamy D R, Dr T S Nanjundeswara Swamy (2015) "A Literature Review on Lean Implementations" https://www.ijera.com/papers/Vol5_issue11/Part%20-%204/N511047381.pdf
- Mohammad Rashid, Dr.R.B.L Shrivastav, Subhash (2022) "An Analysis of Indian Textile Industry: A Literature Review Approach" <https://www.jetir.org/papers/JETIR2212548.pdf>
- Anurag Shanu (2019) "Processes of Manufacturing in the Textile Industry" <https://www.jetir.org/papers/JETIREO06031.pdf>
- Dr. Bharati Rathore (2023) "Textile Industry 4.0: A Review of Sustainability in Manufacturing" <http://dx.doi.org/10.58972/eiprmj.v10i1y23.41>