

DURBAN UNIVERSITY OF TECHNOLOGY

COMPARING THE EFFECTIVENESS OF LEAN MANUFACTURING

PRINCIPLES BETWEEN A SMALL AND A MEDIUM

ORGANISATION IN THE APPAREL INDUSTRY

IN

KWAZULU-NATAL (KZN)

PUSHPA GOVENDER

November 2025



**COMPARING THE EFFECTIVENESS OF LEAN MANUFACTURING
PRINCIPLES BETWEEN A SMALL AND A MEDIUM ORGANISATION IN
THE APPAREL INDUSTRY IN KWAZULU-NATAL (KZN)**

by
PUSHPA GOVENDER
(20203839)

Submitted in fulfilment of the requirements for the degree
MASTER OF MANAGEMENT SCIENCES
(QUALITY MANAGEMENT)

Department of Operations and Quality Management
Faculty of Management Sciences

DURBAN UNIVERSITY OF TECHNOLOGY

NOVEMBER 2024

APPROVED FOR EXAMINATION

Supervisor (Affiliation):

Date: 23rd October 2025

Co-Supervisor (Affiliation):

Date: 23rd October 2025

ABSTRACT

The South African apparel industry faces intense competition from both domestic and international markets, largely driven by low-cost imports and strong local rivalry prompting companies to seek operational efficiencies through the adoption of Lean Manufacturing Principles (LMPs). This study quantitatively examines the effectiveness of LMP implementation within small and medium-sized enterprises (SMEs) in the KwaZulu-Natal (KZN) apparel sector. A comparative analysis is conducted between a small-sized company (Company A) and a medium-sized company (Company B) to assess the degree of LMP adoption and its impact on operational performance, quality management, and competitiveness. A structured survey using a five-point Likert scale was administered to employees across various functional levels to collect data. The findings reveal significant differences in LMP adoption between the two companies, with Company B demonstrating more comprehensive implementation and greater improvements in efficiency and quality. Identified challenges include limited resources, insufficient managerial support, and knowledge gaps, particularly in smaller firms. This study uses a purposive sampling method to deliberately select two different apparel companies, one small and one medium, based on their level of Lean Manufacturing (LM) adoption. By comparing these two contrasting cases, the study provides a focused analysis of how lean principles are implemented in different organisational settings. This type of comparative case approach is rarely applied in studies focusing on small and medium enterprises in the South African apparel industry, making the research design a distinctive contribution. The study contributes to the understanding of LMP effectiveness in SMEs, proposing strategies to enhance lean adoption, reduce waste, and promote sustainable practices in the South African apparel sector. These strategies offer practical guidance for SMEs to implement lean practices more effectively, enabling real-world improvements in productivity, cost reduction, and sustainability.

Keywords: Lean Manufacturing Principles (LMPs), Small and Medium Enterprises (SMEs), South African Apparel Industry, Operational Efficiency, Quality Management, Comparative Analysis.

ABBREVIATIONS

CI	Continuous Improvement
CM	Cellular Manufacturing
CMS	Cellular Manufacturing System
GDP	Gross Domestic Product
JIT	Just-In-Time
KZN	KwaZulu-Natal
LM	Lean Manufacturing
LMM	Lean Manufacturing Model
LMT	Lean Manufacturing Theory
LT	Lean thinking
MSMEs	Micro, Small, and Medium-Sized Enterprises
NDP	National Development Plan
NVA	Non-value-adding
SME	Small and Medium Enterprise
TPS	Total Production System
TQM	Total Quality Management
VM	Visual Management
VA	Value adding
VSM	Value Stream Mapping
WIP	Work in Process
QRM	Quick-response manufacturing
LMP	Lean Manufacturing Principal

ACKNOWLEDGEMENTS

First, I am grateful to my Creator for guiding me during this academic journey.

I want to express my sincere gratitude to the following people for their support and contribution throughout this journey:

- My late mum Mrs Govindammah Govinden, for always keeping me in her prayer
- My Husband, Gordon for his support and patience during this time
- My aunt for her encouragement and love
- My children, Thegan, Parshen and Tiya for their support, faith and encouragement.
- My nephew Stason, for his love and support
- The employees of Company A and B
- My supervisor, Dr Trevor Naidoo, and co-supervisor, Dr Xhanti Dyonase, for their guidance and patience
- To my librarian, Sara Mitha from Library Postgraduate Services, for guiding me and helping me with EndNote Referencing and Word layout.
- Reshma Sewpersadh, for all the support and encouragement.
- To the Textile Science and Apparel Technology staff for all their support.
- To all my family and friends, I am grateful for your support.
- To Samantha Moodley for her invaluable guidance and insightful contributions throughout this project. Her dedication and expertise greatly enhanced the quality of this work.

DECLARATION

I, Pushpa Govender, declare that this thesis for the Master of Philosophy in Quality Management degree, submitted to the Faculty of Management Science at the Durban University of Technology is my independent work and has not been submitted for any degree to this or any other University. Where other sources have been used, they are duly acknowledged and given reference.

Ms. Pushpa Govender

Student No. 20203839

TABLE OF CONTENTS

ABSTRACT	i
ABBREVIATIONS	ii
ACKNOWLEDGEMENTS	iii
DECLARATION	iv
TABLE OF CONTENTS	v
LIST OF TABLES	x
LIST OF FIGURES	xi
CHAPTER ONE OVERVIEW OF THE STUDY	1
1.1 Background to the Study	1
1.2 Problem Statement.....	4
1.3 Rationale for the Study	5
1.4 Title.....	6
1.5 Aims	6
1.6 Objectives.....	7
1.7 Research questions.....	7
1.8 Delimitations of the Study.....	7
1.9 Scope	7
1.10 Research Methodology	8
1.11 Layout of the Research Report	9
1.12 Conclusion	10
CHAPTER TWO LITERATURE REVIEW	11
2.1 Introduction.....	11
2.2 Global Evolution and Clothing Manufacturing.....	11
2.3 Clothing Manufacturing: The International Perspective	12
2.4 Clothing Industry in South Africa	15
2.5 Garment Manufacturing Process.....	16
2.6 Sustainability of SMEs in the Clothing, Textile, and Leather Industry.....	17
2.7 Garment Manufacturing Processes in KZN	18
2.8 Defining Lean Manufacturing.....	18

2.8.1	History of Lean Manufacturing	21
2.8.2	Comparing Traditional Mass Manufacturing Methods with Lean Mass Production Methods.....	22
2.9	Critical Lean Manufacturing Success Factors	23
2.10	Challenges to Lean Manufacturing.....	26
2.11	Implementing Lean Manufacturing	27
2.11.1	Kanban System	29
2.11.2	Standardising of work	30
2.12	Lean Manufacturing Principles	30
2.13	Value Stream Mapping (VSM).....	32
2.14	Elimination of waste	33
2.14.1	Transportation waste	34
2.14.2	Excess Inventory	35
2.14.3	Waste of Waiting	35
2.14.4	Waste of motion.....	36
2.14.5	Over-processing of waste	36
2.14.6	Waste of defects.....	37
2.14.7	Continuous Improvement.....	41
2.14.8	Just-in-Time (JIT).....	41
2.14.9	Total Quality Management (TQM) and Zero Defects.....	42
2.14.10	Multifunctional Teams.....	44
2.14.11	Cellular Manufacturing (CM).....	45
2.14.12	Visual Management (VM)	47
2.14.13	Single Minute Exchange of Die (SMED)	49
2.14.14	Supplier Relationship Management in the framework of Lean Manufacturing.....	51
2.14.15	Customer Relationship Management	53
2.15	Theoretical Framework.....	54
2.15.1	Lean Manufacturing Theory:.....	54
2.15.2	Total Quality Management (TQM):	54
2.15.3	Application:	56

2.16	Conclusion	57
CHAPTER THREE RESEARCH METHODOLOGY.....		58
3.1	Introduction.....	58
3.2	Research Methodology.....	58
3.3	Methodological Approaches	58
3.3.1	Quantitative (Positivism).....	59
3.4	Research design.....	60
3.4.1	Descriptive research design.....	60
3.4.2	Pretest	61
3.4.3	Population.....	62
3.4.4	Sample.....	63
3.5	Data collection method and research instruments.....	67
3.5.1	The Measuring Instrument	68
3.6	Data analysis.....	69
3.6.1	Descriptive statistics	69
3.6.2	Chi-square test of independence	70
3.6.3	Binomial test	70
3.6.4	One sample t-test.....	70
3.6.5	Independent sample t-test	70
3.7	Validity.....	70
3.8	Reliability	71
3.9	Ethical considerations.....	71
3.10	Limitations.....	72
3.11	Delimitations of the study	72
3.12	Conclusion	72
CHAPTER FOUR DATA ANALYSIS AND FINDINGS		74
4.1	Introduction.....	74
4.2	Presentation of Results	75

4.2.1	Section 1: Respondents profiles by department and occupation	75
4.2.2	Section 2: Occupational Roles of Respondents	77
4.2.3	Section 3: Individual sectional analysis	78
4.2.4	Section 4: Perspectives and insights.	102
4.3	Conclusion.....	110
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS.....		111
5.1	Introduction.....	111
5.2	Aims and Objectives.....	111
5.3	Summary of findings.....	112
5.3.1	Continuous Improvement variables analysis:.....	112
5.3.2	Total Quality/Zero Defects analysis:	112
5.3.3	Just-in-Time (JIT) variables analysis:.....	112
5.3.4	5S Methodology analysis:	112
5.3.5	Visual Boards analysis:.....	112
5.3.6	Multi-functional Teams analysis:	112
5.3.7	Customer Input analysis:	112
5.3.8	Lean adoption success analysis:	113
5.4	Conclusions.....	113
5.4.1	Conclusion from the literature review	113
5.4.2	Conclusion from the empirical study	114
5.5	Recommendations.....	116
5.6	Limitations	117
5.7	Suggestions for future study.....	118
5.8	Conclusion.....	119
REFERENCE LIST.....		120
APPENDICES		139
Appendix A - Gatekeeper letter.....		139
Appendix B - Letter Of Information.....		141
Appendix C – Letter Of Consent		142
Appendix D – Ethics Clearance Report.....		144

Appendix E - Questionnaire	146
Appendix F- Statisticians Certificate	153
Appendix G – Research Ethics Certificate	154
Appendix H- Turnitin Report.....	155
Appendix I-Editors Certificate.....	157

LIST OF TABLES

Table 1.1 Target population for inclusion in Company A and Company B.....	8
Table 3.1 Target population.....	62
Table 3.2 Sample population.....	66
Table 4.1: Continuous Improvement.....	79
Table 4.2: Total Quality/Zero Defects.....	82
Table 4.3: Just-in-Time.....	86
Table 4.4: The Role of 5S.....	90
Table 4.5: Visual Boards.....	93
Table 4.6: Multi-Functional Teams.....	97
Table 4.7: Customer Input.....	100
Table 4.8: Quantitative Inquiry.....	102
Table 4.9: Responses.....	104
Table 4.10: Responses to the Success of Lean Adoption.....	109

LIST OF FIGURES

Figure 4.1: Profiles of employees within their respective departments.75

Figure 4.2: Occupational Roles of Respondents77

Figure 4.3: Continuous Improvement79

Figure 4.4: Total Quality / Zero Defects82

Figure 4.5: Just-in-Time.....85

Figure 4.6: The Role of 5S.....89

Figure 4.7: Visual Boards93

Figure 4.8: Multi-Functional Teams96

Figure 4.9: Customer Input.....99

Figure 4.10: Responses to Questions 104

Figure 4.11: Responses on Continuous Improvement..... 107

CHAPTER ONE

OVERVIEW OF THE STUDY

In recent years, Lean Manufacturing (LM) has shifted its focus from shop floor equipment to lean principles that integrate value and waste elimination throughout the production chain (Womack and Jones 1994; cited in Karunarathne and Samarasinghe 2019). According to Gamage *et al.* 2012, cited in Karunarathne and Samarasinghe (2019), LM has emerged as a response to the growing pressure on businesses to achieve a competitive edge in terms of product pricing, service, and quality. This is because LM has been shown to have a favourable influence on operational performance. The apparel industry is undergoing rapid change. Factors such as dynamic fashion designs, variable order quantities, and increased quality standards at the lowest possible cost make it necessary for apparel manufacturers to focus on more effective and efficient manufacturing processes to survive in this fiercely competitive market. Manufacturers now have to embrace LM, where waste minimisation is the main focus, to reduce production costs.

1.1 Background to the Study

Amid the era of globalisation and rising competition the clothing sector, a major player in KwaZulu-Natal's (KZN) economy encounters mounting obstacles. Companies in the manufacturing sector are increasingly embracing manufacturing strategies, which focus on enhancing quality reducing waste, and cutting production expenses to tackle these challenges effectively. For garment manufacturers aiming to enhance their edge in the market by optimising operations and increasing production capacity, LM has emerged as a vital strategy (Reddy 2021). The concept and implementation of Lean Manufacturing Systems (LMS) is a modern and progressive production method that minimises unnecessary waste while enhancing value for customers (Bashar, Hasin, Ray, Sakib, Rahman and Bashar 2024a).

Bamisaye, Oroye, Farayibi, Adeitan and Agbo (2023) posit that the implementation of LM in SMEs, particularly in garment production, offers numerous advantages. These include optimised space utilisation, lower operational costs, better inventory management, fewer machine breakdowns, waste reduction, shorter operational cycle times, and increased organisational productivity. Bamisaye *et al.* (2023) further add that Lean practices also lead

to enhanced learning processes, greater flexibility, improved financial performance, and a reduction in garment rework. Moreover, LM improves delivery times, strengthens worker capabilities, accelerates task completion, boosts customer and employee satisfaction, enhances garment quality, reduces defects, sharpens the SME's competitive edge, and provides economic benefits.

In this regard, the goal of this study is to examine the effectiveness of LMPs in the KZN apparel industry, with a particular emphasis on comparing SMEs. According to Taçoğlu, Ceylan and Kazançoğlu (2019) SMEs play a vital role in driving economic growth, creating jobs, and fostering innovation. Though they often serve as suppliers to larger companies, SMEs must address various factors that impact their sustainability to remain competitive. SMEs in the clothing manufacturing industry continue to face significant pressure to stay competitive. This is largely due to insufficient government regulations, leading to an influx of cheap imports from international markets, which undermines local competitiveness and puts SMEs at a disadvantage. This challenge appears to arise from a lack of knowledge and understanding of the key factors that contribute to their competitiveness (Mkhize 2022b). Taçoğlu, Ceylan and Kazançoğlu (2019) argue that it is essential for SMEs to develop adaptable business strategies to remain viable in the market.

This study intends to shed light on the parallels, gaps, and best practices in lean implementation techniques by analysing the adoption and application of LMPs in small and medium-sized apparel industries. The purpose of the study is to compare different degrees of LM adoption and effectiveness, which is as evidenced by the selection of study participants, which includes Company A, a small business, and Company B, a well-known medium-sized industry.

Company A has been trained but has not completely implemented lean principles. Company A specialises in the manufacture of protective outerwear, including ballistic protective wear, freezer and cold protective wear, rain protective wear, chemical protective wear, abrasion protective wear, and related products for the safety, security, military, uniform, and promotional industries. Currently, the South African market for these products is experiencing saturation, characterised by an abundance of suppliers and intensified competition. Consequently, companies in this sector face challenges such as pricing

pressures, the necessity for innovation, and the importance of differentiating their offerings (Reddy 2021).

In this context, Company A's current production system involves a complex workstation with a single assembly line. This complexity has resulted in low productivity, increased lead times, high reject rates, poor line balancing, and limited flexibility for style changeovers. To remain competitive, the company must address these operational challenges while continuing to enhance its production processes and explore new market opportunities (Reddy 2021).

Company B commenced operations in 1975 as a Cut, Make, and Trim (CMT) clothing manufacturer. It has achieved rapid and efficient production through extensive automation and computerised systems, rigorous quality control management, and precise material requirement planning. In response to the current economic climate in South Africa, Company B has adopted an employment policy aimed at the upliftment and advancement of its employees, which has contributed to its reputation for continuous improvement. With four production lines focused primarily on menswear, the company implemented world-class manufacturing principles as a framework for ongoing enhancement. To further align with these principles, Company B initiated a cellular production system and adopted LM practices, emphasising a vision-driven approach along with employee engagement and creativity. In comparison, Company B has a history of proactive engagement in training and advanced process improvement approaches. With this choice, the effectiveness of LM in various organisational situations may be explored in more detail.

In addition, this study seeks to determine the obstacles and challenges that small and medium-sized enterprises face when implementing lean manufacturing, with the ultimate objective being the creation of an implementation guide intended particularly for small clothing manufacturers. By focusing on these issues, this research aims to provide insights and guidance for the effective implementation and integration of LMPs, thereby improving operational effectiveness, reducing costs, and enhancing competitiveness in KZN's clothing sector.

1.2 Problem Statement

LM is widely recognised for its ability to reduce waste, enhance productivity, and improve quality in manufacturing operations. However, there are obstacles associated with LM that frequently keep businesses from reaping its full benefits. According to Balakauskaitė (2020), many manufacturers see LM as a powerful method for boosting efficiency, ensuring product or service quality, and staying competitive. With shifting market demands and challenges like global competition, shorter product cycles, and increasing costs, companies must refine their processes to meet these pressures. Though adopting lean practices is often essential for adapting to change, the journey is frequently met with significant obstacles. Failing to address these can result in production inefficiencies. Therefore, strong process management is vital for overcoming the hurdles associated with lean adoption. Lingkon, Saha, Manzid, Hasan and Mahalanobish (2024) attest that the common challenges of implementing lean, along with limited experience in the manufacturing sector, may stem from insufficient training for both management and employees. Govender and Jasson (2018) indicate that over 90% of businesses globally implementing LM either fail or partially succeed. This high failure rate, despite the recognized advantages of lean principles, is concerning and has prompted researchers to investigate the factors hindering successful implementation and explore variables that could improve the effectiveness of lean adoption. The two most commonly mentioned reasons why lean implementations fail are a lack of knowledge and experience necessary to carry out the strategy and inadequate managerial support (Mbewe 2022).

There is a gap in the existing literature regarding how specific combinations of lean tools and techniques, referred to as lean bundles, contribute to enhancing manufacturing performance. In order to achieve maximum growth in a highly competitive business, the Lean Manufacturing Model (LMM) is essential for increasing the efficiency of a manufacturing line by minimising waste while enhancing quality (Reddy 2021).

In South Africa and around the world, SMEs have been identified as effective generators of inclusive economic growth and development (The Banking Association Of South Africa 2019). According to some experts, small and medium-sized businesses in South Africa account for around 34% of the country's GDP, employ about 60% of the labour market, and makeup 91% of formal businesses. SME growth of fresh, underdeveloped economic sectors promotes diversity while making a major economic contribution. Additionally, in the

economies of Brazil, Russia, India, China, and South Africa (BRICS), innovative and technologically based small and medium-sized businesses can offer a foundation for local, regional, and global growth. SMEs are viewed as major economic contributors and forces behind the decline in unemployment (The Banking Association Of South Africa 2019). These figures highlight the economic and social importance of SMEs, demonstrating why their sustainability and competitiveness, particularly within the clothing sector, are critical. Since this study focuses on LM in small and medium apparel businesses in KZN, understanding the broader contribution of SMEs underscores the relevance and potential impact of improving their operational effectiveness.

This study is crucial for determining how much a significant lean tool can optimise production while ensuring that the company's products are of high quality from the conception stage to the end product stage. This will act as a starting point for research into the causes of quality defects and waste in the garment industry, followed by recommendations for improvement-related activities. Additionally, it aimed to support SMEs in the apparel manufacturing sector as they grow their knowledge and add to the economy by adding additional jobs.

Notably, Ukey, Deshmukh and Arora (2021) state that comprehending the efficacy of LM in the clothing sector is vital for multiple reasons. It has a direct effect on SMEs' sustainability and competitiveness, which is important for economic growth and creating jobs. Furthermore, detecting and resolving inefficiencies and quality problems in production processes can result in lower costs, better-quality products, and greater customer satisfaction. Moreover, SMEs must be equipped with successful lean strategies to survive and develop in the face of intense global competition along with rapidly changing market dynamics.

This study seeks to contribute by investigating the effectiveness of LM in the apparel industry, which will serve as a benchmark for SMEs. It will also add to the theoretical framework of lean principles, specifically in the apparel industry.

1.3 Rationale for the Study

The rationale for the study lies in addressing a significant gap in the existing literature regarding the application of LM practices, specifically in the apparel industry. The choice of Company A and Company B was deliberate, aiming to compare and contrast their

approaches to lean principles implementation. Company B was selected due to known information indicating a substantial integration of lean principles within its operations. Conversely, Company A was chosen as a contrasting case, as they had received some training in lean principles but had not fully implemented them. This selection strategy enables an exploration of how varying levels of lean implementation impact operational efficiency and performance within the clothing manufacturing industry.

The study acknowledges that while there have been some studies in different industries exploring lean principles, there is a lack of sufficient research on the effectiveness of specific lean bundles in improving manufacturing performance within the apparel sector. Moreover, this study is motivated by the need to identify practical solutions to the challenges that manufacturing companies are currently facing amidst the intense global competition. To thrive amidst intense competition, these companies must navigate the complexities of reducing production costs, eliminating waste, increasing productivity, and improving product quality, all while maintaining profitability. Recognising LM as a strategic imperative, defined as 'manufacturing without waste' (Ramasubramaniam 2020), this study seeks to explore the industry's reliance on LM as a pivotal solution to the overarching objective of waste reduction. By delving into the effectiveness of LM in addressing these challenges, the study aims to contribute valuable insights to the ongoing discourse on optimising manufacturing practices (Sadiku, Olaleye and Musa 2019).

1.4 Title

Comparing the effectiveness of Lean Manufacturing Principles between a small and a medium organisation in the apparel industry in KwaZulu Natal (KZN).

1.5 Aims

The study aims to compare the effectiveness of LMPs between a small and medium-sized enterprise within the apparel industry in KZN by assessing the challenges encountered and evaluating the impact of LMP implementation on operational efficiency, quality, and competitiveness.

1.6 Objectives

1. To explore the LMPs adopted by the medium versus small apparel industries.
2. To conduct a comparative analysis between small and medium apparel industries in terms of LM usage.
3. To identify problems and challenges in implementing LM.
4. To develop an implementation guide for LM for small apparel industries.

1.7 Research questions

1. What are the LMPs adopted by the SMEs in the Apparel industry?
2. What are the similarities, differences, and best practices between SMEs in terms of LMPs?
3. What problems and challenges do SMEs encounter in implementing LMPs?

1.8 Delimitations of the Study

The study is limited to the apparel industry in KZN, and findings may not directly apply to other regions or industries. The comparison is specifically focused on a medium-sized apparel manufacturing company (Company B) and a small-sized company (Company A). Findings may not be generalised to other organisations. Additionally, the study is delimited to the apparel manufacturing sector, and the effectiveness of LMPs may differ in other industries. The study is conducted in a specific language (e.g., English), and findings may not be fully applicable or transferable to studies conducted in other languages. This study is delimited to a quantitative research approach, as it aligns closely with the overall research design. The primary data collection instrument is a structured survey questionnaire. This delimitation is chosen for its effectiveness in gathering measurable data, enabling the analysis of patterns, trends, and relationships through statistical methods.

1.9 Scope

The scope of the study focuses on conducting a comparative analysis between Company A and Company B, to explore how these organisations, varying in size, implement and experience the effectiveness of LMPs. The geographical scope is limited to the KZN region in South Africa, specifically within the apparel industry. It should be noted that Company B is located in Tongaat, KZN, while Company A is based in Durban, KZN.

1.10 Research Methodology

This study employs a quantitative approach. The collection of quantitative data occurred concurrently, allowing for a comprehensive exploration of the effectiveness of LMPs in SMEs within the apparel industry.

A survey questionnaire was utilised as the primary data collection instrument, incorporating quantitative items. This instrument facilitated the collection of structured quantitative data.

The target population for this study comprised of full time employees from the two selected companies, Company A and B. The identified categories for inclusion in this study are as follows:

Table 1.1 Target population for inclusion in Company A and Company B

Managers	13
Section Managers	7
Supervisors	40
Training Managers	1
Quality Managers	2
Quality Control Inspectors	33
Team Leaders	52
Total population	148

A purposive sampling method was employed to select a representative sample from the identified categories. Due to the smaller numbers in certain categories, all respondents in those categories were included. The selected sample population size is approximately 139 employees.

The data collection involved hand-delivering questionnaires using a gatekeeper's letter to approach the selected companies. Respondents were assured that their participation was voluntary and that their responses and identity would remain confidential. Questionnaires were collected after one week to ensure a timely response. Selected respondents received the questionnaire in person, allowing them to answer at their convenience. The researcher then arranged for the collection of completed questionnaires.

SPSS (Statistical Package for the Social Sciences) was employed as the primary statistical tool for the analysis, with further details provided in Chapter 3.

1.11 Layout of the Research Report

Chapter 1: Introduction and Background

This chapter introduces the study, providing an overview of the research problem and the significance of examining the effectiveness of LMPs in the apparel industry of KZN. It outlines the study's aims, objectives, and research questions, emphasising the need to understand the challenges and benefits of LMP implementation for SMEs in this sector. The chapter also discusses the limitations and delimitations of the study to establish its scope and context.

Chapter 2: Literature Review

This chapter reviews the existing body of literature on LMPs and their application in various industries, with a focus on the apparel sector. It highlights key theoretical frameworks, discusses global best practices, and identifies gaps in the current research, particularly in relation to the implementation and effectiveness of lean principles in small and medium-sized apparel manufacturing companies. The review provides a foundation for understanding how lean processes can drive operational efficiency and competitiveness.

Chapter 3: Research Methodology

This chapter details the research methodology employed to achieve the study's objectives. It describes the research design, data collection methods, and sampling strategy used to select participants from Company A (small-sized) and Company B (medium-sized). The chapter also explains the quantitative research approach and outlines the statistical tools and techniques used to analyse the collected data.

Chapter 4: Data Analysis and Findings

This chapter presents the analysis of the data collected from the survey and interviews, highlighting key findings on the effectiveness of LMPs in both companies. The results are discussed in relation to the study's objectives, supported by graphs and tables to provide a

visual representation of the data. This chapter also explores the differences in LMP adoption between the two companies and the challenges faced by each company in implementing these principles.

Chapter 5: Conclusions and Recommendations

This chapter summarises the main conclusions drawn from the research findings and discusses their implications for the apparel industry in KZN. It offers recommendations for enhancing LMP adoption in small and medium-sized apparel manufacturers, suggesting strategies for overcoming identified challenges. The chapter concludes by proposing an implementation guide tailored to the unique needs of SMEs in the sector and highlights areas for future research.

1.12 Conclusion

This chapter provided the context of the study with the background of the research and the research problem. The aim, objectives, research questions, and research methodology are also presented. This chapter also highlighted the significance of the study.

These elements collectively lay the groundwork for understanding the research focus on LMPs within SMEs in the KZN apparel sector. By presenting these components clearly, the chapter ensures that readers are aligned with the purpose and direction of the study.

These foundational aspects not only guide the research but also frame the analysis of LM practices in SMEs, helping to explore how they can contribute to improved operational efficiency. The research aims to shed light on the challenges and opportunities of lean adoption, providing valuable insights for the apparel industry.

Chapter 2 highlights the literature review undertaken for this study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature relevant to the effectiveness and implementation of LMPs in the apparel industry, with a particular focus on SMEs in KZN, which forms the focus of this study. By incorporating relevant literature from national and international sources, the researcher aims to identify best practices, challenges, and opportunities associated with implementing LMP in similar industries worldwide.

2.2 Global Evolution and Clothing Manufacturing

Alam, Selvanathan, Selvanathan and Hossain (2019) state that up until the middle of the 18th century, all clothing was manufactured by individuals, tailors, or family members at home. The production was entirely bespoke because there was little to no mechanical support for the hand-cutting, hand-sewing, and hand-designing processes. Yet, when a French tailor by the name of Barthelemy Thimonnier created the sewing machine in 1830, factory-based clothing manufacturing began in France. Three years later, Walter Hunt created a comparable type of sewing machine in the United States, starting a parallel evolution. Although the development of these sewing machines was regarded as one of the key turning points in the development of the garment industry, they were unable to stimulate the industrialisation of tailor-based apparel production. This was primarily because early sewing machines had limited capabilities, were costly, faced resistance from traditional tailors, and the industrial infrastructure required for mass production was not yet in place.

Only in the 1850s did the industrialisation process begin when American inventor Isaac MeritSinger created a useful and profitable sewing machine (Alam *et al.* 2019; Antony, Psomas, Garza-Reyes and Hines 2021). The invention of the sewing machine sparked not just an industrial but also a cultural revolution because the mass production of clothing in factories had all but eliminated the tailoring industry. In the major cities of the United States and Europe, thousands of clothing manufacturers were created between 1850 and 1950 (Alam *et al.* 2019).

Jana and Tiwari (2021) believe that as a result of globalisation and the development of digital technology, consumers now have access to a greater range of superior goods and services at affordable rates. The global marketplace is becoming more competitive, and manufacturers are developing new strategies to function, thrive, and outperform in their specialised fields. Manufacturing of clothing is not an exception. Shorter product cycles in the dynamic fashion industry put pressure on producers to deliver garment products more quickly and at a lower cost while maintaining high-quality requirements. LM practices are being adopted by an increasing number of textile manufacturing companies, but they are still being used sparingly in comparison to other sectors, particularly auto manufacturing. Lean methodologies are being more widely used, and progress toward achieving operational excellence is evident.

Preproduction, production, and postproduction are the three stages that apparel manufacturers often divide their work into. Order confirmation, sample development, material acquisition, planning of order quantities, and other post-production activities are included, whereas production is typically thought of as beginning with the bulk spreading and cutting of the fabric and ending with the product output in the form of a semifinished or finished good. The products must be finished, packaged, and sent as part of postproduction activities. The majority of the resources in a typical garment manufacturing setting are used for production and postproduction tasks, which are widely regarded as core apparel manufacturing. This could be a likely explanation for why the majority of lean tools and approaches are exclusively used in these sectors (Jana and Tiwari 2021).

2.3 Clothing Manufacturing: The International Perspective

Rahman, Abdul, Manjurul and Mahmud (2023) conducted a study focusing on the impact of LM strategies on production and layout design in the apparel industry. The study identified various types of waste that exist in the sewing section of a garment manufacturing facility and demonstrated how lean tools such as 5S, line balancing, and Just-in-Time (JIT) can streamline processes to enhance efficiency. The results indicated that after implementing lean, significant improvements were observed. The standard minute value (smv) decreased by 0.9 minutes, production increased by 1,664 pieces per month, and the workforce was reduced by two employees. Alteration rates dropped to 4%, spot defects to 1.80%, and the rejection rate to 0.68%. Work in Process (WIP) was reduced by seven pieces, and overall efficiency reached 69.08%. LM had a transformative impact on the sewing department by

establishing a standard workflow, enhancing process efficiency, and boosting productivity, ultimately helping to meet production targets. The study's findings indicated significant improvements in line efficiency and production output, emphasising the need for tailored lean tools in specific sections of the apparel manufacturing process.

Aryarathne and Galahitiyawe (2020) highlighted that LM has become increasingly relevant in the apparel industry as it contributes to eliminating waste and improving operational efficiency. The study identified ten LM practices that are commonly applied in the apparel sector, such as customer involvement, production leveling, and total productive maintenance. Aryarathne and Galahitiyawe (2020) confirm that LM practices should prioritise long-term benefits and be integrated into the daily responsibilities of everyone in the organisation. The study also noted that while LMPs are globally applicable, their effectiveness may vary depending on regional operational practices and the availability of resources.

Perera, Wickramarachchi, Abeysekara and Vidanagamachchi (2020) examined the application of lean principles in a Sri Lankan apparel manufacturing company. The study developed a step-by-step lean implementation model customised for the local manufacturing culture, integrating lean tools like value stream mapping (VSM), 6S (5S + Safety), kanban systems, and standard operating procedures (SOPs). The results indicated significant improvements in key performance indicators such as on-time delivery, reduced fabric utilisation, and higher production efficiency. This study serves as an example of how lean principles can be adapted to local contexts while achieving global standards of operational excellence.

According to Hanson (2021), the government removed barriers to exporting, lowered import tariffs, expanded the sectors in which foreign investment was permitted, consolidated smaller, inefficient state-owned enterprises, and allowed labour to move from rural farms to urban factories to first meet the conditions for China's accession to the World Trade Organisation in 2001. As a result, China became the world's factory (Reddy 2021). The greatest notable increase in output for the nation has been seen in the export of consumer items like apparel and footwear. Global and regional markets, including South Africa, which has also acquired the title "world's factory," have been overrun by Chinese exports. Based on the advantage of low wages, China's manufacturing industry developed quickly, enabling it to attain exceptional GDP growth and higher living standards. China surpassed the United

States to become the world's top manufacturer of products in 2011 (Hou, Gelb and Calabrese 2017).

One of the most significant economic sectors in terms of investment, revenue, trade, and employment creation is the garment sector (Keane and Te Velde 2008) (cited in Raj, Ma, Gam and Banning 2017). According to Mokwana (2021) one of the world's oldest, biggest, and most international sectors is the textile and apparel sector. It is a labour-intensive "starter" industry that is common in nations that are industrialising with an eye toward exports. Many opportunities are available in the textile and apparel industries, including entry-level positions for unskilled labour in developing nations. The textile and apparel industry's technological advantages have made it suitable as the first step on the "industrialisation ladder". In developing nations, some of which, like Bangladesh, Sri Lanka, Vietnam, and Mauritius, have seen very high output growth rates in the sector and have since developed into middle-income nations.

Raj *et al.* (2017) assert that the shift in the clothing manufacturing business away from wealthy countries has been attributed to the strict labour laws and lower wage rates in developing and less developed nations. Furthermore, although poor countries are constantly creating, their innovations are not as well-absorbed as those made by developed countries. Recent changes in consumer behaviour, rising manufacturing and shipping costs, increased worldwide rivalry, and expectations of social compliance have had a significant impact on Bangladesh's apparel manufacturing industry (Bashar, Hasin and Adnan 2021).

Kumar, Mohan and Mohanasundaram (2019) reveal that clothing production is an extremely contentious topic due to global competitiveness in the garment industry. The shifting demand in market conditions is the trend that has the apparel sectors looking for a change in the manufacturing paradigm. As a result, the paradigm of lean manufacturing was developed to increase industry competitiveness by removing waste. Some of the tools used in lean manufacturing, which consists of numerous approaches and technologies aimed at improving performance, include 5S, Value stream mapping (VSM), and line balancing. In the clothing industry, there are four basic steps in the production process: designing/pattern creation, cutting, sewing, and packing. The sewing sector, which involves more activities, is the most crucial aspect of the apparel industry.

The international experiences reviewed above illustrate that while LMPs and strategies have been successfully adapted across diverse apparel manufacturing contexts worldwide, their effective implementation depends heavily on local economic conditions, labour dynamics, and organisational culture. Understanding these details is crucial for South African SMEs in the clothing industry, which face unique challenges shaped by global competition, resource constraints, and socio-political factors. The following section explores how these global insights apply within the South African apparel industry context.

2.4 Clothing Industry in South Africa

Manufacturing in South Africa has experienced fierce international competition as it transitioned from a closed, protected market supported by an active industrial strategy (Wood and Bischoff 2020). Apartheid's demise eliminated a significant source of workplace conflict, which made it easier to embrace better value-added production paradigms. Nonetheless, given the fierce worldwide competition, the majority of South African garment and textile companies have struggled to keep up (Wood and Bischoff 2020).

South Africa's textile, apparel, and leather goods industry faces numerous challenges in regaining its competitive edge, which has been steadily eroded by foreign competitors for over two decades. Factors including labour costs, import levies, policy changes, and political influence that affect the economy to generate sustainability in the textiles, apparel, and leather goods sector have an impact on the industry's capacity to support long-term growth and offer employment (Mokwana 2021). Mbatha (2018) argues that the South African textile, apparel, and leather goods sector has seen a reduction in employment and a loss of competitive advantage, although it still accounts for 14% of the country's manufacturing output.

Small and medium-sized businesses are found in South Africa's textile, apparel, and leather goods industries. However, globalisation as well as competition from countries like China and Malaysia are having an impact on the South African textile, apparel, and leather goods industries (Mokwana 2021). According to the South African Market Insights (2019) most of South Africa's unskilled workers in the textile, apparel, and leather products industries have been laid off as a result of the high rate of fibre imports, and some businesses have been forced to shut down. These issues highlight the urgent need for South African SMEs to adopt more efficient and resilient manufacturing strategies, such as LM. However, successful

implementation will depend on more than simply applying tools developed in other industries or countries. It will require a careful understanding of the operational, cultural, and socio-economic factors at play. Therefore, adapting international LM lessons to local constraints is not just beneficial, it is essential for long-term sustainability and competitiveness in the South African apparel sector.

2.5 Garment Manufacturing Process

In the past 170 years, the structure of the apparel industry has shifted from hand-sewn, individually tailored, and sometimes robotically mass-produced ready-to-wear products to mechanised, automated, and occasionally robotic mass production. Many product categories, types of materials, style considerations, and processes involving the manipulation of flexible materials are all part of the apparel manufacturing industry. To maximise production efficiency, effective balancing and low stocks of work in progress while sewing are fundamental aspects.

Jayakumar and Krishnaraj (2017) add, that in the process of sewing a garment, the parts are put together through a subassembly procedure to create the finished item. As a result, the manufacturing process consists of several workstations where a particular duty is performed by hundreds of workers and thousands of bundles of subassemblies to produce multiple styles at once.

Typically, clothing manufacturers are concerned with whether assembly work will be completed in time for delivery, ways to increase efficiency, how machines and workers are being utilised, and ways to reduce labour intensity, as well as whether any station in the assembly line is running behind schedule and how the assembly line is doing overall.

In view of Xu, Thomassey and Zeng (2018), cutting, sewing, finishing, and packing are the four essential steps in the apparel manufacturing process. The configuration of several processes and resources while dealing with a variety of uncertainties and while subject to limitations on quantity, quality, time, and cost constitutes a complex system.

2.6 Sustainability of SMEs in the Clothing, Textile, and Leather Industry

More than 300 million people are employed globally by the 1.3 trillion dollar fashion sector, which is a large economic force and a considerable contributor to the world's Gross Domestic Product (GDP). This industry competes in a fiercely cutthroat market that is dominated by major international brands. Notwithstanding the severe financial crises of the previous ten years, the fashion sector has recently achieved rapid growth and undergone significant changes (Gazzola, Pavione, Pezzetti and Grechi 2020).

To improve their performance, large manufacturers are using LM, and small businesses Micro, Small, and Medium-Sized Businesses (MSME) must participate in this process. The (MSMEs), that supply the big manufacturers, are likely to be impacted by this (Shrimali and Soni 2017). Small and medium-sized enterprises (SMEs), according to Gherghina, Botezatu, Hosszu and Simionescu (2020) are essential for regional economic growth, contributing significantly to job creation, poverty reduction, and economic growth, but they face numerous funding challenges.

The National Development Plan 2030 (NDP) in South Africa aims to accomplish many extremely ambitious objectives by the year 2030. A new and comprehensive policy for SMEs has also been developed by the NDP. The primary objective of this policy is to encourage SMEs' expansion, advancement, and sustainability in close proximity to the labour market (Gherghina *et al.* 2020; Mokwana 2021).

Small and medium-sized businesses (SMEs) have recently faced tremendous difficulties due to the competitive nature of the economic landscape in various nations, particularly in less developed countries (Al-Hakimi, Goail, Al-Hattami, Murshid, Saleh and Moghalles 2023). Several studies cited in Cespedes-Pino, Hurtado-Laguna, Macassi-Jaurequi, Raymundo-Ibañez and Dominguez (2020); Arica-Hernandez, Llagas-Llontop and Khaburzaniya (2022a); Kulasekara and Ranaweera (2023) have shown that implementing lean in SMEs would be beneficial to the business (Arumugam, Kannabiran and Vinodh 2022).

2.7 Garment Manufacturing Processes in KZN

Mkhize (2022a) asserts that in KwaZulu-Natal (KZN), garment manufacturing processes typically encompass several essential stages, which may vary depending on specific products and utilised technologies. Common in KZN, these processes involve the following:

1. **Design and Pattern Creation:** Initially, garment designs are conceived and patterns developed accordingly. This phase may involve digital design software or manual methods.
2. **Fabric Procurement and Cutting:** Following the finalisation of designs and patterns, fabrics are sourced and then precisely cut based on patterns to optimise material usage.
3. **Sewing and Assembly:** Fabric pieces are subsequently sewn together using various techniques and specialised machinery to assemble the garments.
4. **Trimming and Finishing:** Post-assembly, garments undergo trimming and finishing procedures to ensure a high standard of neatness and quality. This includes tasks like thread trimming, attaching labels, and adding closures.
5. **Quality Assurance:** Throughout manufacturing, rigorous quality checks are conducted to guarantee compliance with defined standards. These checks encompass visual inspections, measurements, and durability testing.
6. **Packaging and Distribution:** After passing quality inspections, garments are packaged as per customer specifications and readied for shipment. This involves labelling, packaging into suitable containers, and arranging transportation to distribution centres or end-customers.

These garment manufacturing processes are executed by various entities in KZN, ranging from small-scale to large manufacturing industries, each employing diverse levels of automation and technology based on their production scale and specialisation.

2.8 Defining Lean Manufacturing

The authors Womack, Jones and Roos (2007); Bashar, Hasin, Sakib and Bashar (2024b) affirm that the term for a new organisational structure for producing things is lean production. It describes a constellation of new interactions both inside and outside the company, a different perspective on employees, clients, and the environment, and a different understanding of how technologies develop and change.

(Bashar *et al.* 2024b) mention that LM, as opposed to mass production, is a means to produce items more quickly, cheaply, efficiently, and with fewer negative effects on the environment and worker health. It also allows for faster adjustment to incorporate the newest features and performance. To avoid wasting time and resources, lean-production managers design manufacturing systems that aim for perfection the first time. These systems are staffed by well-trained employees who are encouraged to assess their performance and suggest ways to continuously improve the product and the process.

Lean thinking is defined according to Womack and Jones (1996); Rini (2021), as a philosophy that promotes superior performance and competitive advantage. Psomas and Antony (2019) define LM as a well-liked technique for continual improvement that has altered production procedures, conventions, and guiding principles all around the world. The strategy was developed for the automotive sector and has been widely applied in the manufacturing industry since the 1990s. Lean manufacturing is essentially the notion of continuously enhancing performances by methodically getting rid of wastes on the production floor.

Lean manufacturing practices according to Womack, Jones and Roos (1990) cited in Wickramasinghe and Wickramasinghe (2017), use less of everything than mass production. This includes half the labour force in the factory, half the manufacturing area, half the investment in tools, and half the number of engineering hours needed to develop a new product in half the time. This definition is comprehensive, encompassing both efficiency and effectiveness aspects of manufacturing performance. Moreover, it creates a larger and constantly expanding array of items while requiring less than half the necessary inventory to be kept on-site. This definition takes into account the relationship between input and output to address system efficiency, while it also takes into account the relationship between output and organisational goals to address system effectiveness. Lean management is a managerial strategy for process improvement built on a complicated network of interconnected socio-technical practices (Åhlström, Danese, Hines, Netland, Powell, Shah, Thürer and van Dun 2021).

Lean manufacturing, in the opinion of Bhasin and Burcher (2006); cited in Naicker (2017), has had a low success rate with some foreign corporations since it has not been adequately

understood as a model or philosophy by which a business should apply all processes at all operational levels. Lean manufacturing is employed only as a method of producing a product, and its application as a component of a business model and way of thinking about the world is disregarded, which accounts for the low rate (Shah and Ward 2007; cited in Naicker 2017). Naicker (2017) posits that lean manufacturing must be thoroughly integrated into the model, which is the strategy utilised to conduct business, as well as how a business is carried out within an organisation. It ought to also be viewed as a systemic strategy for the organisation, additionally, it should also serve as a manual for how a company should run its operations and allocate its resources.

According to Womack and Jones (1996); Wickramasinghe and Wickramasinghe (2017) any industry can benefit from applying lean principles. Several organisations such as the textile industry, garment industry, service industry, automotive, printing and packaging, construction industry, etc. have adopted lean manufacturing. Mulugeta (2021) argues that traditional manufacturing is distinct from LM. Lean manufacturing challenges the traditional production paradigm, which emphasises the system's inventory. The "Lean" philosophy views inventory as an organisational waste (Ghobadian, Talavera, Bhattacharya, Kumar, Garza-Reyes and O'Regan 2020).

Kumar, Mohan and Mohanasundaram (2019) state that the shifting demand in market conditions is the trend that is forcing the apparel sectors to look for a change in the manufacturing paradigm. As a result, the paradigm of lean manufacturing arose to increase industry competition by removing waste. Fedousi and Ahmed's (2009) study, cited in Maware and Adetunji (2019) believe that when compared to non-lean organisations, lean makes an organisation more responsive to market developments, delivers goods and services more quickly, and costs less to manufacture goods and services.

An entire organisation is influenced by lean production. It includes lean manufacturing, lean distribution, lean development, and lean buying. It is made up of a complicated concoction of concepts, such as collaborative supply chain management, flattened organisational structures, teamwork, waste elimination, and effective use of resources (Dhingra, Kumar and Singh 2019; Bubber, Jain and Babber 2023).

The truth is very different from the oversimplified notion that lean manufacturing and management are just a collection of techniques that can assist increase productivity, as many publications attest (Alefari, Almani and Salonitis 2020) on the subject have demonstrated up to this point. Lean affects the entire organisation, and in many cases, it's thought of as a new management philosophy. How successfully lean is implemented, a lot depends on the organisation's culture and willingness to accept change. High complexity and, frequently, ambiguity describe the frameworks that are now accessible. Given that stakeholders both inside and outside of the business may have competing interests, it should be clear that several considerations need to be taken into account before any lean implementation project is started.

Every person, according to Naicker (2017), from management down to shop floor workers, has a responsibility to understand the concept of lean management to guarantee that it is used as an effective tool to maximise profitability and business efficiency.

2.8.1 History of Lean Manufacturing

According to Bashar, Hasin and Adnan (2021); Schmitt, Wolf, Lennerfors and Okwir (2021), the Toyota Production System (TPS), is a management philosophy and set of practices developed by Toyota Motor Corporation in the mid-20th century. The roots of LM can be traced back to the post-Second World War era in Japan when Toyota faced significant challenges due to limited resources and a turbulent economic environment. Taiichi Ohno, a Toyota executive, is often credited as the key figure behind the development of the TPS. Ohno sought to eliminate waste, improve efficiency, and enhance productivity by creating a system that focused on continuous improvement and employee empowerment.

For many years, the only people who were aware of the entire system of lean concepts and practices were specialist manufacturers, a select group of university researchers, and quality experts. Most organisations were unaware of their full potential (Yamamoto, Milstead and Lloyd 2019).

Womack and Jones published their findings in the book "The Machine That Changed the World" in 1990, Womack and Jones (1996) cited in Touriki, Benkhati, Kamble and Belhadi (2021); Mathiyazhagan, Gnanavelbabu and Agarwal (2022) which introduced the concept of lean production to a broader audience. Since then, the principles and practices of LM

have been widely adopted by organisations around the world across various industries. Lean thinking (LT) has evolved beyond the manufacturing sector and has been applied to areas such as healthcare, services, and software development, among others. The principles and ideas of LM have become widely adopted by businesses in India and other nations in recent years with the aim of outperforming rival businesses (Gurumurthy, Nair and Vinodh 2021; Mathiyazhagan, Gnanavelbabu and Agarwal 2022).

2.8.2 Comparing Traditional Mass Manufacturing Methods with Lean Mass Production Methods

Lean production methods differ significantly from industrial mass manufacturing methods utilised in the 20th century (Yamamoto, Milstead and Lloyd 2019). Keeping one's attitude might be challenging because lean differs from conventional Western ways of thinking, organisational structures, and management approaches. Conventional methods of operation continue to have power and drive.

Latif, Vang and Sultana (2023) noted that during the era of mass production, industrial workers were not required to engage in interpersonal interactions. Instead, professionals were expected to remain detached from the production floor and concentrate solely on their designated responsibilities, which could potentially explain the acceptance of noisy production environments. The secluded workers put on their earplugs and blocked out the outside world. But, in a lean organisation, employees on the shop floor must communicate often to resolve production-related issues and implement process changes. Additionally, they require immediate access to their expert support and visibility into the state of the complete production system.

In this increasingly competitive economic environment, Tseng, Bui, Lim, Fujii and Mishra (2022), state that the apparel industry is also looking for strategies and tactics to reduce costs and boost output. The garment sector has issues related to price, delivery time, and service supplied, among others, at a time when other industries are under intense pressure from rivals. This industry has room for improvement, but certain adjustments are needed. The garment sector has many chances to develop and adopt lean concepts in this highly competitive environment.

Gurahoo and Salisbury (2018) describe agility as the ability to respond to fluctuations in demand, both in terms of product volume and variety, while lean manufacturing is more

suited for production scenarios involving low product variety and high volumes. Similarly, Abdelilah, El Korchi and Amine Balambo (2023) suggest that companies must prioritise either responsiveness (agility) or efficiency (leanness) based on the specific demands of their markets. They argue that agility is beneficial in markets requiring high levels of service and responsiveness, whereas leanness is more effective in environments with stable demand, supporting a low-cost production strategy.

The business strategy of a traditional mass production system is focused on producing as much of a product as possible based on projected sales and uses uniform product concepts and generic technological tools that produce a product of sub-optimal quality because there is a lack of understanding of what the customer requires and a reliance on the projections made into the level of products that need to be manufactured (Naicker 2017). Hardcopf, Liu and Shah (2021) assert that to successfully apply lean, businesses appear to need to balance competing organisational demands, such as the need to be flexible while yet maintaining some amount of control, to look both inside and externally, and to value both the individual employee and the customer. It is conceivable that managing these conflicting demands calls for a complicated corporate culture.

By revealing the waste that is occurring in a system, LM helps to increase business performance by employing basic tools and procedures to improve quality, delivery, people's involvement, and cost. LM is essential to succeed in the market by efficiently using the available resources and only producing what the customer needs or has requested (Debnath, Shakur, Bari and Karmaker 2023).

2.9 Critical Lean Manufacturing Success Factors

According to Bhadu, Kumar, Bhamu and Singh (2022), in both the manufacturing and service sectors, maximising customer expectation is sought after. To do this, organisations must perform well in terms of competence, adaptability, and productivity. However, the type of processing or work should be taken into consideration when choosing lean tools or processes. Focusing on management-related elements is necessary for the successful application of the lean concept in businesses. Measuring the leanness factors and indicators is also crucial for planning and decision-making. It is believed that the lack of an appropriate system to measure and monitor the levels of leanness before and after the deployment of

lean strategies is the primary cause of the failure of the majority of lean implementation tools and practices.

Lean management is a philosophy that prioritises reducing or eliminating waste in value chain operations. It encompasses all ideas, methodologies, and practices for modern business organisation and management. Finding solutions to enhance procedures, goods, or services that provide clients with added value requires first identifying the crucial points in the system and then analysing the factors that led to them. The implementation of the lean production concept in various businesses and organisations has demonstrated to the world the distinctions between waste and value-creating activities as well as how to incorporate quality into products from the inside out to create unique goods and services and satisfy consumer demands (Florescu and Barabas 2022).

The lean approach according to Indriati, Rasi, Setiaji and Hadiwinata (2023), encourages organisations to continuously recognise and distinguish between value-adding (VA) and non-value-adding (NVA) activities from the perspective of their customers during the processes of developing and delivering a product or service and to continuously eliminate those activities that are perceived as NVA. According to Reddy (2021) LM can be viewed as a business model that emphasises the development of an adaptable and effective production system that reduces waste and increases customer satisfaction.

Dave (2020) argues that many business models have been created since the 1980s to advise and demonstrate to managers how to run their companies. Though several of these models had excellent intellectual foundations, only a few provided a stable and long-lasting framework for implementation. Managers, consultants, and academics have been debating how to alter, enhance, or replace current corporate procedures and processes for many years. Most organisations lacked a toolkit of approaches for enhancing their operations and carrying out transformation processes successfully.

As a result, many businesses used Japan as an example of a developing manufacturing nation in the late 1980s. such as Toyota, Nissan, Sony, and Honda began to take the lead in the market not only in Japan but also in North America and Europe. Due to these companies' sudden and rapid growth, other market participants, consultants, and academics became interested in learning how these businesses created, implemented, and managed

their manufacturing systems. They were to be referred to as "lean production" procedures (Dave 2020).

The following presents a summary of the critical success factors discussed:

Customer Satisfaction: Bhadu *et al.* (2022) emphasise that maximising customer satisfaction is a primary goal for both the manufacturing and service sectors. Success in lean implementation is tied to performance in competence, adaptability, and productivity.

Appropriate Selection of Lean Tools: The success of lean manufacturing depends on selecting the appropriate tools and processes based on the type of work or processing. This suggests that understanding the specific context and needs of the business is critical for lean success.

Management-Related Factors: Successful lean implementation necessitates a focus on management-related elements, such as leadership commitment, strategic alignment, and resource allocation.

Measurement and Monitoring: Bhadu *et al.* (2022) also highlight the importance of measuring leanness factors and having an appropriate system to monitor these levels before and after implementing lean strategies. The lack of such a system is cited as a major reason for the failure of lean initiatives.

Elimination of Non-Value-Adding (NVA) Activities: According to Indriati *et al.* (2023), the continuous identification and elimination of non-value-adding activities are fundamental for achieving success in lean processes.

Adoption of Lean Principles as a Business Model: Reddy (2021) suggests that lean manufacturing should be viewed as an adaptable business model that focuses on waste reduction and customer satisfaction, thereby increasing the likelihood of achieving long-term success.

Learning from Successful Implementations: Dave (2020) points out that many businesses have modeled their success on the practices of leading Japanese companies like Toyota, Nissan, and Sony, which became benchmarks for lean production methods globally. This historical context implies that learning from successful lean implementations and adapting best practices can serve as a success factor.

2.10 Challenges to Lean Manufacturing

As per Schulze and Dallasega (2023), implementing lean manufacturing poses several challenges for organisations, requiring them to navigate through a complex set of obstacles. These challenges can significantly impact the success of lean implementation. Even though many businesses have implemented some form of lean initiative, (Sahoo and Yadav 2018a; Yadav, Jain, Mittal, Panwar and Sharma 2019) claim that most of these initiatives are only band-aid solutions that rarely result in the development of a genuine learning culture.

First and foremost, the cultural shift required to embrace lean principles is no small feat. Organisations must overcome deeply ingrained habits and beliefs to foster a new mindset centred around continuous improvement and employee empowerment. Convincing employees, who may be accustomed to hierarchical structures and traditional work approaches, to embrace change can be met with resistance and scepticism (Gupta and Chandna 2022).

According to Garza-Reyes, Kumar, Chaikittisilp and Tan (2018), due to their size, SMEs are restricted by a variety of important concerns, such as a lack of sufficient capital and leadership weaknesses. Leadership commitment is a critical challenge. The success of lean manufacturing heavily relies on the unwavering dedication and support of organisational leaders. Their active involvement, provision of necessary resources, and unwavering belief in the lean philosophy are essential for overcoming barriers and driving successful implementation.

LM is a systematic technique for locating and eliminating waste or operations that don't add value through ongoing innovation by streamlining the flow of the product and the information required to generate a high-quality product (Flores-Meza, Limaymanta-Perales, Eyzagirre-Munarriz, Raymundo-Ibañez and Perez 2020). However Cortez, Di Laura, Viacava, Raymundo and Dominguez (2020) argue, that these changes in production methods have also generated greater wastes, a common problem, which also leads to a greater number of defaults on meeting the demand. As a result, several efforts have been made to solve this issue, such as using emerging lean or Just-in-Time (JIT) philosophies with different approaches.

2.11 Implementing Lean Manufacturing

According to Kumar, Mohan and Mohanasundaram (2019) the production process for the clothing industry has a short life cycle and a number of sub-processes. The values in clothing production are created by the market's rapid shift in fashion and client emphasis. The production process for the clothing business exposes it to a variable supply of raw materials. Due to its inherent complexity, resource allocation is a key activity in every organisation that necessitates ongoing examination of both internal and external elements. Value stream mapping (VSM), line balance, task standardisation, and other lean techniques are used in lean manufacturing to reduce waste and increase efficiency. Combining several lean tools, such as 5S, line balancing, standardised work, and value stream mapping, improves both labour intensity and equipment adaptability in terms of production. Kumar, Mohan and Mohanasundaram (2019) go on to say, increases in labour force, equipment, and production techniques result from the effective application of the lean manufacturing tool in SMEs. Value stream mapping is a key performance indicator that evaluates how well a manufacturing process is working. Lean manufacturing boosts operational speed, decreases flow quality delay, and enhances delivery capabilities. While Poka-Yoke is one of the LM tools that can decrease waste by pool proofing, line balancing is a tool that increases productivity and improves the efficiency of the production process.

Any product's delivery time and ability to interact with customers more quickly will both be reduced by speeding up the sewing process. To incorporate the LM philosophy into the sewing process, businesses create a variety of projects (Ünal and Bilget 2021). Lean solutions benefit businesses, which improves society as a whole. Instils a positive attitude in all those engaged while fostering a lean workplace atmosphere that fosters the growth and creation of thinkers. People that are empowered will become more aware of sustainable development and become more interested in researching, adopting, and practising environmentally friendly ideas and behaviours. Using employees' abilities reduces one of the wastes that are thought of in a lean setting (Maia, Alves and Leão 2019).

Odeyinka and Nwoye (2019) claim that to minimise waste and implement improvements to production and other areas of need, lean transformation focuses on continuous improvement and uses tools and techniques including Kaizen, Six Sigma, value stream mapping, and the 5s (sort, straighten, shine, standardise, and maintain).

Organisations that have adopted lean management practices have seen an improvement in manufacturing performance in terms of lower prices, higher quality, and faster turnaround times. Following lean concepts reduces waste in the value stream, which enhances organisational operations. Moreover, lean processes help to attain a high level of quality, which helps SMEs operate successfully with small batch sizes and constrained timelines. Lean manufacturing has grown to be the dominant industrial paradigm (Reddy 2021).

The lean approach is a multifaceted idea that emphasises a variety of techniques for "doing more with less" and delivering more value to customers (Dieste, Panizzolo, Garza-Reyes and Anosike 2019). It is this strategy that integrates several management techniques such as just-in-time, quality control, work teams, cellular manufacturing, supplier management, etc. Lean production's basic tenet is that these techniques can combine to produce a streamlined, high-quality system that produces finished goods at a rate consistent with customer demand with little to no waste. Research on lean manufacturing shows that businesses create unique operational resources and capabilities through the application of bundles of lean approaches.

These authors El-Khalil (2022); Aripin, Nawani, Mahmud, Fauzi, Hussain and Lee (2023) demonstrate that when adjusting processes to increase efficiency and involving employees in efforts toward continuous improvement that demand specific competencies to execute and coordinate lean techniques, lean firms often try to reduce any waste and rework. Lean Production emphasises eliminating waste, focusing on value-adding activities, and strictly integrating humans into the manufacturing process (Krdžalić and Hodžić 2019).

According to Realyvásquez-Vargas, Arredondo-Soto, Carrillo-Gutiérrez and Ravelo (2018), there are seven categories of wastes in the manufacturing industry: overproduction, inventory, transport, movements, overprocessing, faults, and waiting time, in clothing manufacturing, waiting time refers to delays in various stages of production, from receiving materials to machine breakdowns and quality checks. It's crucial to minimise waiting time through efficient supply chain management, maintenance, and LMPs to enhance productivity and meet deadlines. Khan, Kaviani, J. Galli and Ishtiaq (2019) confer that the focus of the Kaizen improvement is the utilisation of value-added and non-value-added work activities, as well as the Muda acronym for the seven kinds of waste (overproduction, delay, transportation, processing, inventory, wasted motion, and defective products) and the 5S's

for workplace organisation. Nallusamy and Saravanan (2018) state the following elements must be present for LM to be successfully implemented: simultaneous use of at least five lean tools; a long-term perspective; continuous improvement; a shift in culture toward empowerment; and a complete execution. Lean implementation needs to be driven from the top of an organisation for it to succeed. Lean deployment is challenging, and management support is crucial to its success in lean manufacturing. A recent study by Bamisaye *et al.* (2023), determines that teamwork is the lean concept that is currently being used in the South-Western Nigerian clothing sector. Just-in-time, worker dedication, daily schedule, and product design have all seen an impact from the adoption of lean principles. The application of a few key lean concepts led to a notable improvement in the manufactured clothes' quality in the apparel industry. Unfortunately, one of the biggest obstacles in this industry has been a lack of knowledge on how to use lean concepts.

2.11.1 Kanban System

According to Xu and Chen (2018), Kanban, a LM method originating from Japan, can be applied effectively in the clothing industry to streamline production processes and optimise workflow. It helps manage material inventory, regulate production flow, and facilitate just-in-time manufacturing. Additionally, Kanban aids in quality control by flagging defects and areas needing rework. When implemented in clothing manufacturing, it results in smoother operations, reduced lead times, decreased inventory costs, and improved quality control, ultimately boosting efficiency and customer satisfaction. In Japanese, the signal cards are known as "kanban." JIT manufacturing's primary goals are to manage the production schedule, deliver products on time, and cut down on unnecessary time in all production processes. These accomplishments may lead to small lot sizes, schedule stability, improved product quality, quick setup times, and effective process design. Bozarth and Robert (2019) add that information like the product name, part code, card number, batch number, lot size, and due date is provided on the Kanban cards for certain work-in-process (WIP) containers or batches that the Kanban card tells when to refill items when they are taken out of a stocking location or used in a sub-assembly.

The pull principle is applied while using the Kanban cards. Employees of one process send cards to the workers of the one that comes before them to let them know that a certain material, product, or procedure is in demand. As a result, the entire production system becomes interconnected, and activities are started by the use of visual cues (Asgari 2019).

Hopp and Spearman 2004; cited in Naicker (2017) perceive that the term "pull" pertains to the manufacturing of goods based on the specific demands and supply needs of customers. In this approach, all the necessary materials for production are scheduled in alignment with the proportions needed to fulfil a product order. In contrast, "push" involves producing stock regardless of the actual customer demand. This indicates that there is a lack of necessity to closely manage the materials used and their coordination based on the required quantity.

2.11.2 Standardising of work

According to Chan and Tay (2018), It should be noted that standardisation is another important kaizen strategy since it helps to consolidate a new level of awareness when an improvement normally entails an issue that is solved.

One of the key benefits of standardisation in LM is eliminating unnecessary steps or movements in the production process. This ensures that workers follow a standardised sequence of tasks, eliminating redundant or non-value-added activities. By doing so, companies can reduce lead times, increase productivity, and minimise the risk of errors or defects (Mohan Prasad, Dhiyaneswari, Ridzwanul Jamaan, Mythreyan and Sutharsan 2020). Moreover, Palange and Dhatrak (2021) argues standardisation enables effective employee cross-training. When work processes are documented and standardised, it becomes easier to train new workers and ensure that they perform tasks correctly and efficiently. It also allows for greater flexibility within the workforce, as employees can be easily re-assigned to different tasks or stations when necessary, without compromising quality or productivity.

2.12 Lean Manufacturing Principles

Lean manufacturing is a philosophy that was developed in the 1990s and named after the Toyota Production System. To increase the entire value of the customer, the Toyota Production System is primarily focused on reducing seven wastes. Lean is a crucial tool that improves everything else by adding value to it. Lean is a technique that aids in finding and getting rid of waste. By reducing waste, it lowers costs and speeds up production while improving quality. Lean Manufacturing Principles can be effectively utilised in the clothing industry to improve efficiency and reduce waste. This involves understanding customer needs, streamlining production processes, minimising waiting times, and producing garments based on actual demand rather than forecasts. By continuously striving for

improvement and eliminating inefficiencies, clothing manufacturers can enhance product quality, reduce lead times, and deliver garments to customers more efficiently (Kumar, Soumya, Manjari, Aishvariya and Akalya 2017).

These tools include Total Productive Maintenance, Control Charts, Rank order clustering, Poka-yoke, Value Stream Mapping, Elimination of time batching, Single point scheduling, Mix model processing, 5S, SMED, Multiprocess Handling, Elimination of Time Batching, and Control Charts (Kumar *et al.* 2017).

Value as defined by the final customer serves as the foundation of lean thinking (LT). The right product or service must be offered to the customer at the appropriate time and the appropriate price (Peralta, Echeveste, Lermen, Marcon and Tortorella 2020). The inefficient wastes that bring no value excessive information or component movement, or transit; much mobility within the design inventory: storage costs are high while working capital is low; processing too much; utilising improper techniques; waiting; idleness; defects; poor product quality; overproduction; unproductive, excessive activity (Junior, Inácio, da Silva, Hassui and Barbosa 2022).

Arica-Hernandez, Llagas-Llontop and Khaburzaniya (2022b) affirm that one effective Lean Manufacturing (LM) tool for locating production stream waste is the Value Stream Mapping (VSM). In many different domains, the VSM approach is frequently applied. It is a method that relies on the visual representation of the production process. The approach is not flawless, especially when it comes to enhancing production procedures. The regulatory approach can increase a company's effectiveness. There is no way to assess the efficiency and optimise operations because every single industry and firm has unique characteristics.

Many businesses have successfully applied lean principles, such as waste reduction and team-based grouping, to enhance the performance of integrated operations and cut down on lead times (Yilmaz, Ozcelik and Yeni 2020). According to Davis, Companiwala, Muschard and Petrusch (2020), understanding what value is and what actions and resources are essential to produce that value is the first stage in the lean thinking process. Faisal and Singh (2019) considered that value stream included all aspects of a specific product, from conception to customer delivery, including both value-adding (VA) and non-value-adding (NVA). Kovács, Kő and Demeter (2020) reveal that the approach aims for a value stream

that is lean, dynamic, and managed by the customer, with short lead times and low inventories. It is frequently employed in industrial settings. Nevertheless, in traditional Value Stream Mapping, only the most basic of quality faults are addressed. The visualisation does not take into account inspection processes, their peculiarities, or the current quality control loops. VSM is a pen-and-paper tool that makes it easier to observe and comprehend how information and material flow when a product moves through the value stream (Sangwa and Sangwan 2023).

Al Qayoudhi (2022); Demir and Paksoy (2023) recognise some of the most popular lean tools including 5S, which focuses on effective workplace organisation and standardised work processes, cellular manufacturing, just-in-time manufacturing, kanban, total preventive maintenance, set-up time reduction, and total quality management.

2.13 Value Stream Mapping (VSM)

The key characteristics of lean production have been a more reasonable distribution of labour during the production process, continuous improvement, and an emphasis on value-adding activities by removing waste. The most crucial of these is realising the added value of each procedure. Value Stream Mapping (VSM) was first introduced in "Learning to See" by Mike Rother and John Shook as a useful tool for visualising this, concentrating on overall production productivity rather than individual cells (Huang, Kim, Sadri, Dowe and Dargusch 2019). VSM, a crucial aspect of lean manufacturing, can be utilised in the clothing industry to analyse and enhance the flow of materials and information throughout production. It involves identifying all production processes, creating visual maps to illustrate material and information flow, and analysing lead times to pinpoint areas for improvement. By identifying and eliminating waste, such as overproduction and waiting times, clothing manufacturers can streamline their processes, reduce lead times, and deliver higher-quality garments more efficiently. Continuous review and improvement of value stream maps ensure ongoing optimisation of production processes in alignment with customer demand. VSM is a graphic representation of the steps used to create a good or service using the functions of design, sourcing, manufacturing, and delivery. Any lean improvement must start with creating a value stream (Prakash and Mothilal 2018).

The authors Jayawardane, Musthaffa and Dias (2022); Biswas (2023) note the relevance of VSM for Sri Lanka's garment sector. According to the research, VSM can be used in the

mass-production apparel sector to achieve beneficial outcomes like a decrease in inventory waste and defects. Also, VSM assisted the example firm's managers in visualising the many wastes produced within the company and potential future methods of decreasing or eliminating them. Khan, Shaikh, Lakho and Mughal (2020) add, that VSM is widely used in the manufacturing sector to increase transparency and promote production process changes. The benefit of digitisation is that it makes real-time or nearly real-time factory monitoring possible. With the aid of monitoring technologies like VSM, decision-makers may effectively identify non-value-adding manufacturing floor processes. As per Lugert, Batz and Winkler (2018) VSM is a systematic method for the analysis and redesign of a value stream that takes into account both material and information flows.

According to Thulasi, Faieza, Azfanizam and Leman (2022), VSM is the process of visualising the flow of information and materials to create a future state map with improved techniques and functionality. Two flows make up the VSM. The first is the transfer of resources from the supplier to the client. Another is the customer-supplier communication flow. Process mapping with VSM is more advanced.

2.14 Elimination of waste

The clothing industry benefits greatly from the principle of waste elimination, a cornerstone of lean manufacturing. Ahmed and Chowdhury (2018) attest that the eight wastes in lean manufacturing are Transport, Inventory, Motion, Waiting, Overproduction, Overprocessing, Defects, and Skills. Eliminating these eight wastes from the factory floor will assist manufacturers in producing excellent goods with less waste, more efficiency, shorter lead times, and prompt delivery. Lean manufacturing techniques can help manufacturers in the sewing sector cut lead times by about 43%. Janasekaran, Vijayasree and Chong (2020) add that despite the abundance of knowledge and readily accessible lean resources, many SMEs struggle to remain "lean." Lean manufacturing aims to produce excellent products most effectively and economically possible while reducing waste in human labour and inventory in addition to being responsive to customer inquiries. This enables items to reach the market on time.

In lean manufacturing, waste is referred to as "muda." Muda, a word from the Japanese language meaning "wastefulness" or "futility," describes any procedure or activity that uses resources but does not improve the quality or utility of the good or service from the

consumer's perspective. A fundamental tenet of lean manufacturing is the identification and elimination of muda, which simplifies operations, lowers expenses, and boosts overall effectiveness (Mehta and Dave 2020). Manufacturing adaptability is crucial for agility and can be increased through effective lean implementation. It implies that the entire lead time is kept as short as feasible and that you build what the customer orders as soon as possible after receiving the order (Mohan Prasad *et al.* 2020). Jeffery (2004) cited in Mohan Prasad *et al.* (2020) recognises this as a waste whenever a product is waiting in a line somewhere. Hatif, Lee and Nawanir (2024) claim that to become a lean producer, one must adopt a mentality that prioritises moving the commodity quickly from input to output and creating a pull mechanism that cascades back through customer demand by quickly replacing what the subsequent process removes.

Overproduction waste is making more clothes than needed resulting in excess inventory and potential markdowns. Producing garments according to demand reduces this waste. As a result, there is an increase in excess inventory, which has various detrimental effects. Excess inventory requires storage, takes up valuable space, and wastes money that may be put to better use elsewhere. Moreover, it lengthens lead times, slowing down deliveries and making them less responsive to consumer needs. Items that are overproduced run the danger of going out of style before they are sold, which could result in losses. However, damaged or deteriorated extra inventory could lower the quality of the final product. Overproduction ultimately results in the waste of resources, the loss of opportunities, and a less effective production process. Lean manufacturing focuses on creating products and services in response to customer needs to reduce this waste (Bugvia, Hameeda, Jamila, Irfana, Murtazaa, Qaisera and Bilala 2021).

According to Reddy (2021) overproduction results in excess inventory in the form of work in progress and precludes prompt correction and improvement. The idea of waste through overproduction is harmful because it has an impact on the capacity of the floor space, the possibility of additional rejections in the system, wasteful resource use, and tied-up capital. Additionally, lowering excessive inventory levels reveals hidden inefficiencies that impede output, which has a detrimental financial impact on the manufacturing process.

2.14.1 Transportation waste

Any movement of people, information, products, or materials is considered a kind of excessive transportation waste (Santosa and Sugarindra 2018). Raaz and Aman (2020)

assert that transferring work from one location to another is an action that adds no value. Transporting stitched clothes from the sewing floor to the finishing department, moving bundles of garments along the line using a centre table or trolley, and moving cuttings from the cutting department to the sewing lines. Where transportation cannot be eliminated, consider ways to cut back on travel time. Transportation of bundles or individual parts can be mechanised in sewing lines by using an overhead rail.

2.14.2 Excess Inventory

Unneeded Inventory, Work in Process (WIP), and lack of equipment and workers lead to wasteful excess inventory or WIP. The following process is delayed by machines with variable cycle times between stations (Rahmanasari, Sutopo and Rohani 2021). According to Raaz and Aman (2020) the items in a factory's inventories are either being manufactured, are idle resources (materials), or are materials that are on hand. Moreover, excess inventory refers to keeping or producing more inventory than is needed for the subsequent operation. Fabric and trim departments, cutting racks, and finishing trolleys all have excess inventory. According to the lean concept, excess inventories are wastes for the factory. Money is inventory. You block your money and restrict your working space when inventory builds up in stores and on floors. Excess WIP is seen as extra inventory even on a sewing line.

Raaz and Aman (2020) argue that making or doing things that are not currently needed might be summed up as waste. Excess inventory results from overproduction. Overproduction is a problem in the cutting and sewing departments of clothing companies. For instance, if the daily demand for sewing production is 5000 pieces and the factory produces/cuts more than that amount (demand), the factory is creating more units of clothing than is required for the day (finishing). Unbalanced work in progress is caused by overproduction.

2.14.3 Waste of Waiting

According to the value stream mapping and waste assessment model, Rahmanasari, Sutopo and Rohani (2021), state that waiting time has the largest percentage of waste at 23%, followed by defects at 22%, and inventory at 18%. The waste types indicated as the most important causes of waste to arise during waiting time. The manufacturing line's shortage of machinery results in a disparity in processing times, which in turn increases the waiting time for the material to move on to the next step. Moreover, the time required for moving materials between workstations contributes to wasted waiting time.

Waiting as waste is present throughout all operations in garment production. Similar to how sewing workers wait for cuttings (instead of sewing), managers wait for final instructions, and quality approvals are granted. Merchandisers wait for permission from customers. Manufacturing workers who are idle while waiting for work or other reasons represent a wasteful use of resources. Other instances of this waste include the inability to source materials quickly enough, cutting delays caused by fabric approvals, and consumption permission delays (Raaz and Aman 2020).

2.14.4 Waste of motion

Raaz and Aman (2020) emphasise that excessive motions are expelled from the workstations where operators sew, press, finish, and pack clothing. Due to inadequate worker training in working procedures and habitual old working practices, excessive motion is observed at workstations. Operators may use excessive motion because of improper workstation arrangements in factories with engineering departments that design layouts in workstations.

According to Che Ani and Abdul Azid (2020) due to excessive motion, poorly designed manual assembly procedures can result in low productivity and production system inefficiency. An excessive amount of movement will result in a production bottleneck and production delays, boost inventory, promote waiting time wastage, and be unable to improve the production flow. To ensure a thorough understanding of the process requirements and to reduce motion waste, it is necessary to study and watch the manual assembly process step-by-step. The waste of motion that is impacting the productivity and efficiency of the production systems must then be identified by analysing each phase of the manual assembly process. To attain maximum manufacturing process flow efficiency, the manual assembly process stages must be revisited and redesigned after the waste of motion has been discovered. For the manual assembly process to need the fewest number of motions, some undesirable operations may be avoided or merged.

2.14.5 Over-processing of waste

The concept of over-processing waste, a core aspect of LM, is highly relevant to the clothing manufacturing industry. Adding unnecessary details or features to garments can inflate costs without adding value. Certain processes used in clothing manufacturing might not be necessary for the finished product's construction or appearance. For example: Finishing

multiple checks (inline checking, pre-final checking, and final checking) (Raaz and Aman 2020). Shah and Patel (2018) agree that in terms of product quality or features, it is mistakenly performing more processing labour than the consumer needs, such as polishing or adding finishing in some product regions that the customer won't notice. When excessively complicated answers are found to basic problems, over-processing can occur.

2.14.6 Waste of defects

The concept of waste from defects is significant in the clothing industry. Raaz and Aman (2020) continue, adding that making mistakes while manufacturing garments is a waste of time and resources. Defective clothing items that do not meet quality standards result in waste. Manufacturing flaws in clothing include shade variance, incorrect cutting, stitching flaws, etc. If there are any defective garments produced, the factory must fix them before passing them on to the customer. Repairs are expensive and time-consuming. Lean manufacturing facilities strive to make clothing accurately the first time. Defects lead to customer dissatisfaction, returns, and harm brand reputation (Tahiduzzaman, Rahman, Dey and Kapuria 2018) conclude that fixing defects through rework or discarding flawed garments adds extra expenses. By implementing quality control measures and continuous improvement strategies, clothing manufacturers can reduce defects, improve product quality, and enhance efficiency and sustainability.

According to Makhija, Wickramasinghe and Tiwari (2021) attaining optimal quality in the final product stands as the foremost necessity. Consumers consistently pursue enhanced products and inherently recognise the value within their purchases. Within the ever-changing landscape of demand, the imperative lies in delivering products and services with increased speed, cost-effectiveness, and superior quality. The lean methodology emerges as a pivotal factor in accomplishing this shared objective. Neglecting to pinpoint defects at their source and addressing flawed products leads to extensive losses across various dimensions. This not only translates to considerable devaluation but also profoundly damages the organisation's reputation. Consequently, to endure and flourish, a continual commitment to elevating quality remains indispensable.

The 5S method according to Alasbali and Almaktoom (2023) is used by the garment sector to eliminate waste and make the most of the factory production layout to facilitate work, clear waste, and maintain the space. This would reduce handling time, allow parts used in clothing

to be moved swiftly from one step to the next, and speed up the stitching and packing of the finished product.

Mohan Prasad *et al.* (2020) state that the 5S technique of lean management, which has its roots in Japan, is utilised extensively across many industries to increase effectiveness, productivity, and quality while lowering waste. The 5S technique emphasises setting up and keeping a tidy workplace, which lowers waste and defect rates. Five crucial steps in the process are denoted by the name "5S":

Sort (Seiri): In this process, the workspace is sorted to remove anything that is not necessary. The removal of unnecessary tools, supplies, and equipment leaves only those needed for the job at hand. De-cluttering the workspace makes it simpler to spot flaws and stop them from happening because of defective tools or materials. A core concept within organisation is stratification management. This entails categorising all items and data in a manner that allows for appropriate treatment. Classification enables decisions about the significance of items, determining what to keep and what to discard, and maintaining the minimum necessary quantity of each item to reduce unnecessary inventory. Essential data is then recorded in a database, and required items are stored in accessible locations for easy retrieval when needed. Stratification management effectively distinguishes between essential and non-essential items, ensuring that vital items are readily available for efficient use. To facilitate stratification management, it's crucial to assign clear and recognisable names to each item. This prevents confusion, as some items may have formal names while people commonly refer to them by different names (Kumar, Akila, Arun, Prabhu and Selvakumar 2022).

The second "S" in the 5-S methodology according to Pinedo, Valladolid and Padilla (2022); Das and Das (2023) is "seiton," referring to "set in place" or neatness. This step emphasises the principle of visually having designated spots for all items within the workspace and ensuring that they are consistently returned to those locations when not in use. Neatness pertains to the arrangement and organisation of the office or workplace layout. It entails determining where and how essential items are positioned. By establishing a well-defined layout, potential hindrances to the workflow become evident and can be eliminated. Decisions need to be made regarding whether storage locations should be centralised or decentralised. These decisions are guided by factors like how frequently items are used and

their intended function. Generally, stored items and tools should be placed where they are needed, easily visible, accessible, organised in the proper sequence for use, and should not obstruct workflow processes. An effective system for identification, labeling, and guiding work processes is essential, one that is comprehensible, consistent to follow, and easy to uphold. Paying particular attention to the cleanliness and organisation of notices and signs is crucial, as they serve as common communication tools and also reflect the company's image. It's vital to allocate appropriate locations for placing these signs. They should be positioned neatly at a convenient height, ensuring visibility without causing any obstructions. Additionally, there should be guidelines regarding the duration for which notices should remain displayed; they ought to be taken down when their relevance diminishes. This practice maintains the currency of information and keeps individuals aware of new updates. Notices should also possess suitable dimensions and be neatly typed, featuring clear headings for easy comprehension (Aaker and Moorman 2023).

Everything should have a place, and it should be simple to locate and use goods and tools as needed. The likelihood of mistakes caused by utilising incorrect materials or losing important tools is decreased by the effective organisation (Alasbali and Almaktoom 2023).

The third "S" in the 5-S methodology is "seiso," which translates to "shine" or cleanliness. In this phase add (Manzanares-Cañizares, Sánchez-Lite, Rosales-Prieto, Fuentes-Bargues and González-Gaya 2022; Ojha, Kumar and Singh 2023), the focus is on maintaining a clean workplace by removing all forms of dirt, dust, grease, and grime. The cleanliness of the environment is apparent to all. To uphold a positive impression of cleanliness, each individual should take personal responsibility for cleaning. Specific areas should be designated, with cleaning tasks assigned to personnel, leaving no regions undefined or overlooked. The process of discarding unnecessary items reveals space for inspections, resulting in a clear and uncluttered area. Outdated data should be eliminated to prevent confusion. Visual clarity is valuable for addressing issues, as it can unveil the underlying causes and facilitate addressing the root problems. This proactive approach helps preempt problems and avert their recurrence. Daily inspections, lubrication, and equipment cleaning constitute preventive maintenance that enhances machinery efficiency. Daily cleaning is essential, and inspections can be integrated to ensure consistent adherence. Cleaning should encompass even less noticeable areas, such as restrooms.

Therefore, routine cleaning not only enhances morale and safety but also makes it easier to spot defects. Frequent cleaning, however, enables faster identification and correction of issues, contributing to a more effective and efficient workplace (Alasbali and Almaktoom 2023).

The fourth "S" in the 5-S methodology is "seiketsu," which signifies "standardisation." In this phase, consistent working conditions are established to uphold the principles of sorting, setting items in place, and maintaining cleanliness. Standardisation ensures that tasks and procedures are executed uniformly, making them understandable to anyone. Visual management takes precedence as "seeing is believing." On-site, standardised conditions are achieved to expedite work processes. Standardisation also fosters transparency, ensuring that everyone comprehends procedures, knows precise item locations, and understands operational methods, leaving no areas of ambiguity. A deeper understanding of colleagues' activities enhances individual performance while enabling work to proceed seamlessly even in an employee's absence. Employees become more adept at identifying ways to enhance operations when they possess a comprehensive understanding of the company's overall functioning. Furthermore, adhering to standardised procedures simplifies the identification of inventory shortages or missing items, contributing to better office organisation (Kharub, Gupta, Rana and McDermott 2023).

To maintain order and cleanliness in the workplace involves developing visual management systems, checklists, and standard operating procedures. When operations are standardised, it is simpler to spot departures and flaws from the established norms, which accelerates the need for corrective action.

The fifth and final "S" in the 5-S methodology is "shitsuke," which translates to "discipline to sustain." In this phase, the goal is to establish a culture of consistently adhering to the correct procedures and perpetually repeating all the steps of the 5S process. Through maintaining all aspects of the 5S approach, numerous workplace issues can be pre-empted. It's crucial to highlight that organisations often falter in ingraining the principles of sustaining or upholding the implementation, resulting in a regression to the initial state or point of origin (da Silva 2023). Creating a culture of ongoing development and worker involvement is required for this. To guarantee that the 5S principles are established in the organisational culture, consistent audits, training, and support are required. The elimination of flaws and

waste can be made a continuous process with consistent effort (Alasbali and Almaktoom 2023).

2.14.7 Continuous Improvement

Lean manufacturing within the organisation can be considered as necessitating continuous improvement to succeed. This LM tool places a strong emphasis on and ensures the participation of all employees involved in the manufacturing process. It also ensures that everyone works together to improve the manufacturing process, which is continuously monitored to identify potential areas for improvement (Naicker 2017; Ciccarelli, Papetti, Cappelletti, Brunzini and Germani 2022).

According to Kapuria, Rahman and Haldar (2017) the majority of root causes are easily discernible through discussion with specialists, are easily represented by graphical diagrams, and can be improved continuously. Using kaizen is a crucial step in reducing sewing flaws. Kaizen, a term from the Japanese language, means to improve anything. The situation with regard to sewing defects is continuously improved using the kaizen technique. Similarly Naicker (2017) noted that continuous improvement can be used indefinitely to improve the processes involved in LM, so it is everyone's responsibility to make sure that these processes are constantly reviewed and improved to ensure that LM is a success within the organisation and that the main objective of continuous improvement is achieved.

2.14.8 Just-in-Time (JIT)

According to Shah and Patel (2018), the basis of LM is JIT. It's aligned to lean methodologies. Right part, right place, right time delivery is provided by JIT production. It is also known as the Toyota Production System (TPS) or JIT-production. Reduced response times for suppliers and customers are the main goals of the JIT methodology.

One of four crucial lean bundles for achieving lean production, analysed by (Iqbal, Huq and Bhutta 2018; Shah and Patel 2018), is JIT. Xu and Chen (2018); Manurung, Anizar and Ishak (2024) argue that the JIT manufacturing approach is extensively embraced and used in manufacturing. JIT manufacturing's primary goals are to manage production timelines, and product deliveries, and minimise any unnecessary time in production processes. These accomplishments may lead to small lot sizes, schedule stability, higher product quality, quick setup times, and effective process design. Because JIT manufacturing necessitates

handling activities in incredibly short time frames, any inconsistency may have a significant impact on production planning and scheduling.

Several researchers have also further added that by minimising buffer inventory through lot size reduction, pull production, shorter cycle time through the elimination of non-value-added operations, and the capacity to match master schedule timelines, JIT also helps to increase delivery reliability and efficiency (Iqbal, Huq and Bhutta 2018; Eggleston 2022; Singh, Gupta and Trehan 2022).

As per Xu and Chen (2018); Vinodh (2022) JIT manufacturing necessitates meticulous production planning and execution at all times, and there is minimal room for error in actual production. This necessitates a high standard of manufacturing operations, as well as a solid and realistic planning system, as the planner must be knowledgeable about all process capabilities, including changeover durations, changeover patterns, and the actual lead times of each product. Xu and Chen (2018); Khanuja and Jain (2023) argue that knowledge sharing and JIT production in timely inter-organisational communication is crucial since it can keep necessary information current whenever needed. If any changes to the lead time or other important manufacturing parameters are not promptly communicated to relevant parties (such as customers, managers, planners, workers, etc.) in other departments, there will not be enough time for them to adopt a mitigation plan, potentially delaying the delivery of the finished product.

Functional departments must work closely together to implement the JIT manufacturing approach. The introduction of JIT manufacturing could be derailed by destructive conflicts, and a lack of communication between departments can be a major contributing factor (Xu and Chen 2018; Masood, Lim, González, Roy and Khan 2022; Raja Santhi and Muthuswamy 2022).

2.14.9 Total Quality Management (TQM) and Zero Defects

Kebede Adem and Viridi (2021) believe that Total Quality Management (TQM) is an integrated management philosophy and set of practices that place a focus on long-term planning, increased employee involvement and teamwork, continuous improvement, meeting customer requirements, reducing rework, process redesign, competitive

benchmarking, team-based problem solving, constant results measurement, and closer ties with suppliers.

Despite how straight forward the TQM definition may seem, corporate culture and climate are necessary for its practical use. The procedure needs to be finished with time and patience. It takes time for the process to complete, and it can be a while before the benefits are apparent. According to some experts, quality management implementation outcomes can take up to ten years to completely manifest (Al-Zoubi, Qablan, Issa, Bataineh and Al Kaabi 2023). Anil and KP (2019) argue that many quality-oriented businesses throughout the world have adopted total quality management techniques to increase performance in terms of quality, productivity, customer satisfaction, and profitability.

Moreover, Sahoo and Yadav (2018b), Cavallone and Palumbo (2022), and Börnfelt (2023) affirm that to enhance their competencies employee participation in various business processes and training are essential for the successful implementation of TQM. Most scholars assume that, as people are frequently the important components in operations, human resources (people) are crucial to the application of quality management strategies. The recipient company should have strong leadership skills and be able to demonstrate good project management techniques to effectively execute the philosophy of quality management within SMEs. Senior management and culture are also regarded as important factors, and top management must comprehend them and offer sufficient assistance for TQM implementation in the company.

A growing focus on sustainable production necessitates that manufacturing firms consistently offer more sophisticated, higher-quality goods at reduced costs, all while controlling resource use (and particularly waste) throughout entire industrial ecosystems (Powell, Magnanini, Colledani and Myklebust 2022). Raabe, Myklebust and Eleftheriadis (2018); Powell *et al.* (2022) emphasised that putting quality first is the key to dominating the market, as higher quality results in lower costs (due to less rework, fewer errors, and fewer delays), as well as better use of tools and resources. To move closer to implementing an organisation's "first-time-right" quality plan, zero-defect manufacturing has emerged. Psarommatis, Vuichard and Kiritsis (2020) assert that although the concept of zero defects is not new, it nevertheless has the potential to fundamentally alter the manufacturing

mentality when production planning, quality management, and maintenance management aspects are all taken into account at the same time.

Product quality is a crucial factor for producers in the modern manufacturing environment. Poor product quality may result in many negative outcomes, such as direct financial losses, an increase in environmental impact, and resource waste. Therefore, quality management is crucial for manufacturing companies who wish to maintain or improve their operational and financial performance (Gobert, Reutzel, Petrich, Nassar and Phoha 2018; Azamfirei, Psarommatis and Lagrosen 2023). As per Juarez and Gregory (2021), poor quality can harm society by negatively impacting a company's reputation with its inferior goods and dissatisfied customers. Also, the sustainability of its production systems and processes must be given priority in the modern manufacturing sector. Consequently, Naicker (2017) argues that achieving zero defects within a manufacturing process based on lean principles depends on employee involvement in resolving faults and ensuring that there is little impact on the production process as a whole while parts are being fixed.

According to Saffar and Obeidat (2020); Durairatnam, Chong, Jusoh and Dharmaratne (2021) the success of TQM adoption depends on employee participation in quality improvement, which also helps the decision-making process. Durairatnam *et al.* (2021); Beraldin, Danese and Romano (2022) reiterate, that employee participation is essential for continuous improvement in a TQM setting. Workers who feel more involved in their jobs are more content with their jobs and are more committed to the organisations.

The TQM perspective on employee empowerment is defined by (Arunachalam and Palanichamy 2017; Arora and Gupta 2020; Georgiev and Ohtaki 2020) provides them with the resources and power to decide on issues relating to quality. Employee empowerment includes not only the transfer of power and authority from superiors to the employees but also the ability for employees to establish their own work-related goals, make decisions, and resolve issues within their scope of authority and responsibility.

2.14.10 Multifunctional Teams

The Toyota Sewing System was the name of the modular system that was initially used by Toyota in 1978 as a component of JIT. Monden (2011); cited in Steinberg (2021) made a U-turn on this system's design and asserted that its greatest benefit was that it allowed for

simple adjustment of the amount produced by altering the number of operators, (Kim and Kim 2020) add that the processes in a modular system are grouped into modules as opposed to being broken down into their smallest parts. On machines that are placed in a U-line, fewer multi-functional operators typically work there (Işık and Yildiz 2024). Each member of the group of operators is accountable for the quality of each product produced on the line. The system functions when a quality issue arises because the group's operators must coordinate their quality work, which results in a quality improvement. The pull-type production system, in which the job order comes from the last stage to prior processes, is the basis for how the modular system operates (Kesen and Sert 2020).

As teams frequently produce greater results than individuals working alone, forming multifunctional teams is a useful strategy against hierarchical structures. As responsibilities can be decentralised to the shop floor employees, levelling the organisation may result in more flexible production. Indirect tasks like maintenance and material handling are also included in the definition of teamwork. Indirect labour refers to employees who support the production process but are not directly involved in physically transforming the product, such as supervisors, cleaners, quality inspectors, and maintenance staff. Indirect labour costs can be decreased by assigning duties to the team working on the assembly line. One of the primary problems with lean manufacturing is the reduction of indirect labour (Haque, Jubair, Khan and Saif 2017).

Padilha and Gomes (2016) as well as Olszewski (2023) found that there is an incentive for creativity and innovation when team members are encouraged to come up with fresh ideas without risking repercussions. As a result, they have a sense of responsibility that is surrounded by a supportive environment that is built on the organisation's successful development and multifunctional teams. According to de Villiers (2022), when an employee feels secure and emotionally safe in the organisation, they can sometimes divert into a plan, which allows for the conception of new possibilities in a unique and creative approach. When the team members are comfortable, open discussion is achievable.

2.14.11 Cellular Manufacturing (CM)

Manufacturing with machinery will be quite challenging if the equipment is not arranged systematically. The parts have to travel farther, which extends the production time for each product. As a result, productivity declines, and the movement of parts is disrupted. For

industries that use batch-type production, the cellular manufacturing (CM) idea is suggested as a way to reduce this issue (Adinarayanan, Dinesh, Balaji and Umanath 2021).

Adinarayanan *et al.* (2021) further assert that machines are organised in a cellular arrangement according to the processing requirements for a set of related products that require related processing. These groups are called cells. Hence, a cellular layout is an equipment layout designed to support cellular manufacturing. Employees in cellular layouts receive cross-training to enable them to manage the cell's output and operate all of the equipment within. At times, production processes are structured like an assembly line where cells contribute to the final product's creation. In certain cases, a cell is established by allocating specific equipment for producing a group of related parts without physically relocating the machinery. This strategy allows the company to bypass the need for a complete layout overhaul. However, physical cells are more commonly employed in practice.

Bashar, Hasin and Adnan (2021) found that modern industrial operations are eager to learn about and put into practice the process used to build a versatile, distinctive, controllable, and effective cellular manufacturing system. Kaizen which is a term used for continuous improvement (CI), thrives when it is ingrained in organisational culture. Effective implementation produces a collaborative environment where everyone is aware of the main objectives and success criteria. Implementing new ideas is easily done in this kind of workplace and is generally successful. Each employee has the ability to contribute to this kind of innovative advancement.

The authors and Yu and Ye (2023) compared the production of conventional and lean-based methods in the clothing industry. Quick-Response Manufacturing (QRM), which is similar to a U-cell design, was used to organise teams as part of the lean methodology. The findings indicate that lean had both positive and negative effects on the psychosocial working environment. The lean teams, experienced fewer time constraints, more demands, and more disputes. On the plus side, there were job roles with more variety, breadth, and skill usage as well as higher cognitive demands. When considering the effects on mental health, it appears that the advantages and disadvantages are equal. Although these factors were excluded from the meticulous study design, the authors also claim that the QRM teams reported lower absenteeism and labour turnover.

Nallusamy and Saravanan (2018) cited in Adinarayanan *et al.* (2021) believe that in this environment, soft skills like leadership, teamwork, and conflict resolution can become equally as crucial as technical ones like mechanics, mathematics, machining, and inspection. As per Chu, Gao, Cheng, Wu, Chen, Shi and Qin (2019); Alimian, Ghezavati and Tavakkoli-Moghaddam (2020), a cellular manufacturing system (CMS) is made up of various manufacturing units, each of which performs several duties under actual production settings. Every CMS employee possesses one or more skill sets at various levels. Typical task durations are predetermined, therefore, considering workers' skill types and proficiency levels when assigning tasks is important to ensure that standard times are met, workloads are balanced, and productivity is maintained.

Due to variations in worker skill classes and levels in practice, task completion times may vary. By giving them varied responsibilities, managers can cross-train their staff. Workers who receive cross-training can improve their existing abilities and learn new ones. Workplaces with cross-trained employees have a greater opportunity to balance the workload and reduce stress than those with limited specialised employees, making them more adaptable. This in turn creates a sense of responsibility and an increased feeling of teamwork. Feedback on quality and efficiency is also generated from the teams, building continuous improvement with the cells and adjusting quality problems immediately instead of passing through the entire section (Chu *et al.* 2019; Yelles-Chaouche, Gurevsky, Brahim and Dolgui 2021).

2.14.12 Visual Management (VM)

Visual management (VM) in a workplace pertains to a setting where all employees involved in a manufacturing process recognise the importance of maintaining an orderly and well-managed physical workspace. This ensures that their tasks are performed in a safe and tidy environment, and employees collectively take responsibility for their organisation (Naicker 2017; Singh and Kumar 2021).

According to Pereira (2023) in the garment industry, visual presentations are employed to convey important information. For instance, operator and line productivity per hour are communicated through a production board situated at the endpoint of the line. Sewing tasks and stitch length details are presented using standard operating procedure format on an A4 whiteboard enclosed within a plastic sleeve. Quality inspection protocols are displayed on

the quality inspection table. Additionally, pertinent data and information are provided to ensure productive and efficient production processes.

According to (Makhija, Wickramasinghe and Tiwari 2021) in shop-floor management, both 5S and Visual Management (VM) are crucial elements for effective activity execution. The 5S philosophy emphasises organising the workplace, while VM facilitates efficient communication of information. These concepts are integral to the lean culture and are considered pillars of lean practices. In complex environments like apparel manufacturing, where human intervention is significant and automation is limited, the importance of 5S and VM is even more pronounced. They help manage multiple ongoing activities by transmitting essential information clearly and simply, enabling timely and informed decision-making. VM's strength lies in its ability to enhance productivity, efficiency, quality, and safety by communicating effectively without heavy reliance on verbal communication.

According to Hassan, Elgamal and Abdelaziz (2018), the core ideology behind "The Five Principles of the Visual Workplace" is to effectively organise and maintain workplace cleanliness. This approach not only improves productivity and quality but also optimises overall economic outcomes. These principles encompass five fundamental stages. Each stage is initiated by a word beginning with the letter "S," resulting in the term "5S."

The 5S methodology is integral to effective visual management, as it enhances workplace organisation and cleanliness, allowing potential issues to be easily identified. As discussed earlier in the **Waste of Defects** section (see pages 36-40), the five stages of 5S—**seiri** (sorting), **seiton** (setting in place), **seiso** (shining), **seiketsu** (standardising), and **shitsuke** (sustaining)—help uncover waste and defects that could otherwise go unnoticed.

Pharaon (2022); Shahriar, Parvez, Islam and Talapatra (2022); Kankkunen (2023) state that establishing the 5-S principles becomes ineffective without consistent adherence, as the situation will deteriorate if proper maintenance is neglected. Moving beyond this, discipline also encompasses the evaluation of existing practices and their modification to ensure their continued relevance. It also entails pursuing kaizen, the Japanese term for continuous improvement.

2.14.13 Single Minute Exchange of Die (SMED)

Makhija, Wickramasinghe and Tiwari (2021) found that in the realm of industrial manufacturing, the ability to swiftly establish rapid setup or quick style changeover proficiency holds a crucial role in effectively implementing lean, flexible, or small-scale manufacturing systems. This significance is amplified for apparel manufacturers, especially those specialising in high-fashion garments. These manufacturers confront the challenge of dealing with tighter lead times, reduced order quantities, and a diverse array of products. To not only survive but also thrive in the competitive manufacturing landscape, apparel manufacturers must promptly adapt to the ever-shifting dynamics of the fashion market. This necessitates enhancing their changeover performance.

While tools for rapid changeovers, such as rapid setup or Single Minute Exchange of Die (SMED), are extensively employed in industries like automobiles and other processing sectors, their application in the apparel industry has been limited to a select few manufacturers possessing specialised technical knowledge (Makhija, Wickramasinghe and Tiwari 2021).

Junior *et al.* (2022); Toki, Ahmed, Hossain, Alave, Faruk, Mia and Islam (2023) assert that limited research has explored the provision of training on lean tools, with none translating into practical application during setup procedures. Furthermore, only a meagre number of studies have monitored the progression of fabricated components during setup over a day. Recently, a recommendation has emerged for conducting a study that traces the SMED setup process using standardised work protocols during production, with a focus on verifying the attainment of setup time objectives. Furthermore, it is advised to record the setup duration and subsequently compute the overall equipment efficiency, subsequently comparing it against the predetermined target.

A recent study by Peças, Faustino, Lopes and Amaral (2022) focused on the application of lean techniques and principles within the context of Industry 4.0. Additionally, two distinct lean tools/methods were employed to underscore the distinction between a direct digital adaptation of a lean tool (Visual Management Boards) and a theoretical "novel" lean approach (SMED) facilitated by its digital integration. The examination carried out in this study illustrates the viability of refining and automating established Lean practices and procedures, thereby enhancing their efficiency and effectiveness. Furthermore, this process

imparts supplementary attributes and broader applicability to some of these tools, culminating not only in enhancement but also transformation.

The subsequent stages outline the procedure for reducing style changeover duration in garment manufacturing facilities, (Toki *et al.* 2023; Ali, Haque, Sarker, Kandasamy and Vlachos 2024; Fernandez-Diaz, Vera-Rojas and Quiroz-Flores 2024; Mohammad, Hamja and Hasle 2024).

1. Examination of the Current Process: The initial step entails a comprehensive review and analysis of the existing process. This assessment aids in the identification and segregation of non-value-added tasks within the process, subsequently pinpointing areas open to enhancement.

2. Establishment of Target Setup Time: Defining a specific target setup time is of paramount significance, achievable through the implementation of SMED techniques. This target serves as a performance objective for the team members. In the realm of garment manufacturing, this duration is contingent upon the segment of the supply chain and the product type. Within style changeovers, the time varies based on factors such as style diversity and the production facility's capacity. This is also influenced by the stages of SMED application. For instance, within a sewing floor, setup time may span from half a day to one and a half days. Initially, the target could be set at a higher threshold, such as 60% to 70%, especially during the inception of SMED. Subsequently, this target would progressively diminish as the scope for improvement decreases.

3. Documenting the components and minute components of batch setup within the current process: This stage involves the meticulous observation, mapping, and documentation of the existing batch setup procedure. The following aspects necessitate attention, outlining the sequence of tasks, both major and minor, with precise time allocations. Additionally, tracking the movements of operators and personnel aids in discerning essential and non-essential actions within the setup timeframe. The aim is to eradicate unnecessary movements.

4. Examination of Components and Micro Components: The elements and micro components associated with machine setup are subject to analysis to distinguish between external and internal elements. Internal elements correspond to those that result in a

manufacturing halt. On the other hand, external elements pertain to actions that can be executed externally without disrupting the machine's operation. Ultimately, the comprehensive compilation of both external and internal elements should be prepared, with clear assignments of responsibilities and the establishment of a timeline. The final stage involves putting the planned process into action and actively seeking ongoing enhancements.

2.14.14 Supplier Relationship Management in the framework of Lean Manufacturing

The notion of integrating suppliers and customers has become a pivotal element in enhancing competitiveness that extends beyond the confines of a company's internal operations (Vanichchinchai 2020; Islami 2023). It aligns with the principles of Supply Chain Management (SCM), which emphasise the flow of information and materials from suppliers further up the chain to customers down the chain (Vanichchinchai 2020; Emon, Khan and Siam 2024). Numerous research investigations have indicated that an effective supply chain should consist of a minimum of three participants: the company itself, its supplier, and its customer (Vanichchinchai 2020; Hoque 2022).

Achieving success in the implementation of contemporary management practices demands more than mere utilisation of tools and methodologies (Vanichchinchai 2020). Dorval, Jobin and Benomar (2019); Vanichchinchai (2020) conducted an extensive examination of the literature on lean culture and concluded that to ensure the effective implementation of lean principles, it's crucial to assess both organisational and cultural viewpoints. Similarly, Zhang and Cao (2018) noted that numerous supply chain resilience endeavors falter due to conflicting organisational cultures and the intricate nature of organisations, and conclude that the involvement of various stakeholders plays a crucial role in both initiating and maintaining the implementation of lean practices.

The apparel industry in Bangladesh serves as an illustration of a buyer-oriented sector, where dominant buyers, influenced by coercive-mediated power dynamics, often exert pressure on suppliers according to their demands (Anner 2020). Buyers make determinations about the sources (suppliers) from which they will procure goods and the specific terms and conditions under which these transactions will occur (Anner 2020 cited in; Hoque, Maalouf, Tanha, Islam, Alam and Sarker 2023). According to Rana, Hoque and

Allen (2019) garment suppliers are obligated to adhere to the demands of buyers to secure orders and establish ongoing business associations with them.

Almeida Marodin and Saurin (2015) cited in Hoque *et al.* (2023) found that when buyers require their suppliers to adopt a new manufacturing system, like a lean manufacturing system (LMS), suppliers are compelled to implement it within their facilities to ensure order placements. Nonetheless, implementing lean practices is not a straightforward process in the garment sector due to various complex challenges inherent to its specific context, (Hoque, Hasle and Maalouf 2020; cited in Hoque *et al.* 2023) including the involvement of various stakeholders plays a crucial role in both initiating and maintaining the implementation of lean practices.

The apparel sector is not classified as a high-tech field, consequently, not all lean techniques that are suitable for industries like automotive and other high-tech domains might be relevant to the garment industry. Therefore, the careful selection of appropriate lean tools becomes pivotal for achieving success within the garment industry. Typically, the garment sector employs a hierarchical approach, with upper management adopting an authoritative leadership approach. Consequently, the active engagement of top management is indispensable when suppliers aim to enhance their long-term production capacities through the utilisation of lean tools (Kumar, Antony and Douglas 2009; cited in Hoque *et al.* 2023).

Additionally, the dedication of suppliers holds a pivotal significance in the triumph of implementing lean tools, as highlighted by (Kumar, Antony and Douglas 2009; Losonci, Demeter and Jenei 2011; cited in Hoque *et al.* 2023). Moreover, the engagement and active participation of employees and workers in lean endeavors are imperative to guarantee enduring production capacities. Should garment suppliers aspire to elevate production capabilities, it becomes essential for them to instil a culture of learning and innovation within their facilities, as emphasised by (Hoque *et al.* 2023). Furthermore, suppliers should furnish appropriate incentives to their workforce, fostering motivation for the adoption and perpetuation of lean tools (Kumar, Antony and Douglas 2009; Dahlggaard, Pettersen and Dahlggaard-Park 2011; Losonci, Demeter and Jenei 2011; cited in Hoque *et al.* 2023). Moreover, garment suppliers should establish a benchmark as a target to strive for in the final outcome (Hoque *et al.* 2023).

2.14.15 Customer Relationship Management

In the contemporary environment, businesses function within a swiftly evolving realm of shifting customer demands and escalating international rivalry. Companies must possess the capability to manufacture products of exceptional quality, marked by significant variability, while ensuring swift and dependable delivery schedules, all at a competitive price point. As a result, a novel strategic objective has emerged for enterprises: one that prioritises rapid responsiveness, adaptability, superior quality, and cost minimisation. Lean production methodologies can serve as a valuable aid in steering businesses towards these very aspirations (Järvenpää and Lanz 2020).

At this juncture, businesses opt for lean production as a means to decrease manufacturing expenses and enhance their capacity to adapt to market fluctuations. As a result, the concept of lean offers numerous advantages to businesses. Several of these advantages encompass accelerated operational execution, heightened customer contentment, diminished inventory quantities and setup durations, enhanced comprehension of processes, financial economies, decreased need for rework, and shortened lead times (Gelmez, Özceylan, Mete and Durmuşoğlu 2020).

Huo, Gu and Wang (2019); Anwar, Jamil, Idrees, Atif and Ali (2023) characterises lean manufacturing as a "business strategy and methodology aimed at enhancing company performance in terms of customer satisfaction and financial outcomes." Extensive evidence supports the significant influence of lean manufacturing on both operational processes and managerial aspects of enterprises.

In today's business environment, companies must navigate a swiftly evolving landscape of shifting customer demands and heightened global competitiveness. To remain competitive, enterprises need to manufacture products that are not only of top-notch quality but also adaptable to diverse requirements, ensuring swift and dependable delivery at a competitive price point. Consequently, this has emerged as a fresh strategic objective for businesses, involving the need for rapid adaptability, superior quality, and cost minimisation. Lean production methodologies offer a valuable means for companies to progress in alignment with these critical goals (Järvenpää and Lanz 2020) (cited in Gelmez *et al.* 2020).

2.15 Theoretical Framework

2.15.1 Lean Manufacturing Theory:

Lean Manufacturing Theory (LMT) centres around minimising waste while maximising value creation. Given that the study examines how LMPs contribute to operational efficiency, cost reduction, and quality improvement, this theory serves as a foundational framework. It covers critical concepts such as value stream mapping, Just-in-Time (JIT) production, and continuous improvement, all of which are extensively discussed in the study.

According to Rashid, Shah, Ain, Khan and Adamjee (2024) LMT focuses on minimising waste and maximising value from the customer's perspective. Value-adding activities are those that the customer perceives as important and is willing to pay for. In a manufacturing setting, this could involve transforming raw materials into final products. However, LM also recognises that not all necessary activities add direct value to the product. Some processes, while essential in the current operational setup, do not enhance the product from the customer's point of view. These non-value-adding activities (such as unnecessary transportation of components or inefficient unloading procedures) should be reduced or eliminated. Improvements can be made by redesigning the production line or coordinating supplier deliveries more effectively.

A core principle of lean is identifying and removing time-wasting activities that do not contribute to the final product's value. Examples include long wait times, overproduction, and inefficient inventory management. Such activities are considered waste and must be prioritized for elimination to streamline the manufacturing process and increase efficiency. For lean to be effective, it is essential that all components of the supply chain are coordinated. If only one part of the supply chain adopts lean practices while others do not, the overall benefits will be limited. Therefore, a holistic approach is necessary to ensure that all participants in the value stream contribute to the lean transformation (Rashid *et al.* 2024).

2.15.2 Total Quality Management (TQM):

Since the study frequently mentions quality improvement as a key outcome of lean adoption, the TQM framework is also relevant. TQM emphasizes a company-wide approach to maintaining and improving quality, which aligns with the study's aim of evaluating lean implementation outcomes in the context of the apparel industry. TQM's focus on customer satisfaction, continuous improvement, and employee involvement are consistent with the study's findings on lean success factors.

The relevance of the TQM framework is underscored by the study's emphasis on quality improvement as a key outcome of lean manufacturing adoption. TQM adopts a comprehensive approach that integrates quality management principles throughout all levels and departments of an organisation. Its primary focus on customer satisfaction aligns with lean's objective of maximizing value for customers by eliminating waste and optimising processes (Berhe, Gebremichael and Beyene 2024).

Berhe, Gebremichael and Beyene (2024) argue that a core tenet of TQM is continuous improvement, which resonates with the lean philosophy through practices such as Kaizen. Both frameworks advocate for sustained efforts to enhance product quality and operational efficiency. In this study, the relationship between these frameworks is evident, as lean principles foster quality enhancements within the apparel industry by refining production processes and minimising inefficiencies.

As emphasised by Berhe, Gebremichael and Beyene (2024), TQM also stresses employee involvement, another critical factor contributing to the success of lean implementations. By engaging employees in problem-solving and decision-making, organisations can ensure that quality initiatives are embraced throughout the company. This is consistent with the study's findings that highlight the significance of employee participation in lean practices for driving quality improvement.

Moreover, TQM's focus on managing quality across the entire system guarantees that all operational aspects, such as procurement, production, and delivery, are centered on upholding high standards. This comprehensive strategy complements lean's emphasis on improving both operational processes and quality outcomes in apparel manufacturing, making TQM an essential theoretical framework for analysing the wider effects of lean practices within the study. By merging TQM and lean principles, the apparel industry can enhance both its operational efficiency and product quality, thereby strengthening its competitive edge in the market. The integration of these theories highlights the necessity of a unified strategy that recognises quality improvement as a collective responsibility across the organisation (Berhe, Gebremichael and Beyene 2024).

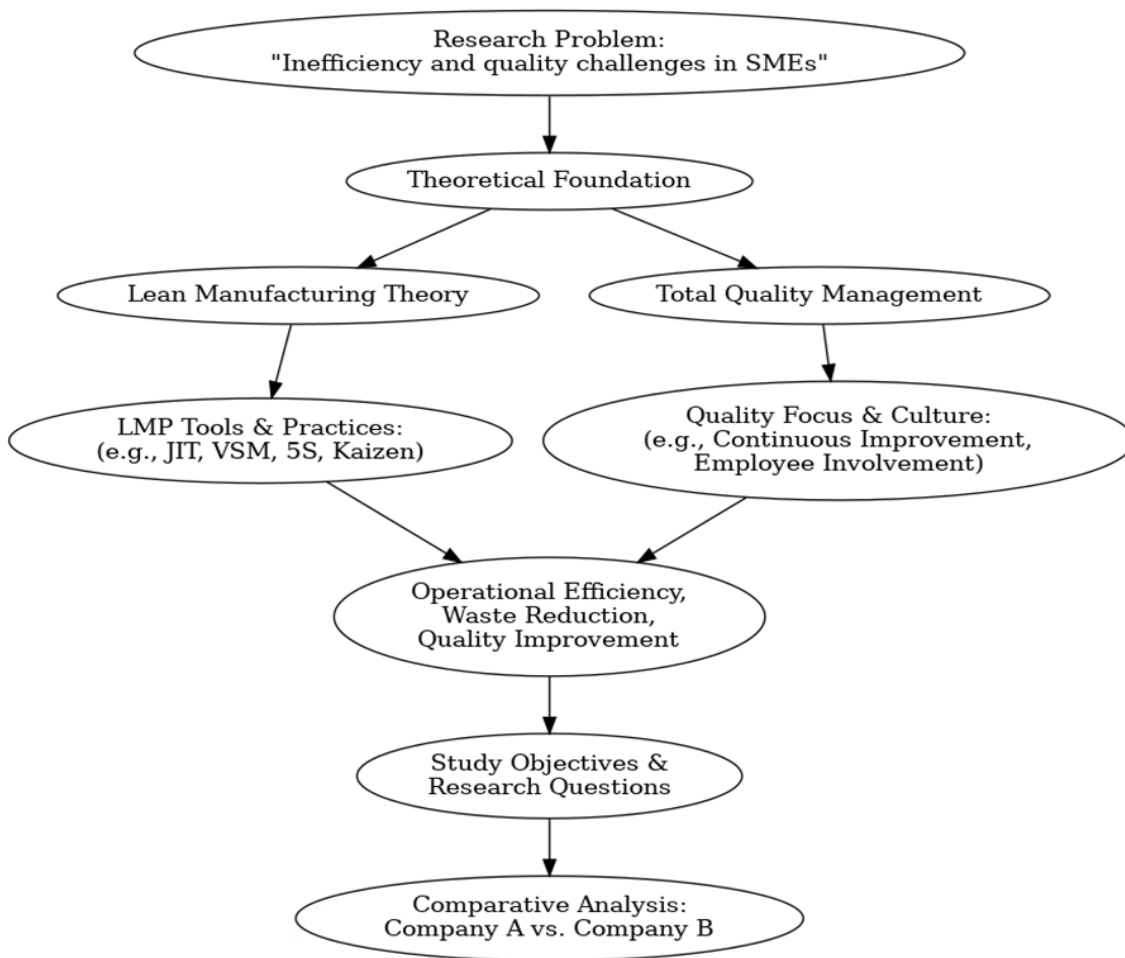


Figure 2.1: Theoretical Framework

Adapted from Lean Manufacturing Theory (Rashid *et al.* 2024) and Total Quality Management principles (Berhe, Gebremichael and Beyene 2024).

2.15.3 Application:

The study integrates the LM and TQM frameworks to provide a holistic perspective on operational improvement within apparel SMEs. From the TQM viewpoint, the implementation of LMPs is examined in terms of its impact on overall quality enhancement. Simultaneously, the lean perspective highlights how these principles contribute to waste reduction, process optimisation, and efficiency gains. This dual framework would provide a more comprehensive understanding of how lean principles can be effectively adopted and sustained in the apparel manufacturing sector. By aligning quality improvement with waste minimisation, the study offers practical insights into developing sustainable lean strategies tailored for resource-constrained SME environments.

2.16 Conclusion

In the ever-evolving view of manufacturing and production, the principles of LM have emerged as a beacon of efficiency and excellence, particularly renowned and embraced by large companies. However, the translation of these principles into practice SMEs has been marked by varying degrees of adoption and implementation (Yadav *et al.* 2019). This disparity highlights a crucial gap that this study aims to bridge, shedding light on the often underexplored perspective of LM adoption within SMEs and advocating for its potential to revolutionise the apparel industry in KZN, South Africa.

The literature review undertaken has meticulously traced the historical trajectory of LM from its origins as a philosophy of waste reduction to its embodiment as a set of principles that have revolutionised how businesses approach operational processes. While large companies have prominently embraced these principles, the SME sector has not fully capitalised on their benefits. This divergence may stem from resource constraints, a perceived misalignment with the scale of operations, or limited exposure to the transformative power of LM. The study carries forward the spirit of LM by exploring its practical application within the apparel industry, focusing on both large organisations that have embraced these principles and SMEs that stand to gain immensely from their adoption. Through a comparative analysis of the effectiveness of LMPs in both contexts, we seek to illuminate the pathways to operational excellence and sustainability. By showcasing the successes and challenges faced by larger apparel companies that aspire to inspire SMEs to embark on a journey of LM implementation, backed by a clear understanding of the potential benefits and pitfalls. At the heart of this endeavor lies the aim to bolster the sustainability of SMEs. Fernando and Ratnayake (2021) argue that while the challenges of implementing LM may seem formidable, the rewards encompassing enhanced efficiency, minimised waste, improved product quality, and a responsive approach to customer demands hold the potential to reshape the competitive aspect.

In the chapters that follow, research methodology will serve as the conduit through which the intricacies of LM will be explored within the context of the apparel industry. By illuminating the experiences, strategies, and outcomes of large organisations and SMEs alike, and aim to contribute not only to the academic understanding of LM but also to its practical adoption, fostering a culture of continuous improvement, efficiency, and sustainability that transcends the size of the enterprise.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

Chapter two discussed the literature review pertaining to the effectiveness of LM and its challenges. The current chapter (three) focuses on the research paradigm which serves as a guide on the different research methods that were used in the study, the research design, population, sampling, research instrument, data collection, data analysis, reliability and validity and ethical aspects that are drawn to the study.

3.2 Research Methodology

Research methodology can be viewed as a means of systemically resolving or responding to the research challenge. Consequently, it can be viewed as the process of learning how scientific research is conducted (Pandey and Pandey 2021). According to Mukherjee (2019) research methodology is crucial for the efficient and maximal information-yielding navigation of the many study components.

3.3 Methodological Approaches

There are three types of methodological approaches, namely quantitative research, which according to Verma, Verma and Abhishek (2024) is an investigation of a known issue based on the testing of a theory, assessed in terms of numbers, and analysed using statistical methods. Determining if a theory's prediction generalisation holds is the aim of such procedures.

The second approach is the research built on a qualitative method of inquiry, which aims to explore a social or human issue from various angles. A detailed and comprehensive image of the phenomenon of interest is developed through the process of qualitative research, which is carried out in a natural setting (Gupta and Gupta 2022).

The last approach is the mixed method approach. This is the approach that integrates quantitative and qualitative data, uses different designs that may incorporate philosophical presumptions and theoretical frameworks, and combines the two types of data (Creswell and Poth 2016). Additionally, qualitative research gives academics the chance to develop

fresh viewpoints on how to understand a phenomenon from the perspective of an insider while recognising the importance of the local context.

A quantitative approach was deemed most appropriate for this research in terms of utilising the strengths to conduct a survey. A quantitative approach was chosen because it provides a more comprehensive understanding of the research problem approach. Within this study, a quantitative method approach enabled a more comprehensive understanding of the effectiveness of LMPs by combining the numerical, objective data from quantitative methods (e.g., surveys, performance metrics). This helps capture the experiences of managers and employees in different-sized companies within the apparel industry, offering a richer and more holistic view of LMP implementation and outcomes. This is to also test the theory by analysing the data in terms of numbers (quantitative aspect) and ensuring the reliability and validity of the study. In organisational settings like Company A and B Clothing Manufacturers, quantitative data may offer a more subtle understanding of employee experiences and organisational dynamics.

The questionnaire used as a data collection instrument incorporated quantitative components. A more detailed explanation of the research methodology used in this study is discussed below.

3.3.1 Quantitative (Positivism)

A quantitative approach was deemed the most appropriate for this study, primarily due to its ability to systematically measure and analyse numerical data to assess the effectiveness of LMPs. This method aligns with the study's objective to objectively evaluate and compare lean implementation in small and medium-sized apparel manufacturers. Quantitative research allows for statistical analysis, helping to establish patterns and correlations between lean practices and organisational performance. Unlike qualitative methods, which explore deeper individual perceptions and lived experiences, quantitative methods provide measurable and generalisable insights. Although qualitative approaches are valuable for exploring complex human experiences, this study sought to test existing theories using empirical data, thereby aligning with the positivist paradigm.

Mixed methods were considered, as noted by McKim (2017); Creswell (2019); Stoecker and Avila (2021), for their holistic value; however, a purely quantitative design was selected

to maintain clarity, focus, and analytical rigour in this context. Data was collected using a structured questionnaire designed to align with the study's research objectives. The instrument consisted of close-ended questions primarily based on a five-point Likert scale, capturing respondents' perceptions and experiences regarding the implementation of lean tools such as 5S, JIT, and VSM. The questionnaire was divided into sections covering demographic details, knowledge and training in LMPs, the degree of implementation, and perceived benefits and challenges.

Reliability was supported by pre-testing the questionnaire with a small group of participants (10) from a similar background to refine ambiguous items. Validity was enhanced through alignment with established literature and expert consultation during the questionnaire design phase. Although quantitative research traditionally focuses on objective measurement, in organisational contexts such as Company A and Company B, it can also capture aggregated employee perspectives, offering valuable insights into implementation trends and operational dynamics.

While quantitative research primarily focuses on objective measurement, it also incorporates collective employee perceptions as valid data (Kuknor and Bhattacharya 2021). Accordingly, this study utilised a quantitative approach to systematically capture employee insights on LM implementation.

3.4 Research design

This study employs a descriptive research design, as these approaches are best suited to achieving the study's objectives of comparing the effectiveness of LM in SMEs in the apparel industry. A brief explanation of the selected research design is provided below to highlight its relevance to the research.

3.4.1 Descriptive research design

Descriptive studies have the primary goal of providing a comprehensive account of the characteristics of individuals, events, or situations. This research type, whether quantitative or qualitative, seeks to gather data that describes the subject under investigation. Quantitative descriptive research involves numerical data and statistical analysis, while qualitative descriptive research focuses on non-numeric information, such as narratives or observations. These studies are valuable for establishing a foundational understanding of a

topic, identifying patterns, and generating hypotheses for subsequent research (Patel and Patel 2019). The choice of a descriptive research method is driven by the study's objective to comprehensively depict and analyse the effectiveness of LMPs within SMEs. Descriptive research is particularly well-suited for this investigation as it aligns to portray the characteristics of the study's variables, in this case, the application of lean principles. The method serves as a valuable tool for establishing a baseline understanding, offering a detailed account of the current state of implementation in both small and medium enterprises. By opting for a descriptive approach, the research aims to provide a solid foundation for subsequent analysis and insights into the level of effectiveness in the utilisation of LMPs among SMEs.

The research will adopt a quantitative approach to conduct a survey, strategically leveraging the strengths of this method. Data collection will be facilitated through the use of a survey questionnaire, which serves as a key component of the research design. This questionnaire provides a systematic and structured means of collecting data aligned with the study's objectives. By employing a quantitative approach, the survey enables a clear, objective analysis of the data, offering a comprehensive understanding of the research subject within the chosen context.

3.4.2 Pretest

A pretest is a preliminary trial of the primary data collection instrument, aimed at identifying potential issues with the tool before it is administered in the main study. In this research, the pretest focused on evaluating the validity and clarity of the questionnaire. According to Srinivasan, Lohith, Srinivasan and Lohith (2017) a pretest ensures the questionnaire is responsive and applicable for the intended participants. Sekaran and Bougie (2016); Buschle, Reiter and Bethmann (2022), stress the importance of pretesting any survey instrument, whether it involves structured interviews or self-administered questionnaires. The pretest helps determine if the questions are clearly understood, appropriately worded, and free from ambiguity.

In this study, the questionnaire was pretested with a small, representative sample of individuals who were not included in the final study. Feedback from the pretest allowed for refinement of the instrument, ensuring that questions were interpreted accurately and that potential biases were minimised before full distribution.

3.4.3 Population

In research, the term population refers to a defined group of individuals or entities that share certain characteristics relevant to the study. For this research on LM within the apparel industry, the population consists of employees who work in manufacturing settings and are involved with lean practices. This includes managers, supervisors, quality control personnel, and other staff responsible for or affected by lean implementation. According to Pandey and Pandey (2021), the target population, sometimes referred to as the "universe," encompasses all individuals within a real or hypothetical group that the researcher aims to generalise their findings. Similarly, Berndt (2020) explains that the research population refers to the entire group of people or occurrences that exhibit behaviours or possess attributes of interest to the researcher.

In this study, the target population includes employees from Company A and Company B in the KwaZulu-Natal apparel industry, particularly those who engage with or influence LM processes. By focusing on this group, the research can gather insights into how lean practices are adopted and sustained within different organisational roles.

3.4.3.1 Population of the study

The target population for this study comprised employees from two selected SMEs. The study focused on individuals holding key positions within the organisations. The identified categories for inclusion in the study were as follows:

Table 3.1 Target population

Managers	13
Section Managers	7
Supervisors	40
Training Managers	1
Quality Managers	2
Quality Control Inspectors	33
Team Leaders	52
Total population	148

The selection of individuals from these specific ranks is essential to gather a comprehensive understanding of LM implementation and its impact on operational effectiveness within the companies. Each group contributes unique insights based on their roles and responsibilities:

- **Managers (13):** As key decision-makers, managers possess a broad perspective on the company's strategic direction and can offer valuable input on how lean principles are incorporated into higher-level operations and long-term planning.
- **Section Managers (7):** Overseeing specific areas of production, section managers provide critical insights into how lean practices influence different departments. Their feedback highlights the operational challenges and successes associated with lean implementation at the departmental level.
- **Supervisors (40):** Directly involved in managing day-to-day operations, supervisors play a pivotal role in applying lean practices on the shop floor. Their involvement is crucial for identifying practical barriers to full implementation and assessing lean's impact on workforce dynamics.
- **Training Managers (1):** Responsible for equipping employees with the skills needed for effective lean implementation, training managers' input is key to evaluating the alignment between training programs and lean objectives.
- **Quality Managers (2):** Quality managers ensure product standards are maintained, making their insights vital for understanding how lean principles affect quality control processes and continuous improvement initiatives.
- **Quality Control Inspectors (33):** Engaged in monitoring product quality on the production line, quality control inspectors provide practical perspectives on how lean practices reduce defects and enhance overall quality assurance.
- **Team Leaders (52):** As frontline leaders, team leaders are instrumental in enforcing lean practices among workers. They offer a practical understanding of how lean principles are applied daily and how the workforce adheres to them.

The selection of these categories allows the study to capture a wide-ranging perspective on the effectiveness of LM, from strategic planning and quality management to its application in everyday operations.

3.4.4 Sample

According to (Pandey and Pandey 2021), sampling involves the selection of a specified number of individuals from a defined population to represent that population. Although rigorous, Berndt (2020) claims that sampling techniques are distinct from those utilised in

quantitative research. Only non-probability sampling techniques are utilised, and none of the qualitative samples are randomly selected. Participants in the study are interviewed by the qualitative researcher to better understand the studied phenomenon. As potential data sources, they might watch occurrences or surroundings, as well as examine documents, artefacts, photographs, and/or drawings (Berndt 2020). Through the random selection of respondents, survey methodologies enable researchers to study broad patterns of experience across groups and allow for relative generalisability (Firchow and Mac Ginty 2020).

3.4.4.1 Sampling Method

Non-probability sampling is a sampling method where the researcher gathers data from a specific target population rather than selecting participants randomly. This technique includes various types, such as purposive sampling, convenience sampling, and snowball sampling. Purposive sampling involves the researcher choosing participants based on their judgment about who is likely to provide relevant information (Stratton 2021). According to Rahman (2023) purposive or judgmental sampling is a method employed by researchers to select individuals with particular traits that are relevant to the study. Participants in this sampling approach can offer valuable insights related to the research question, even if the sample does not reflect the entire population. This type of sampling is particularly useful when there are only a small number of individuals in a larger community who have the desired characteristics identified by the researcher.

This study used purposive sampling to select respondents from Company A and Company B based on their size (small and medium) and involvement with LMPs. The total population included 148 employees, such as managers, supervisors, team leaders, and quality and training personnel, all with practical experience in lean practices.

A total of 139 questionnaires were distributed (38 to Company A and 101 to Company B), with 100 valid responses received (16 from Company A and 84 from Company B), yielding a response rate of approximately 72%, which is acceptable for organisational research (Saunders, Lewis and Thornhill 2023).

The sample size was appropriate because purposive sampling targeted participants directly involved in lean activities, ensuring relevant and representative data. Additionally, including

employees from various operational levels strengthened the reliability and validity of the comparative analysis between small and medium-sized apparel companies.

3.4.4.2 Sample selection method

The technique utilised in this study is a non-probability sampling method, specifically the judgmental sampling method (purposive sampling). In this approach, the researcher relies on their own judgment regarding participant selection while considering the study's objectives. It involves selecting cases based on an expert's judgment or a specific aim. Purposive sampling is not only cost-effective and accessible but also allows the researcher to focus on subjects that are relevant to the study's design. Although this method offers convenience, its effectiveness is significant as it yields valuable information that may not be available through other sampling options (Showkat and Parveen 2017; cited in Govender 2023). The judgmental or purposive sampling method was employed in this study because it was deemed the most suitable for selecting all textual components that aid in addressing the research questions, achieving the study's objectives, and ensuring the collection of accurate and reliable data (Govender 2023).

Sekaran and Bougie (2013); cited in Govender (2023), suggest that sample sizes less than 500 and greater than 30 are suitable for the majority of studies. The study involved a targeted sample of middle management participants from two prominent South African apparel manufacturers. The sample selection methods employed in this study varied based on the category size within the population.

All Respondents: In categories with a smaller number of individuals (Managers, Section Managers, Training Managers, Quality Managers), all eligible individuals were included in the study to ensure a comprehensive representation.

For categories with a larger number of individuals (Supervisors, Quality Control Inspectors, Team Leaders), a non-probability sampling method was applied. The sample comprised 100 respondents, with 16 representing Company A, a small and medium-sized enterprise (SME), and 84 from Company B, a medium size manufacturer. The study focused on middle management participants from two apparel manufacturers in KwaZulu-Natal, South Africa, aimed at conducting a comparative analysis of lean manufacturing practices. A total of 139

questionnaires were distributed, 38 to Company A, a small business, and 101 to Company B, a medium-sized enterprise. The targeted sample size was 139, however, after data cleaning, 100 responses were used to generate the primary data.

Inclusion Criteria:

- Participants were middle managers actively engaged in production processes at Company A and Company B.
- Both companies were located in KwaZulu-Natal and had at least one year of experience in the apparel industry.

Exclusion Criteria:

- Employees who do not hold any of the positions listed above (e.g., general workers, temporary staff, administrative staff) will be excluded.
- Individuals who are on extended leave or are unavailable during the data collection period will also be excluded.

3.4.4.3 Sample population

Due to practical constraints and the need for efficiency, a sample was drawn from the larger population for data collection. The sample size included representatives from each category to ensure a comprehensive understanding of the organisational dynamics. The sample population was as follows:

Table 3.2 Sample population

Managers	13
Section Managers	7
Supervisors	36
Training Managers	1
Quality Managers	2
Quality Control Inspectors	32
Team Leaders	48
Total Respondents	139

This resulted in a total sample size of 139 respondents. The decision on the sample size took into account the need for statistical relevance while considering the practicalities of data collection.

3.5 Data collection method and research instruments

The benefits of using questionnaires include open-ended, standardised answers to a variety of subjects from a sizable sample or population. They might be inexpensive, trustworthy, legitimate, quick, and simple to finish. The questionnaire is a popular and practical tool for gathering data for surveys. It offers organised, frequently numerical data, may be delivered remotely, and is usually very easy to interpret. The time required to create, test, and improve the questionnaire must be balanced by these attractions (Cohen, Manion and Morrison 2018). According to Thiessen and Blasius (2012); cited in Mthembu (2018), when a researcher knows exactly what is needed and how to quantify the variables of interest, questionnaires are an effective tool for gathering data. You have three options for administering questionnaires: in-person, by mail, or electronically.

The questionnaire used in this study was adapted from a previous study by (Rathilall 2011) and (Naicker 2017), which explored lean manufacturing principles within the automotive industry and electronic manufacturing sectors. Recognising the relevance of lean manufacturing principles across the automotive, electronic, and clothing industries, the decision was made to adopt a previously developed questionnaire for this study. The original questions were carefully evaluated to ensure they effectively covered the objectives relevant to the current study. A Likert scale was incorporated into the questionnaire, allowing respondents to indicate the extent of their agreement or disagreement with each statement. This choice of scale was particularly useful for capturing detailed insights into participants' views on lean manufacturing principles as they apply to the clothing industry. The reason for choosing a previously developed questionnaire was that the earlier study was conducted in the automotive industry, where lean manufacturing principles are deeply established

The data collection primarily involved the use of a survey questionnaire. The researcher contacted the selected SMEs to obtain details of the targeted individuals in each category. Questionnaires were personally delivered to the selected sample respondents, allowing them to answer at their convenience. Subsequently, arrangements were made to facilitate

the collection of completed questionnaires, ensuring a comprehensive and timely data collection process.

3.5.1 The Measuring Instrument

The study employed a well-structured questionnaire consisting of 72 items, which were designed to be measured on either a nominal or ordinal scale. The questionnaire was designed with the target audience in mind, ensuring that the language and structure were accessible to middle management, who may have varying educational backgrounds. The questions were carefully chosen to ensure comprehensive coverage of essential constructs, avoiding any redundancy while ensuring clarity. This careful attention to design minimised the potential for ambiguity or misinterpretation, ensuring that the collected data would be valuable for both the current study and future research in similar areas. The questionnaire was organised into four distinct sections, each targeting specific areas relevant to the research objectives.

1. Employee Profiles by Department

The first section gathered demographic data, focusing on the respondent's roles within their respective departments. This information was crucial for analysing the distribution of participants across different organisational functions.

2. Respondent's Job Titles

The second section aimed to collect details regarding the job titles of the respondents, facilitating an analysis of responses based on their positions within the company.

3. Quantitative analysis using Likert Scale

The third section employed a Likert scale to quantitatively assess key aspects of lean manufacturing tools. Respondents were asked to indicate their level of agreement with a series of statements on a 5-point scale, ranging from "Strongly Disagree" to "Strongly Agree." This method allowed for a structured measurement of attitudes and perceptions, providing clear data on the extent to which these tools were utilised within the organisation.

4. Quantitative analysis using Likert Scale

The final section also utilised a Likert scale, participants were asked to rate various aspects on a scale of 1 to 5, where 1 represented "Very Little" and 5 represented "Very High." This approach effectively captured the participant's opinions regarding the impact and challenges of LM within the organisation.

3.6 Data analysis

Once data is collected, the raw data needs to be analysed and interpreted. There are several techniques for analysing data, each of which is distinct and has discrete advantages and drawbacks (Li and Zhang 2022).

Following Reddy (2021), data can be presented using charts, tables, and graphs created with a variety of software applications. This makes it possible for the researcher to draw a conclusion or devise a plan of action for using analysis to provide answers to the research questions. In quantitative research, the statistical package for the social sciences SPSS programme is used to sort data or answers from questionnaires. SPSS version 27.0 was utilised once the data collection was complete.

Several tests were carried out to analyse the data collected. A one-sample t-test was applied to all questions measured on a 5-point Likert agreement scale to determine if there is significant agreement or disagreement with the statement. The independent samples t-test was applied to determine if the agreement with statements differed significantly between the two companies. The binomial test was used to determine if one of two possible responses was selected by a significant proportion of the respondents. This applied to questions regarding change in leadership style to accommodate Lean and acceptance of Lean by the diversity of employees. Pearson's chi-square test or Fisher's exact test was used to determine significant relationships between the company and questions measured on a categorical scale, e.g., the success rating of Lean adoption.

3.6.1 Descriptive statistics

Siedlecki (2020), asserts that descriptive statistics are instruments that aid in the organisation and summarisation of data. Familiar examples include charts, percentages, and mean values. Descriptive statistics were employed to present essential characteristics derived from the quantitative data obtained in this study. Descriptive statistics including

means and standard deviations, where applicable. Frequencies are represented in tables or graphs.

3.6.2 Chi-square test of independence

The Chi-square statistic is a non-parametric tool specifically developed for examining differences between groups when the dependent variable is measured nominally. Similar to other non-parametric statistics, Chi-square exhibits robustness in handling various data distributions (Turhan 2020). The chi-square test of independence was used in this study on cross-tabulations to see whether a significant relationship exists between the two variables represented in the cross-tabulation. When conditions are not met Fisher's exact test was used.

3.6.3 Binomial test

According to Atz (2020), the binomial test employs the binomial distribution to assess whether the results of an experiment, involving the counting of occurrences for one of two alternatives, are statistically significant. A binomial test was used in the study to test whether a significant proportion of respondents selected one of a possible two responses.

3.6.4 One sample t-test

A one-sample t-test contrasts a sample's mean with an a priori score, sometimes known as the population mean. A sample standard deviation or a known population standard deviation is used in the test. Interval scores are analysed in the test (Ross and Willson 2017). For this study, a one-sample t-test was used to test whether a mean score is significantly different from a scalar value.

3.6.5 Independent sample t-test

The t-test is commonly employed to compare means between two groups. These groups under comparison can be independent, for instance, comparing men and women (Kim 2019). An Independent samples t-test was used to compare two independent groups of cases because it is primarily a comparative study.

3.7 Validity

In keeping with Aryadoust, Ng and Sayama (2021), the effectiveness of a measuring tool hinges primarily on two key attributes: reliability and validity. Validity pertains to whether the

measuring procedure accurately assesses the intended phenomenon it is meant to measure.

Validity was maintained by ensuring each objective was catered to in the questionnaire. Validity is described as the extent to which a set of items collectively forms a sufficient operational definition of a construct. This process encompasses two main stages: initial efforts by the scale developer, conducted beforehand, to improve content validity through thoughtful conceptualisation and domain analysis before item creation, followed by subsequent efforts to assess the appropriateness of the scale's content through expert evaluation (Cabilan, McRae, Learmont, Taurima, Galbraith, Mason, Eley, Snoswell and Johnston 2022). Shafie, Majid, Damio and Hoon (2020) assert that every item is examined to guarantee clear and appropriate phrasing, as well as to assess its relevance to the intended construct, involving potential modifications to the sentence structure and the choice of words for improvement. Fifteen participants from the sample population took the pre-test.

3.8 Reliability

Reliability was ensured by adapting a previously tested questionnaire used in a similar study by (Rathilall 2011) and (Naicker 2017). In this context, reliability is often synonymous with repeatability, reproducibility, or consistency, indicating the instrument's ability to consistently produce similar results.

3.9 Ethical considerations

Under Sekaran and Bougie (2016), all personnel must be made aware of the proposed research whenever an issue is identified and an investigation is decided upon. Although it is not required to inform them of the study's objectives (since this could skew their responses), letting them know that the research aims to benefit them in their place of employment will gain their cooperation. Thus, the element of unpleasant surprise will be removed for the staff. Employees must also be reassured of the confidentiality of their answers and that specific responses won't be shared with anybody else working for the company.

The researcher informed the participants that the study was voluntary and that all responses would be confidential and would only be used by the researcher for the study's purposes. Respondents were asked to sign a consent form to participate in the research and were also informed that they could withdraw at any point. Respondents would remain anonymous and

the participants were assured of confidentiality. The researcher also complied with the DUT research ethical prescriptions, and several ethical processes were observed throughout the research.

3.10 Limitations

According to Govender (2023), constraints are factors that are beyond the control of the researchers. One of the main drawbacks of the non-probability sampling approach is that the findings it generates are not universally applicable. Because the results obtained using this method mostly relate to the community under study, it might be inaccurate to generalise these conclusions outside of that particular sample. Applying study results to a larger target population is known as generalisation. The study's focus on two specific companies, Company A and B, may limit the generalisability of findings to the broader apparel industry. Resource constraints may impact the depth of analysis. Subjective measures of lean manufacturing effectiveness and external factors like economic conditions further complicate the analysis.

3.11 Delimitations of the study

Delimitations described by (Akanle, Ademuson and Shittu 2020) as the decisions made by the researcher. These decisions specify the limitations the researcher has established for the investigation. The study is delimited to the apparel industry within KwaZulu-Natal, specifically focusing on Companies A and B. This limits the generalisability of findings to other regions or industries. The chosen research approach utilises quantitative methods, with data collection conducted primarily in English, potentially affecting cross-cultural applicability. The use of a survey questionnaire as the primary data collection instrument and the specific time frame may also constrain the study's depth and long-term insights.

3.12 Conclusion

Chapter three outlined the research methodology employed in this study, aimed at comparing the effectiveness of lean manufacturing principles within the apparel industry. The chosen quantitative approach offers a comprehensive understanding of the research problem. The chapter discussed the rationale behind this approach, highlighting its ability to capture the multifaceted nature of the phenomenon under investigation.

Various research designs were tailored to address specific research objectives and enhance the depth of analysis. Additionally, the chapter detailed data collection methods, sampling techniques, and data analysis procedures, ensuring validity, reliability, and ethical considerations throughout the study.

Acknowledging certain limitations and delimitations, such as constraints related to sampling techniques and the focus on specific companies, Chapter 3 set the stage for the empirical investigation. By adopting a quantitative approach, the study aimed to provide valuable insights into LM principles and effectiveness within the apparel industry, contributing to the existing body of knowledge in the field. The results analysis and discussion based on the information gathered from the questionnaires will be presented in Chapter Four.

CHAPTER FOUR

DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter marks a crucial phase in the study, transitioning from the formulation of research questions to a detailed analysis of data gathered from small and medium-sized apparel industries. The primary focus of this chapter is a thorough examination of the data collected for this study.

The objective was to explore the intricacies of LM adoption by gaining insights into the operational dynamics of small and medium-sized apparel industries. This involved a detailed analysis of the collected data through statistical methods, providing an objective understanding of the factors influencing LM implementation.

A statistical tool such as SPSS version 27.0 was employed to extract numerical summaries and identify patterns. Descriptive statistics, including means and standard deviations, provided an overview of central tendencies and variations within the responses. Additionally, tests such as the Chi-square test of independence, Binomial test, One Sample t-test, and Independent Samples t-test were applied to discern relationships, proportions, and group differences.

4.2 Presentation of Results

4.2.1 Section 1: Respondents profiles by department and occupation

Section 1 outlines the respondent demographics by department and job title.

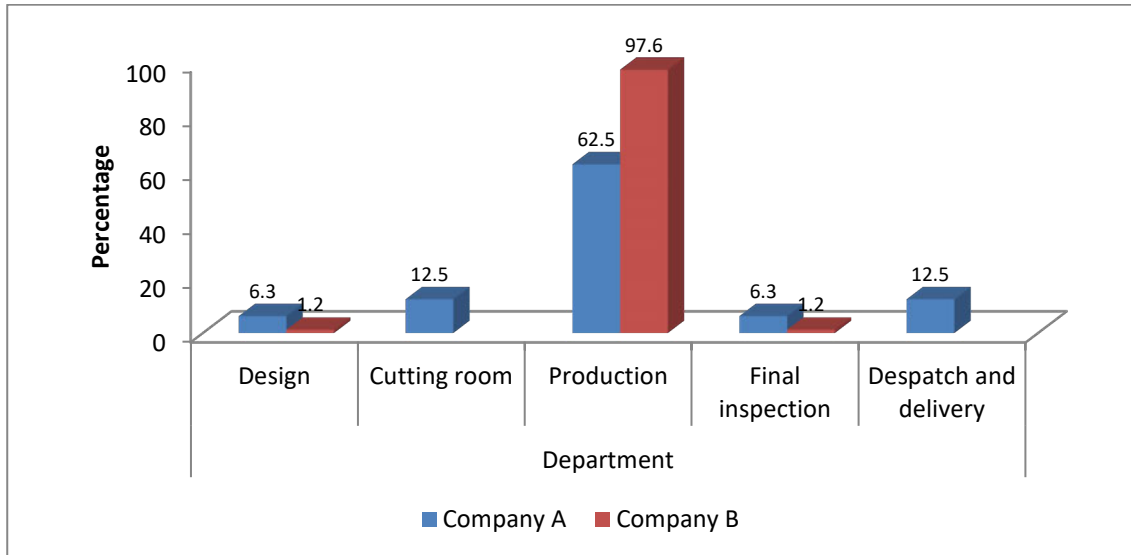


Figure 4.1: Profiles of employees within their respective departments.

Below is an overview of the departments listed above.

4.2.1.1 Respondent Demographics by Department:

The distribution of respondents across different departments offers valuable insights into the representation within both companies.

- **Design Department:** Company A shows a higher percentage of respondents from the design department, with 6.3%, compared to only 1.2% from Company B. This suggests that the design function has a slightly stronger presence in the small manufacturer (Company A) than in the medium-sized manufacturer (Company B).
- **Cutting Room:** In the cutting room, 12.5% of respondents were from Company A, while Company B reported no responses from this department. This indicates that a significant portion of the workforce at Company A contributes to the cutting room, whereas it is not represented in Company B.
- **Production:** A substantial majority of respondents in both companies were engaged in production. Company A accounted for 62.5% of respondents from this department, while Company B had an even larger share at 97.6%. This underscores the

production-centric nature of Company B's operations, reflecting a higher concentration of production staff among its respondents.

- **Final Inspection:** Both companies exhibited minimal representation from the final inspection department. Company A had 6.3% of its respondents from this area, while Company B recorded only 1.2%. These low percentages indicate that final inspection constitutes a smaller segment of the workforce in both companies.
- **Despatch and Delivery:** Company A had 12.5% of respondents from the despatch and delivery department, while Company B had no respondents from this department. This suggests that despatch roles are more prominently represented in the small manufacturer (Company A).
- The design department is responsible for developing designs and patterns that meet the needs of the target market. The department works closely with other departments.
- Cutting room: The primary function of the cutting room is to precisely cut fabric according to patterns or markers provided by the design department. This process requires skilled personnel who can accurately lay out patterns on the fabric to minimise waste and maximise fabric utilisation.
- The production department is where the actual manufacturing of garments takes place, where the raw materials are transformed into finished products through many processes.
- Final inspection: Trained quality inspectors thoroughly examine each garment to ensure it meets the quality standards as per specification and this is done before the garment is packaged for distribution.
- Despatch and delivery are the final stages of the garment manufacturing process, where finished products are prepared for shipment and transported to customers or distribution centres.

4.2.2 Section 2: Occupational Roles of Respondents

Section 2 of the questionnaire:

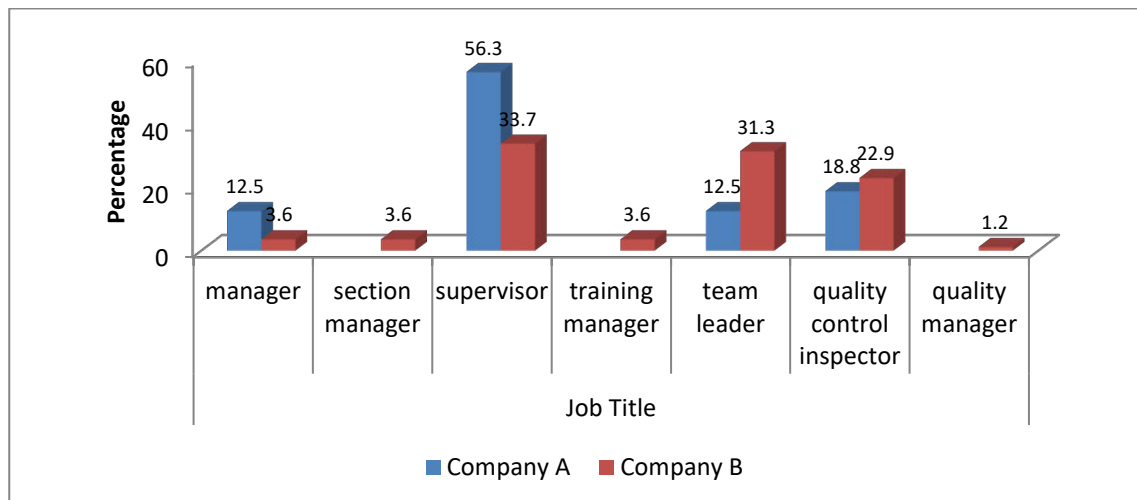


Figure 4.2: Occupational Roles of Respondents

Occupational Roles of Respondents:

The distribution of respondents across various occupational roles provides insights into the management frameworks and workforce configurations of the two companies.

- **Manager:**

Company A reported 12.5% of respondents in managerial positions, while Company B had a lower figure of 3.6%. This suggests that the small manufacturer (Company A) has a larger proportion of managers compared to the medium-sized manufacturer (Company B).

- **Section Manager:**

Only Company B had respondents in the section manager role, also at 3.6%. This indicates that section management may be less prevalent or absent in Company A.

- **Supervisor:**

Supervisors made up a significant portion of respondents in both companies, with Company A representing 56.3% and Company B 33.7%. This illustrates that supervisors play a crucial role in Company A's workforce, reflecting a more hands-on management style in the smaller organization.

- **Training Manager:**

The training manager position was present solely in Company B, accounting for 3.6% of respondents. This suggests that Company B emphasises training within its workforce, whereas this role is not found in Company A.

- **Team Leader:**

For team leaders, Company A had 12.5% of respondents, while Company B had a greater representation at 31.3%. This indicates that team leadership positions are more common in the medium-sized manufacturer, potentially due to its larger operational scale.

- **Quality Control Inspector:**

Company A reported 18.8% of respondents in the quality control inspector role, while Company B had 22.9%. This shows a relatively similar focus on quality control in both companies, with a slightly stronger emphasis in Company B.

- **Quality Manager:**

Lastly, the quality manager role was only indicated by Company B, representing 1.2% of respondents. This suggests that the presence of quality management is minimal in both companies, indicating that this role may not be as significant in their operational contexts.

4.2.3 Section 3: Individual sectional analysis

Section 3 of the questionnaire

4.2.3.1 Question 1: Continuous Improvement (CI)

Tesfay (2021) defines Continuous Improvement, Kaizen, which translates to "do, change, and Zen, well," as a philosophy that permeates Japanese daily life in addition to the management sector. It denotes improvement, intensity, value growth, and steady and ongoing advancement. George, Tung, Truc, Ngoc and Nhi (2022) state that utilising the input of every worker, continuous improvement aims to raise the performance, availability, quality, dependability, and safety of manufacturing equipment.

Figure 4.3 and Table 4.1 depict the results for Continuous Improvement.

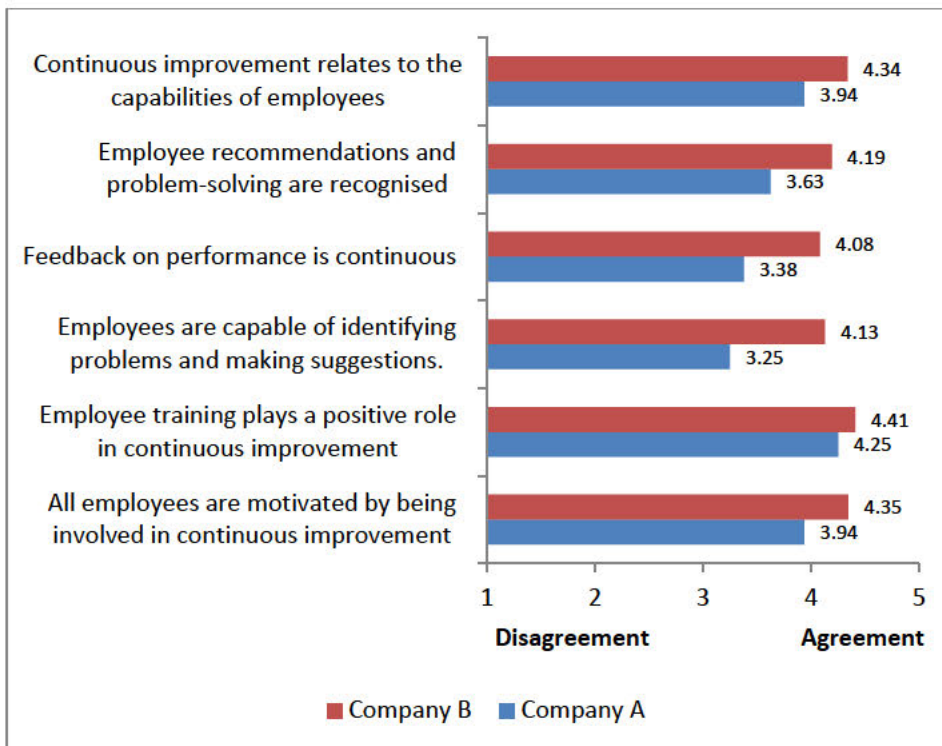


Figure 4.3: Continuous Improvement
Table 4.1: Continuous Improvement

Continuous improvement	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	t	df	p-value	Mean difference	t	df	p-value
All employees are motivated by being involved in continuous improvement	A	16	3.94 (1.181)	3.174	15	.006*	-.408	-1.336	17.076	.199
	B	84	4.35 (.703)	17.545	83	<.001*				
Employee training plays a positive role in continuous improvement	A	16	4.25 (.683)	7.319	15	<.001	-.160	-.806	97	.422
	B	84	4.41 (.733)	17.517	82	<.001				
Employees are capable of identifying problems and making suggestions.	A	16	3.25 (1.065)	.939	15	.362	-.881	-3.203	17.094	.005
	B	84	4.13 (.636)	16.301	83	<.001				
Feedback on performance is continuous	A	16	3.38 (1.088)	1.379	15	.188	-.708	-2.495	17.796	.023
	B	84	4.08 (.748)	13.277	83	<.001				

Employee recommendations and problem-solving are recognised	A	16	3.63 (.619)	4.038	15	.001	-.565	-2.827	98	.006
	B	84	4.19 (.752)	14.507	83	<.001				
Continuous improvement relates to the capabilities of employees	A	16	3.94 (.443)	8.474	15	<.001	-.400	-3.147	25.611	.004
	B	84	4.34 (.569)	21.410	82	<.001				

4.2.3.1.1 Analysis of Continuous Improvement variables

- **All employees are motivated by being involved in Continuous Improvement:**

Both groups significantly agree that all employees are motivated by being involved in continuous improvement. The one-sample t-test for Group A yielded a significant result ($t(15) = 3.174$, $p = 0.006$), indicating that Group A significantly agrees with this statement. However, the independent samples t-test comparing the means between Group A and Group B did not show a significant difference ($t(17.076) = -1.336$, $p = 0.199$), suggesting that the level of agreement between the two companies is not significantly different.

- **Employee training plays a positive role in Continuous Improvement:**

There was no significant difference between the two groups regarding the positive role of employee training in continuous improvement. The independent samples t-test did not show a significant difference in means between Group A and Group B ($t(97) = -0.806$, $p = 0.422$).

- **Employees are capable of identifying problems and making suggestions:**

Group B significantly outperformed Group A in terms of employees' capabilities of identifying problems and making suggestions for continuous improvement. The independent samples t-test revealed a significant difference between the two groups ($t(17.094) = -3.203$, $p = 0.005$), indicating that Group B's mean score was significantly higher.

- **Feedback on performance is continuous:**

Group B demonstrated a significantly higher mean score compared to Group A regarding continuous feedback on performance. The independent samples t-test indicated a significant

difference between the two groups ($t(17.796) = -2.495, p = 0.023$), suggesting that Group B provides more continuous feedback on performance.

- **Employee recommendations and problem-solving are recognised:**

Group B significantly outperformed Group A in recognising employee recommendations and problem-solving efforts. The independent samples t-test showed a significant difference between the means of the two groups ($t(98) = -2.827, p = 0.006$), indicating that Group B's mean score was significantly higher.

- **Continuous Improvement relates to the capabilities of employees:**

Group B demonstrated a significantly stronger relationship between continuous improvement and employee capabilities compared to Group A. The independent samples t-test revealed a significant difference between the means of the two groups ($t(25.611) = -3.147, p = 0.004$), indicating that Group B's mean score was significantly higher.

Conclusion of presentation of results: Overall, while both companies generally agree on the motivation aspect of continuous improvement, significant differences exist between the two groups regarding various other aspects, including employees' capabilities, feedback mechanisms, and recognition of employee contributions. These findings suggest areas where each company may excel or need improvement in fostering a culture of continuous improvement within their organisation.

4.2.3.2 Question 2: Total Quality / Zero Defects

Defects in the clothing industry can result in significant losses or reduce profits. Any manufacturer's top priority should be to create and deliver high-quality goods on schedule. On the other hand, poor quality products typically result in rejection, rework, increased labour costs, and unhappy customers. Lean tools are used in the apparel industry to reduce waste and address all of these issues (Tahiduzzaman *et al.* 2018).

Figure 4.4 and Table 4.2 depict the results for total quality/zero defects.

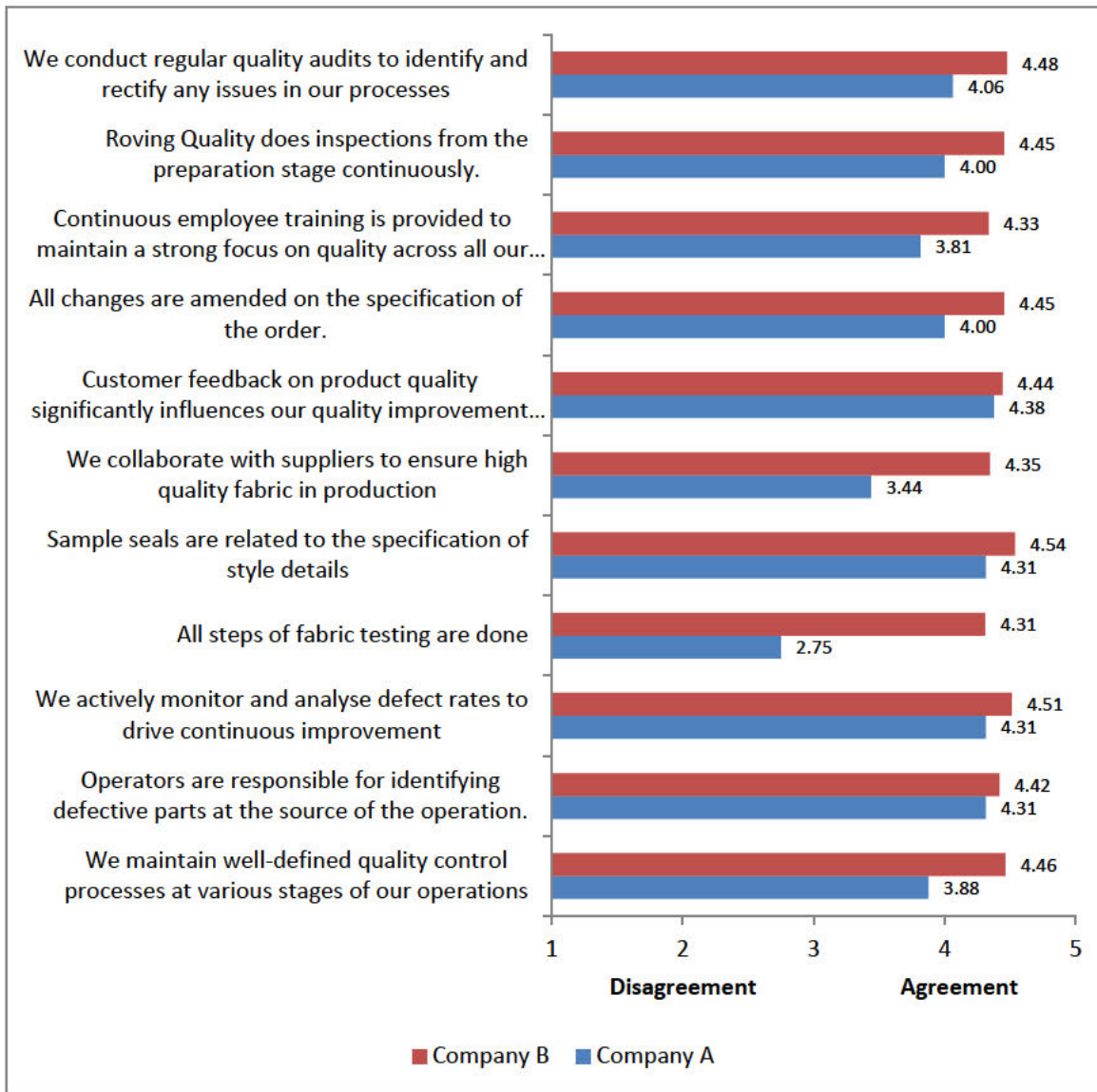


Figure 4.4: Total Quality / Zero Defects

Table 4.2: Total Quality/Zero Defects

Total Quality/Zero Defects	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	t	df	p-value	Mean difference	t	df	p-value
We maintain well-defined quality control processes at various stages of our operation	A	16	3.88 (.500)	7.000	15	<.001	-589	-3.868	31.750	.001
	B	84	4.46 (.798)	16.811	83	<.001				
	A	16	4.31	6.012	15	<.001	-104	-558	98	.578

Operators are responsible for identifying defective parts at the source of the operation.			(.873)							
	B	84	4.42 (.644)	20.16 3	83	<.001				
We actively monitor and analyse defect rates to drive continuous improvement	A	16	4.31 (.793)	6.619	15	<.001	-.199	-1.271	98	.207
	B	84	4.51 (.526)	26.33 0	83	<.001				
All steps of fabric testing are done	A	16	2.75 (.577)	- 1.732	15	.104	-1.560	-7.778	98	<.001
	B	84	4.31 (.760)	15.79 0	83	<.001				
Sample seals are related to the specification of style details	A	16	4.31 (.602)	8.720	15	<.001	-.223	-1.308	98	.194
	B	84	4.54 (.630)	22.35 8	83	<.001				
We collaborate with suppliers to ensure high quality fabric in production	A	16	3.44 (.629)	2.782	15	.014	-908	-4.528	98	<.001
	B	84	4.35 (.752)	16.38 6	83	<.001				
Customer feedback on product quality significantly influences our quality improvement efforts.	A	16	4.38 (.719)	7.652	15	<.001	-.065	-.383	98	.702
	B	84	4.44 (.608)	21.70 7	83	<.001				

All changes are amended on the specification of the order.	A	16	4.00 (.516)	7.746	15	<.001	-.452	-3.137	23.103	.005
	B	84	4.45 (.589)	22.59 4	83	<.001				
Continuous employee training is provided to maintain a strong focus on quality across all our operations	A	16	3.81 (1.109)	2.931	15	.010	-.521	-1.808	17.465	.088
	B	84	4.33 (.717)	17.04 4	83	<.001				

Roving Quality does inspections from the preparation stage continuously	A	16	4.00 (.516)	7.746	15	<.001	-.452	-3.227	20.733	.004
	B	84	4.45 (.501)	26.58 4	83	<.001				
We conduct regular quality audits to identify and rectify any issues in our processes	A	16	4.06 (.680)	6.249	15	<.001	-.414	-2.227	21.215	.037
	B	84	4.48 (.685)	19.74 9	83	<.001				

4.2.3.2.1 Analysis of Total Quality/Zero Defects Variables

The total quality/zero defects variables assess the commitment of Company A and Company B to maintaining high standards of quality control and minimising defects in their operations. This analysis examines the statistical results and implications of these variables.

- **Presentation of data:**

The provided table summarises the means, standard deviations, sample sizes, and results of one-sample t-tests and independent samples t-tests for each total quality/zero defects variable, separately for Company A and Company B.

- **Statistical analysis:**

One-sample t-tests were conducted to determine if the mean scores for each variable significantly differed from a neutral value (e.g., 3 on a 5-point Likert scale). Independent samples t-tests were used to compare the means between Company A and Company B.

- **Interpretation of results:**

Company A demonstrated significant agreement with statements related to maintaining well-defined quality control processes, operators' responsibility for identifying defective parts, active monitoring and analysis of defect rates, collaboration with suppliers, and conducting regular quality audits. However, Company A did not significantly agree with statements regarding fabric testing, sample seals, customer feedback influence, and amendment of changes on order specifications.

In contrast, Company B consistently showed significantly higher mean scores across all variables compared to Company A. Company B's stronger performance indicates a more

robust implementation of total quality/zero defects practices, as evidenced by higher scores in areas such as defect monitoring, supplier collaboration, and quality audits.

- **Discussion of implications:**

The significant differences between Company A and Company B suggest that Company B maintains a stronger commitment to total quality/zero defects principles. These findings have implications for product quality, customer satisfaction, and operational efficiency. Company B's practices may lead to better overall performance and competitive advantage in the marketplace.

4.2.3.3 Question 3: Just-in-time

Just in Time (JIT) is a method that emphasises ongoing problem-solving by prioritising throughput and minimising inventory. Under JIT, materials are delivered precisely when and where they are required. Any deviation from this timing signals a problem that needs to be addressed (Valamede and Akkari 2020).

Figure 4.5 and Table 4.3 depict the results of Just-in-Time.

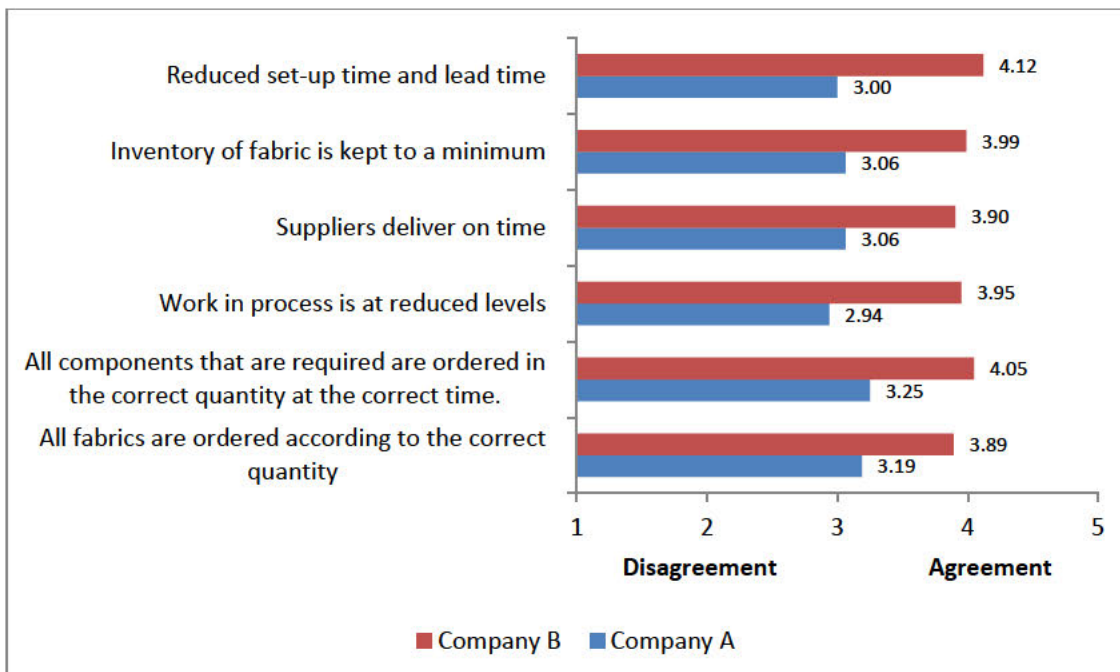


Figure 4.5: Just-in-Time

Table 4.3: Just-in-Time

Just-in-Time	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	t	df	p-value	Mean difference	t	df	p-value
All fabrics are ordered according to the correct quantity	A	16	3.19 (.750)	1.000	15	.333	-.705	-2.62	98	.009
	B	84	3.89 (1.006)	8.133	83	<.001				
All components that are required are ordered in the correct quantity at the correct time.	A	16	3.25 (.577)	1.732	15	.104	-.798	-3.596	98	.001
	B	84	4.05 (.849)	11.311	83	<.001				
Work in process is at reduced levels	A	16	2.94 (.680)	-.368	15	.718	-1.015	-3.910	98	<.001
	B	84	3.95 (.993)	8.792	83	<.001				
Suppliers deliver on time	A	16	3.06 (.680)	.368	15	.718	-.842	-3.117	98	.002
	B	84	3.90 (1.037)	7.997	83	<.001				
Inventory of fabric is kept to a minimum	A	16	3.06 (.772)	.324	15	.751	-.926	-4.662	98	<.001
	B	84	3.99 (.720)	12.584	83	<.001				
Reduced set-up time and lead time	A	16	3.00 (.632)	.000	15	1.000	-1.119	-6.519	98	<.001
	B	84	4.12 (.629)	16.313	83	<.001				

4.2.3.3.1 Analysis of Just-in-Time (JIT) Variables

The Just-in-Time (JIT) variables assess the extent to which Company A and Company B adhere to the principles of JIT manufacturing, focusing on aspects such as inventory management, supplier performance, and production efficiency.

- **Presentation of data:**

The table presents the means, standard deviations, sample sizes, and results of one-sample t-tests and independent samples t-tests for each JIT variable, separately for Company A and Company B.

- **Statistical analysis:**

One-sample t-tests were conducted to determine if the mean scores for each variable significantly differed from a neutral value (e.g., 3 on a 5-point Likert scale). Independent samples t-tests were used to compare the means between Company A and Company B.

4.2.3.3.2 Interpretation of results:

- **All fabrics are ordered according to the correct quantity:**

Company A did not significantly agree that all fabrics are ordered in the correct quantity, while Company B demonstrated a significantly higher mean score, indicating better adherence to JIT principles in fabric ordering practices.

- **All components that are required are ordered in the correct quantity at the correct time:**

Company A showed a lower mean score compared to Company B, with a significant difference between the two companies. This suggests that Company B is more effective in ordering components in the correct quantity and at the correct time.

- **Work in process is at reduced levels:**

Both companies demonstrated a significant difference in mean scores, with Company B exhibiting a higher score, indicating better management of work in process levels and alignment with JIT principles.

- **Suppliers deliver on time:**

Similar to the previous variables, Company B showed a significantly higher mean score compared to Company A, indicating better supplier performance in terms of on-time delivery.

- **Inventory of fabric is kept to a minimum:**

Company B significantly outperformed Company A in keeping inventory levels of fabric to a minimum, indicating a stronger adherence to JIT principles in inventory management practices.

- **Reduced set-up time and lead time:**

Company B again demonstrated a significantly higher mean score compared to Company A, indicating more efficient set-up and lead times, which are critical aspects of JIT manufacturing.

- **Discussion of Implications:**

The significant differences between Company A and Company B across all JIT variables suggest that Company B exhibits a stronger commitment to JIT principles and practices. Adhering to JIT principles can lead to several benefits, including reduced inventory carrying costs, improved production efficiency, and enhanced responsiveness to customer demand.

By effectively implementing JIT principles, Company B may achieve operational excellence, leading to improved competitiveness and profitability. In contrast, the lower scores obtained by Company A highlight potential areas for improvement, particularly in inventory management, supplier performance, and production efficiency.

4.2.3.4 Question 4: The Role of 5S

The 5S methodology aims to improve workplace organisation, efficiency, and safety by establishing and maintaining orderly workspaces (Alasbali and Almaktoom 2022).

Figure 4.6 and Table 4.4 depict the results of 5S.

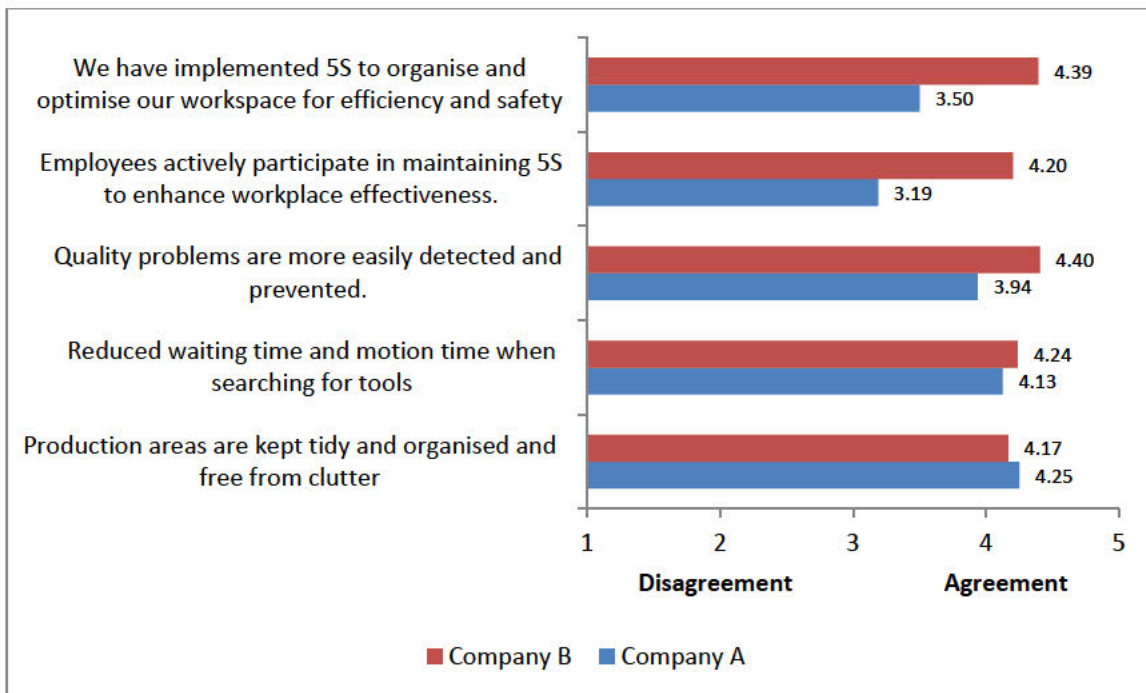


Figure 4.6: The Role of 5S

Table 4.4: The Role of 5S

5S	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	t	df	p-value	Mean difference	t	df	p-value
Production areas are kept tidy and organised and free from clutter	A	16	4.25 (.856)	5.839	15	<.001	.083	.395	98	.694
	B	84	4.17 (.758)	14.110	83	<.001				
Reduced waiting time and motion time when searching for tools	A	16	4.13 (.885)	5.084	15	<.001	-.113	-.534	98	.594
	B	84	4.24 (.754)	15.041	83	<.001				
Quality problems are more easily detected and prevented.	A	16	3.94 (.250)	15.000	15	<.001	-.467	-4.822	63.919	<.001
	B	84	4.40 (.679)	18.969	83	<.001				
Employees actively participate in maintaining 5S to enhance workplace effectiveness	A	16	3.19 (1.047)	.716	15	.485	-1.015	-4.019	98	<.001
	B	84	4.20 (.902)	12.215	83	<.001				
We have implemented 5S to organise and optimise our workspace for efficiency and safety	A	16	3.50 (.966)	2.070	15	.056	-.893	-3.551	17.593	.002
	B	84	4.39 (.640)	19.935	83	<.001				

4.2.3.4.1 Analysis of 5S variables.

The analysis of the 5S variables examines the extent to which Company A and Company B implement and adhere to 5S practices.

- **Presentation of data:**

The table presents the means, standard deviations, sample sizes, and results of one-sample t-tests and independent samples t-tests for each 5S variable, separately for Company A and Company B.

- **Statistical analysis:**

One-sample t-tests were conducted to determine if the mean scores for each variable significantly differed from a neutral value (e.g., 3 on a 5-point Likert scale). Independent samples t-tests were used to compare the means between Company A and Company B.

4.2.3.4.2 Interpretation of results:

- **Production areas are kept tidy and organised:**

Both Company A and Company B demonstrated significantly high mean scores, indicating a strong adherence to maintaining tidy and organised production areas.

- **Reduced waiting time and motion time when searching for tools:**

Similarly, both companies exhibited significantly high mean scores, suggesting efficient tool management practices with reduced waiting and motion times.

- **Quality problems are more easily detected and prevented:**

Company B showed a significantly higher mean score compared to Company A, indicating better detection and prevention of quality problems. This suggests that Company B's implementation of 5S practices may contribute to improved quality control and defect prevention.

- **Employees actively participate in maintaining 5S:**

Company B displayed a significantly higher mean score compared to Company A, indicating greater employee participation in maintaining 5S practices. This suggests a stronger culture of continuous improvement and employee engagement at Company B.

- **Implementation of 5S to organise and optimise workspace:**

Company B again outperformed Company A with a significantly higher mean score, indicating better organisation and optimisation of workspace for efficiency and safety. This suggests that Company B's implementation of 5S practices may lead to a more productive and safer work environment.

- **Discussion of implications:**

The findings suggest that both Company A and Company B prioritise the implementation of 5S practices to varying extents. While both companies demonstrate strengths in maintaining tidy and organised workspaces and efficient tool management, Company B appears to excel in detecting and preventing quality problems, fostering employee participation, and optimising workspace for efficiency and safety. The implementation of 5S practices has several implications for organisational performance, including improved productivity, enhanced quality control, and a safer work environment. By actively maintaining 5S practices, companies can streamline operations, reduce waste, and enhance overall workplace effectiveness.

- **Conclusion:**

In conclusion, the analysis of 5S variables underscores the importance of maintaining orderly and efficient workspaces in achieving operational excellence and ensuring workplace safety. Companies that effectively implement 5S practices are better positioned to meet customer demands, improve product quality, and maximise operational efficiency.

4.2.3.5 Question 5: Visual Management

Visual Management plays a crucial role in conveying information, tracking progress, and fostering employee engagement within organisations (Veres 2020).

Figure 4.7 and Table 4.5 depict the results of visual boards.

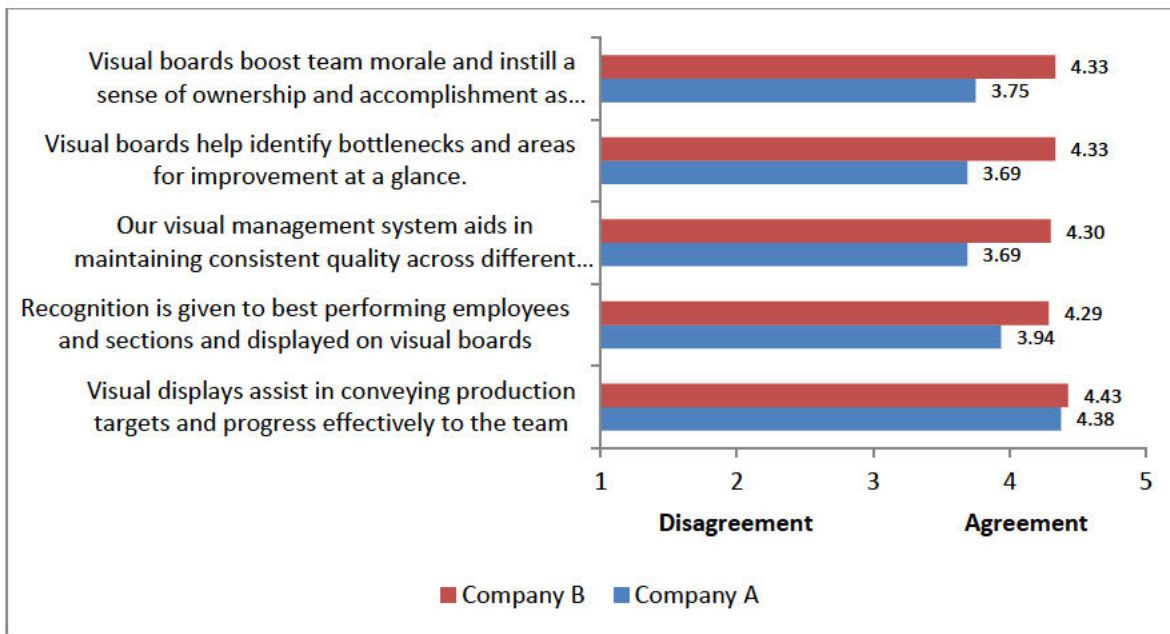


Figure 4.7: Visual Boards

Table 4.5: Visual Boards

Visual boards	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	t	df	p-value	Mean difference	t	df	p-value
Visual displays assist in conveying production targets and progress effectively to the team	A	16	4.38 (.806)	6.822	15	<.001	-.054	-.274	98	.785
	B	84	4.43 (.699)	18.727	83	<.001				
Recognition is given to best performing employees and sections and displayed on visual boards	A	16	3.94 (1.063)	3.529	15	.003	-.348	-.306	98	.760
	B	84	4.29 (4.514)	2.611	83	0.11				
Our visual management system aids in maintaining consistent quality across different processes.	A	16	3.69 (.793)	3.467	15	.003	-.614	-3.165	97	.002
	B	83	4.30 (.694)	17.087	82	<.001				
	A	16	3.69	3.149	15	.007	-.646	-3.129	98	.002

Visual boards help identify bottlenecks and areas for improvement at a glance.			(.873)							
	B	84	4.33 (.734)	16.65 8	83	<.001				
Visual boards boost team morale and instill a sense of ownership and accomplishment as progress is visible to all	A	16	3.75 (.856)	3.503	15	.003	-.583	-3.649	98	<.001

4.2.3.5.1 Analysis of Visual Board Variables

The analysis of visual board variables assesses the effectiveness of visual displays in facilitating communication, recognition, quality management, and problem-solving.

- **Presentation of data:**

The table presents the means, standard deviations, sample sizes, and results of one-sample t-tests and independent samples t-tests for each visual board variable, separately for Company A and Company B.

- **Statistical analysis:**

One-sample t-tests were conducted to determine if the mean scores for each variable significantly differed from a neutral value (e.g., 3 on a 5-point Likert scale). Independent samples t-tests were used to compare the means between Company A and Company B.

4.2.3.5.2 Interpretation of results:

- **Visual Displays convey production targets and progress effectively:**

Both Company A and Company B demonstrated high mean scores, indicating effective use of visual displays to convey production targets and progress. However, Company B exhibited a slightly higher mean score, suggesting a more robust implementation of visual management practices.

- **Recognition given to best performing employees and sections:**

Company A showed a significantly lower mean score compared to Company B, indicating a weaker practice of recognising best performing employees and sections and displaying them

on visual boards. This suggests a potential area for improvement in Company A's employee recognition practices.

- **Visual Management System maintains consistent quality:**

Company A demonstrated a lower mean score compared to Company B, indicating lesser effectiveness of the visual management system in maintaining consistent quality across different processes. This highlights an opportunity for Company A to enhance its quality management practices through visual boards.

- **Visual Boards identify bottlenecks and areas for improvement:**

Both Company A and Company B exhibited high mean scores, indicating effective use of visual boards in identifying bottlenecks and areas for improvement. However, Company B displayed a slightly higher mean score, suggesting a more comprehensive utilisation of visual boards for problem-solving and process improvement.

- **Visual Boards boost team morale and instill ownership:**

Company A showed a lower mean score compared to Company B, indicating a lesser impact of visual boards on boosting team morale and instilling a sense of ownership and accomplishment. This underscores the importance of leveraging visual boards as a tool for enhancing employee engagement and motivation.

- **Discussion of implications:**

The findings suggest that while both Company A and Company B utilise visual boards, there are notable differences in their effectiveness and impact. Company B demonstrates stronger practices in employee recognition, quality management, and fostering employee morale through visual boards. These findings highlight the importance of effective visual management practices in promoting communication, engagement, and continuous improvement within organisations.

- **Conclusion:**

In conclusion, the analysis of visual boards variables underscores the significance of visual management systems in enhancing communication, recognition, quality management, problem-solving, and employee morale within organisations. By leveraging visual boards

effectively, companies can improve operational efficiency, quality, and employee engagement, ultimately leading to greater success and competitiveness in the marketplace.

4.2.3.6 Question 6: Multi-Functional Teams

Naicker (2017); (Subramanian and Suresh 2024) state that Multifunctional Teams are comprised of employees equipped with diverse skills and training, enabling them to undertake various tasks efficiently and ensure the successful implementation of lean manufacturing principles within the organisation.

Figure 4.8 and Table 4.6 depict the results of Multi-Functional Teams.

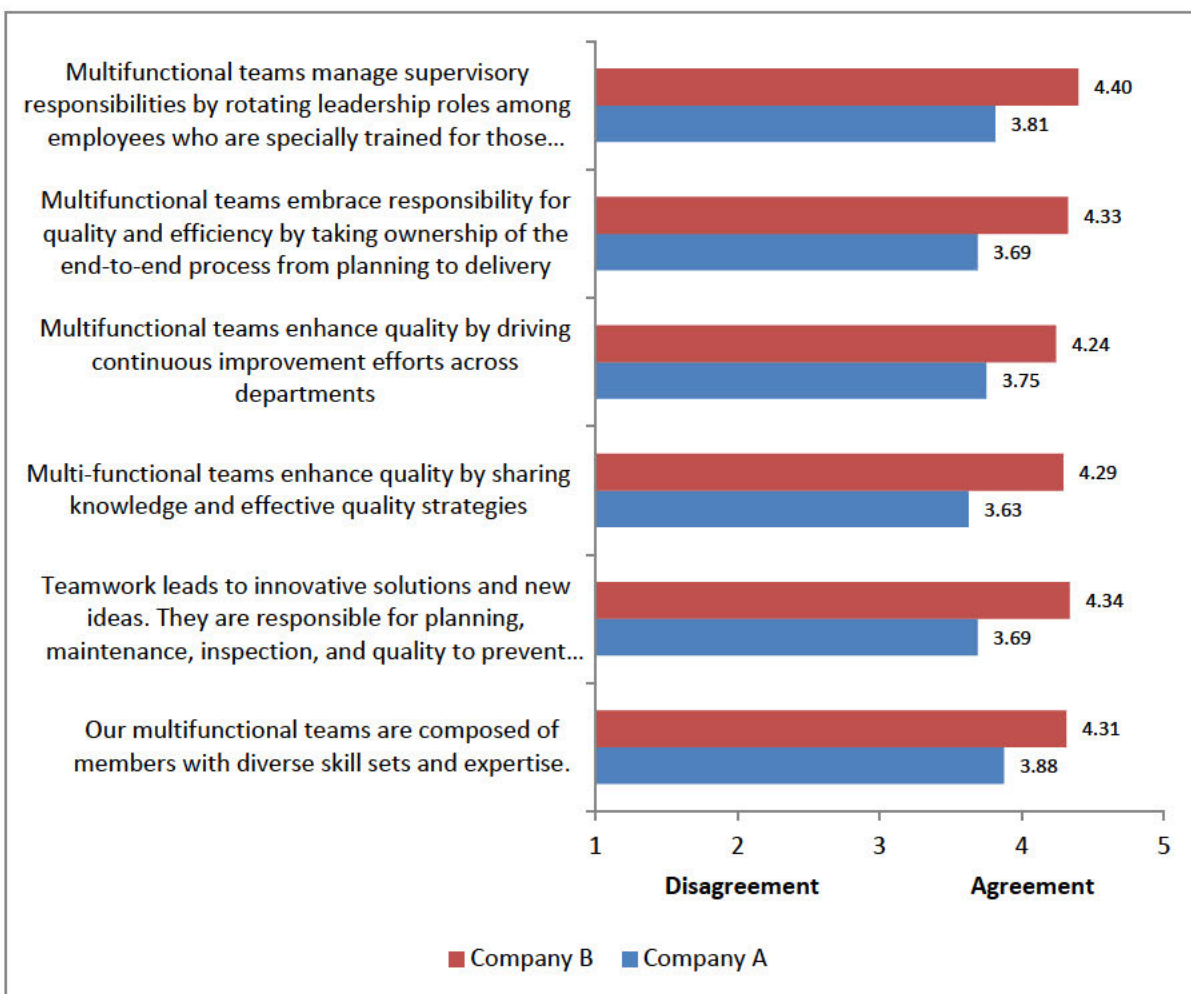


Figure 4.8: Multi-Functional Teams

Table 4.6: Multi-Functional Teams

Multi-functional teams	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	t	df	p-value	Mean difference	t	df	p-value
Our multifunctional teams are composed of members with diverse skill sets and expertise.	A	16	3.88 (.957)	3.656	15	.002	-.438	-2.291	97	.024
	B	83	4.31 (.643)	18.620	82	<.001				
Teamwork leads to innovative solutions and new ideas. They are responsible for planning, maintenance, inspection, and quality to prevent the disruption of product flow	A	16	3.69 (1.138)	2.416	15	.029	-.650	-2.204	17.271	.041
	B	83	4.34 (.703)	17.325	82	<.001				
Multi-functional teams enhance quality by sharing knowledge and effective quality strategies	A	16	3.63 (1.025)	2.440	15	.028	-.668	-3.236	96	.002
	B	82	4.29 (.694)	16.875	81	<.001				
Multifunctional teams enhance quality by driving continuous improvement efforts across departments	A	16	3.75 (.931)	3.223	15	.006	-.491	-2.363	97	.020
	B	83	4.24 (.726)	15.580	82	<.001				
Multifunctional teams embrace responsibility for quality and efficiency by taking ownership of the end-to-end process from planning to delivery	A	16	3.69 (.946)	2.905	15	0.11	-.638	-3.265	97	.002
	B	83	4.33 (.665)	18.168	82	<.001				
Multifunctional teams manage supervisory responsibilities by rotating leadership roles among employees who are specially trained for those specific tasks.	A	16	3.81 (.911)	3.569	15	.003	-.585	-2.864	97	.005

4.2.3.6.1 Multi-functional Teams analysis

Multi-functional teams play a crucial role in modern organisations, facilitating collaboration, innovation, and quality improvement. The analysis examines the effectiveness of multi-functional teams in Company A and Company B, focusing on their composition, innovation capabilities, quality enhancement strategies, and responsibility for process efficiency.

- **Composition of Teams:**

Both Company A and Company B report high mean scores for the composition of multi-functional teams, indicating that they consist of members with diverse skill sets and expertise. However, Company B demonstrates a significantly higher mean score compared to Company A, suggesting a more robust composition of multi-functional teams in Company B.

- **Innovation and planning responsibilities:**

Company B scores significantly higher than Company A in terms of teamwork leading to innovative solutions and assuming responsibilities for planning, maintenance, inspection, and quality management.

This indicates that Company B's multi-functional teams are more effective in generating new ideas and ensuring smooth production processes compared to Company A.

- **Quality enhancement and Continuous Improvement:**

Both companies recognise the importance of multi-functional teams in enhancing quality and driving continuous improvement efforts across departments.

Company B again outperforms Company A with significantly higher mean scores, indicating a stronger emphasis on sharing knowledge, implementing quality strategies, and driving continuous improvement initiatives.

- **Responsibility and efficiency:**

Multi-functional teams in both companies demonstrate a strong commitment to taking ownership of the end-to-end process from planning to delivery.

While both companies exhibit high mean scores, Company B shows a significantly higher score, suggesting a more proactive approach to ensuring quality and efficiency throughout the production process.

- **Supervisory responsibilities:**

Company B's multi-functional teams also excel in managing supervisory responsibilities, with significantly higher mean scores compared to Company A.

This indicates that Company B's teams effectively rotate leadership roles among specially trained employees, contributing to smoother operations and better performance.

- **Conclusion:**

The analysis reveals significant differences between Company A and Company B in the effectiveness of their multi-functional teams. While both companies prioritise diverse team compositions and responsibility for quality and efficiency, Company B demonstrates superior performance in innovation, quality enhancement, and process efficiency. These findings underscore the importance of effective team collaboration and leadership rotation in driving organisational success.

4.2.3.7 Question 7: Customer Input

Value, which serves as the foundation of lean production, refers to the characteristic of a product or service that a customer is willing to pay for, meeting their specific needs at a particular time and price point (Goshime, Kitaw and Jilcha 2019).

Figure 4.9 and Table 4.7 depict the results of Customer input.

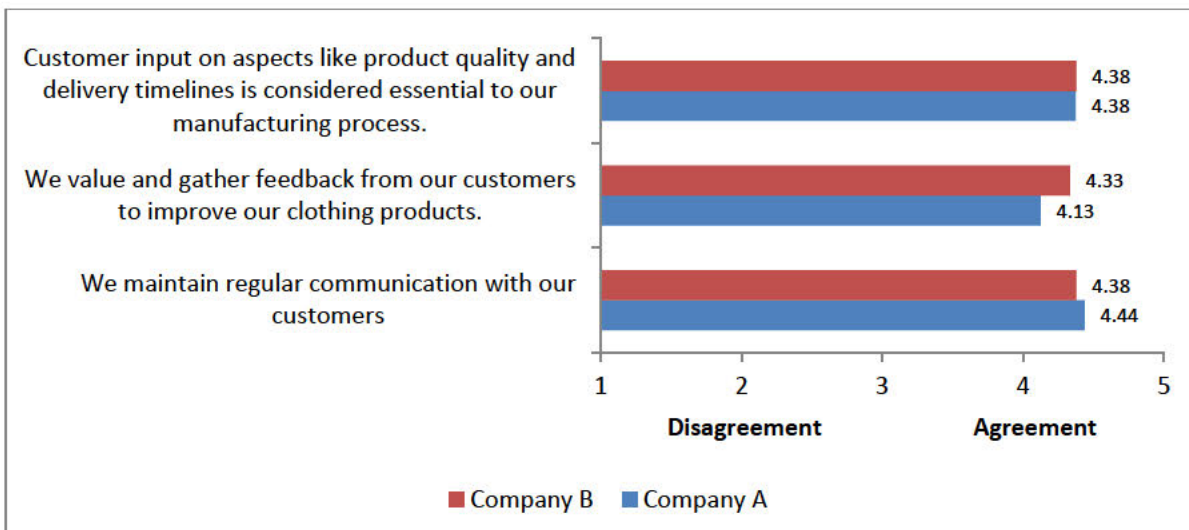


Figure 4.9: Customer Input

Table 4.7: Customer Input

Customer Input	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	t	df	p-value	Mean difference	t	df	p-value
We maintain regular communication with our customers	A	16	4.44 (.629)	9.139	15	<.001	.059	.317	96	.752
	B	82	4.38 (.696)	17.919	81	<.001				
We value and gather feedback from our customers to improve our clothing products.	A	16	4.13 (.619)	7.268	15	<.001	-.208	-1.122	95	.265
	B	81	4.33 (.689)	17.411	80	<.001				
Customer input on aspects like product quality and delivery timelines is considered essential to our manufacturing process.	A	16	4.38 (.719)	7.652	15	<.001	-.003	-.017	96	.987

4.2.3.7.1 Customer Input analysis

Customer input plays a vital role in shaping organisational processes, enhancing product quality, and improving overall customer satisfaction. The analysis of customer input variables evaluates the extent to which Company A and Company B engage with customers, value their feedback, and incorporate it into their manufacturing processes.

- **Regular communication with customers:**

Both Company A and Company B demonstrate high mean scores, indicating regular communication with customers.

Statistical analysis reveals that both companies significantly value maintaining communication with customers, fostering relationships, and staying attuned to customer needs and preferences.

- **Gathering feedback for product improvement:**

Company A and Company B also show high mean scores for valuing and gathering feedback from customers to improve their clothing products.

While both companies prioritise customer feedback, there's no significant difference between the mean scores, suggesting that both are equally committed to leveraging customer input for product enhancement.

- **Consideration of customer input in manufacturing process:**

Both companies acknowledge the importance of customer input, particularly regarding aspects like product quality and delivery timelines.

However, statistical analysis indicates that there's no significant mean difference between Company A and Company B in terms of considering customer input in the manufacturing process. This suggests that both companies recognise the significance of customer feedback in their operations.

- **Implications:**

The findings from the analysis of Customer Input variables carry several implications for organisational practice and customer-centred strategies:

- **Customer engagement:**

Regular communication with customers and gathering feedback are essential for building strong customer relationships and maintaining a customer-centred approach.

- **Product improvement:**

Incorporating customer feedback into the manufacturing process is crucial for enhancing product quality, meeting customer expectations, and staying competitive in the market.

- **Continuous Improvement:**

Companies should continuously seek ways to improve their customer engagement strategies, streamline feedback collection processes, and ensure that customer input is effectively integrated into decision-making and product development efforts.

- **Conclusion:**

In conclusion, the analysis highlights the importance of customer input in driving organisational success and competitiveness. By prioritising regular communication with customers, valuing their feedback, and considering it in the manufacturing process, companies can enhance customer satisfaction, improve product quality, and achieve sustainable growth in today's dynamic business environment.

4.2.4 Section 4: Perspectives and insights.

1. Did the management/leadership style change to accommodate Lean?
2. Was lean accepted by the diversity of employees in the organisation?

Table 4.8: Quantitative Inquiry

Item	Company	Frequency (%)		n	p-value
		Yes	No		
Did the management/leadership style change to accommodate Lean?	A	10 (63)	6 (38)	16	.454
	B	67 (81)	16 (19)	83	<.001*
Was Lean accepted by the diversity of employees in the organisation?	A	10 (67)	5 (33)	16	.302
	B	71 (86)	12 (14)	83	<.001*

* indicates significance at the 95% level

In this section, the findings derived from the quantitative inquiry into the implementation of lean principles within Company A and Company B are presented. The analysis focused on two key aspects: changes in management/leadership style to accommodate lean and the acceptance of lean by the diversity of employees in the organisations.

- **Changes in Management/Leadership Style to accommodate lean**

The data revealed varying perceptions regarding the adaptation of management/leadership style to incorporate lean principles. In Company A, 63% of respondents indicated affirmative responses, suggesting a notable degree of acknowledgment of such changes. Conversely, 38% of respondents expressed disagreement.

On the other hand, in Company B, a strikingly higher proportion (81%) of respondents affirmed the adaptation of management/leadership style, with only 19% disagreeing. Statistical analysis revealed a non-significant difference in perceptions within Company A ($p = .454$), while Company B exhibited a highly significant difference ($p < .001$), indicative of a robust association between the company and respondents' perceptions of management/leadership style change.

- **Acceptance of lean by diversity of employees**

Regarding the acceptance of lean principles by the diversity of employees, both companies displayed notable levels of affirmation. In Company A, 67% of respondents reported positive perceptions, indicating acceptance by a significant portion of the workforce, while 33% expressed disagreement. In contrast, Company B demonstrated a higher degree of acceptance, with 86% of respondents affirming the incorporation of lean principles, and only 14% expressing disagreement. Statistical analysis revealed a non-significant difference in perceptions within Company A ($p = .302$), whereas Company B exhibited a highly significant difference ($p < .001$), underscoring a strong association between the company and respondents' perceptions of lean acceptance.

- **Analysis**

The analysis suggests that while both companies demonstrated varying levels of acceptance and adaptation to Lean principles, Company B exhibited a more pronounced endorsement of these changes compared to Company A. The statistically significant differences observed in Company B's responses point to a deeper integration of Lean principles within the organisational culture, potentially driven by factors such as effective communication strategies, training initiatives, or organisational leadership.

4.2.4.1 Quantitative inquiry

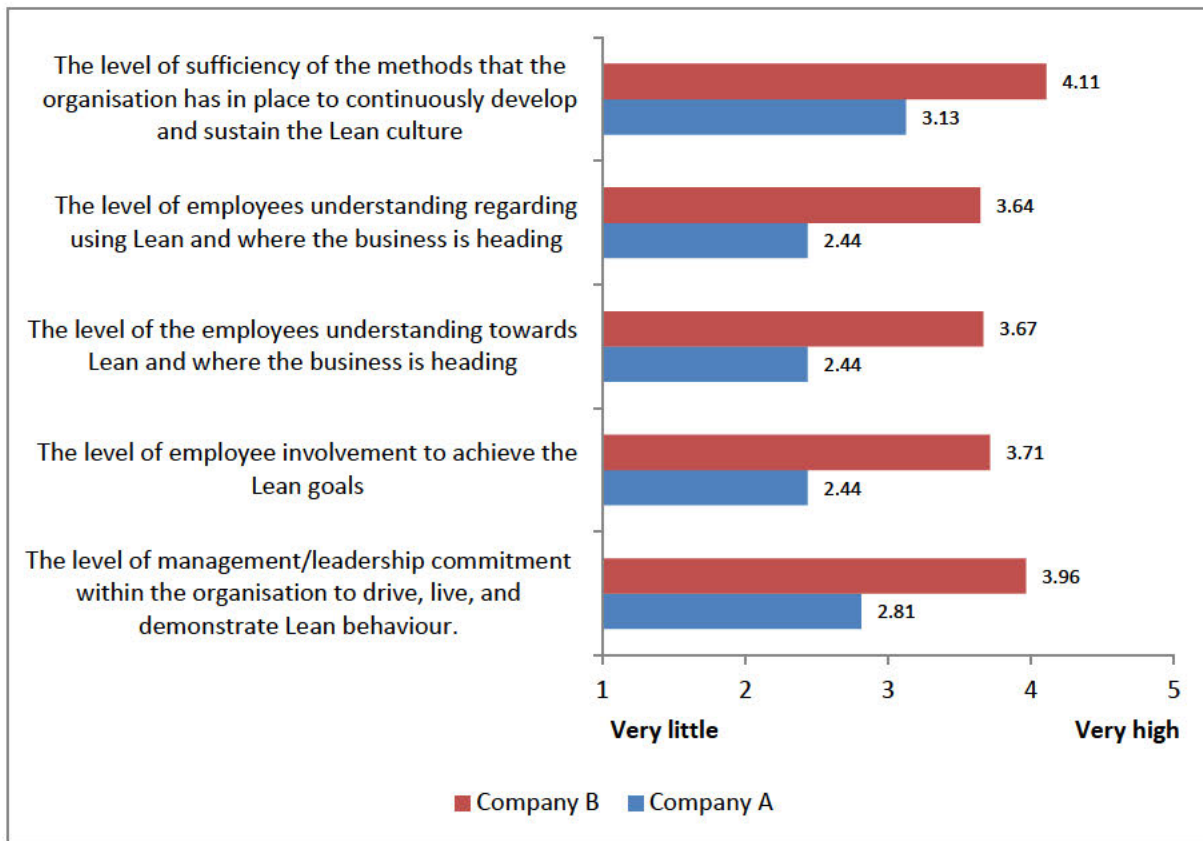


Figure 4.10: Responses to Questions

Table 4.9: Responses

	Company	One-sample t-test					Independent samples t-test			
		n	Mean (SD)	T	df	p-value	Mean difference	t	Df	p-value
The level of management/leadership commitment within the organisation to drive, live, and demonstrate Lean behaviour.	A	16	2.81 (.911)	-.824	15	.423	-1.152	-4.949	98	<.001
	B	84	3.96 (.842)	10.492	83	<.001				
The level of employee involvement to achieve the Lean goals	A	16	2.44 (.814)	-2.764	15	.014	-1.277	-6.133	98	<.001
	B	84	3.71 (.754)	8.686	83	<.001				
The level of the employees understanding towards Lean	A	16	2.44 (.964)	-2.334	15	.034	-1.229	-4.908	98	<.001

and where the business is heading	B	84	3.67 (.910)	6.718	83	<.001				
The level of employees understanding regarding using Lean and where the business is heading	A	16	2.44 (.892)	-2.522	15	.023	-1.205	-4.392	98	<.001
	B	84	3.64 (1.025)	5.745	83	<.001				
The level of sufficiency of the methods that the organisation has in place to continuously develop and sustain the Lean culture	A	16	3.13 (1.088)	.460	15	.652	-.982	-3.479	17.401	.003
	B	84	4.11 (.695)	14.610	83	<.001				

The following patterns were observed:

This analysis examines the differences between two groups (Group A and Group B) in various aspects related to lean implementation within an organisation.

- **Level of Management/Leadership commitment:**

Company A has a mean score of 2.81, indicating a moderate level of management/leadership commitment to drive, live, and demonstrate lean behaviour.

In contrast, Company B demonstrates a significantly higher mean score of 3.96, suggesting a strong commitment from management/leadership. This is supported by a large positive t-value (10.492) and a highly significant p-value (<.001).

- **Level of Employee involvement:**

Company A exhibits a mean score of 2.44, indicating a relatively low level of employee involvement in achieving lean goals.

Conversely, Company B displays a substantially higher mean score of 3.71, suggesting significantly greater employee involvement. This is supported by a large positive t-value (8.686) and a highly significant p-value (<.001).

- **Employees' understanding of lean and organisational direction:**

In both aspects of understanding lean and where the business is heading, Company A scores lower (mean scores of 2.44 and 2.44, respectively) compared to Company B (mean scores of 3.67 and 3.64, respectively).

This difference is further highlighted by the highly significant p-values (<.001) and notable mean differences between the companies, indicating a clearer understanding and alignment with Lean principles and organisational direction among employees in Company B.

- **Sufficiency of methods for lean culture development:**

Company A has a mean score of 3.13, suggesting a moderate level of sufficiency of methods for continuously developing and sustaining Lean culture.

In contrast, Company B demonstrates a higher mean score of 4.11, indicating a significantly greater sufficiency of methods. This is supported by a large positive t-value (14.610) and a highly significant p-value ($<.001$).

In summary, the analysis reveals differences between Company A and Company B in various aspects related to lean implementation. Company B appears to have stronger commitment from management/leadership, higher employee involvement, better understanding of lean principles and organisational direction among employees, and more effective methods for developing and sustaining lean culture. These findings underscore the importance of leadership commitment, employee engagement, and organisational alignment in the successful implementation and maintenance of lean practices.

4.2.4.2 Responses to the section on Continuous Improvement

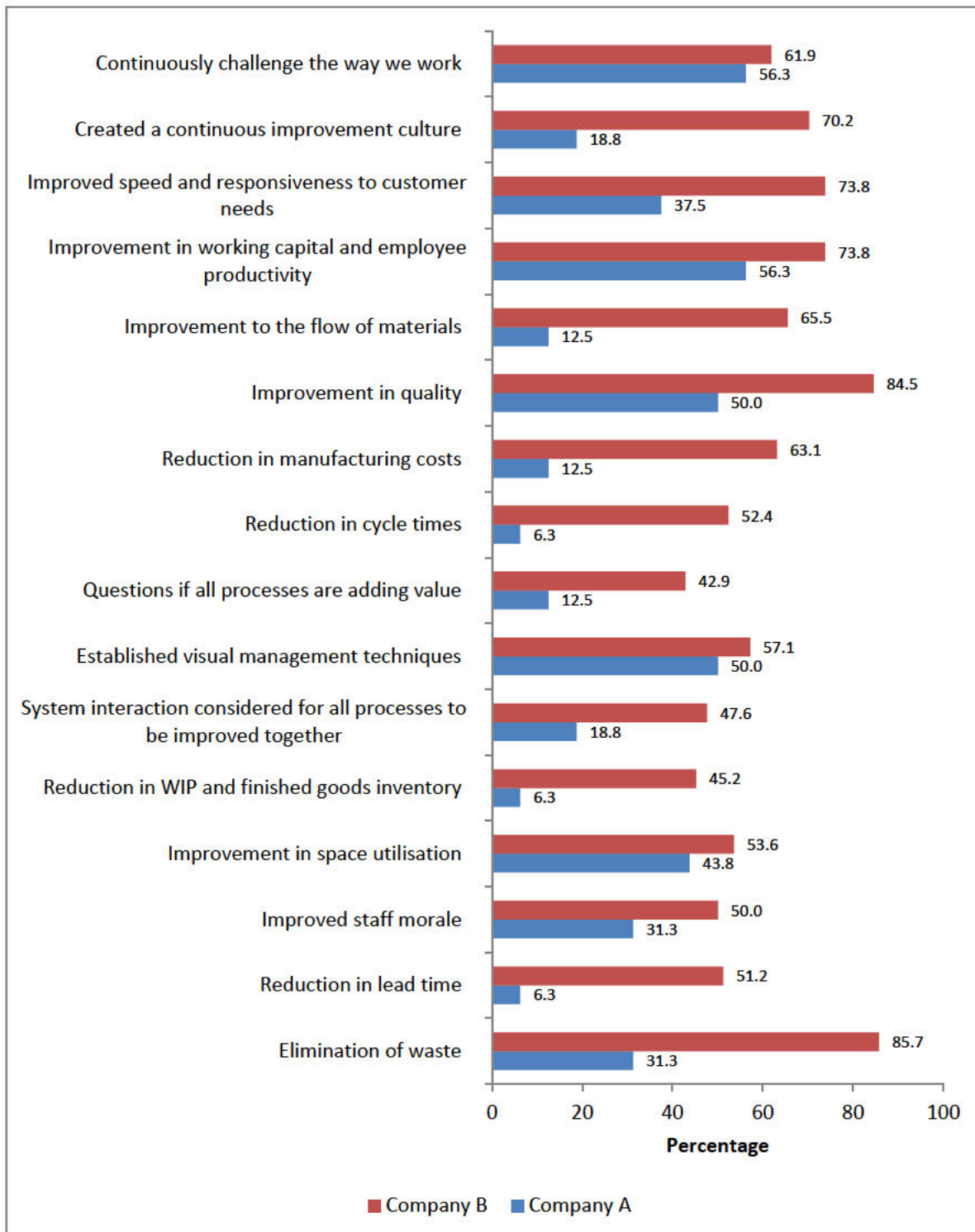


Figure 4.11: Responses on Continuous Improvement

In the analysis of improvements observed within the organisation post the adoption of lean techniques, several notable findings emerged. The data presented in Figure 4.11 illustrates the percentages of reported improvements across various dimensions in both Company A and Company B.

Firstly, the elimination of waste was notably higher in Company B (85.7%) compared to Company A (31.3%), suggesting a more effective reduction in wasteful processes. Similarly, Company B demonstrated significant improvements in various areas such as the reduction in lead time, improvement in space utilisation, establishment of visual management techniques, and enhancement of quality, with percentages notably surpassing those of Company A.

Moreover, Company B exhibited a remarkable advancement in fostering a continuous improvement culture, with 70.2% reporting such a culture compared to a mere 18.8% in Company A. This signifies a more robust commitment to ongoing enhancements and operational excellence within Company B.

Furthermore, Company B showcased higher percentages across dimensions like improvement in working capital and employee productivity, speed and responsiveness to customer needs, and the continuous challenge of existing processes. These results imply that Company B has been more adept at leveraging lean principles to drive positive organisational change and achieve operational excellence compared to Company A.

In summary, this indicates that the adoption of lean techniques has led to substantial improvements within both companies, with Company B demonstrating superior outcomes across several key performance areas. These findings highlight the effectiveness of lean methodologies in driving organisational improvement and fostering a culture of continuous enhancement.

4.2.4.3 Responses on the success of lean adoption

Table 4.10: Responses to the Success of Lean Adoption

The success of Lean Adoption	Company	Responses as Frequency (%)				Fisher's exact Test	p-value
		Total failure	Some success	Many areas	Total success		
How would you rate the success level of Lean adoption within the organisation?	A	1 (6.7)	13 (86.7)	1 (6.7)	0 (0)	46.336	<.001*
	B	0 (0)	6 (7.3)	38 (46.3)	38 (46.3)		

- **Analysis of lean adoption success**

In this section, the perceived success levels of Lean adoption within Company A and Company B are analysed and compared. The data presented in Table 4.10 illustrates the distribution of responses regarding the success of Lean adoption within each company, followed by a statistical analysis using Fisher's exact test to determine the significance of observed differences.

- **Perceived success levels**

Table 4.10 displays the frequency distribution of responses indicating the success level of Lean adoption within Company A and Company B. The responses are categorised into "Total Failure," "Some Success," "Many Areas were Successful," and "Total Success."

- **Company A:**

Majority of respondents (86.7%) reported "Some Success" in Lean adoption. A smaller proportion indicated "Total Failure" (6.7%) or "Many Areas were Successful" (6.7%), with no responses indicating "Total Success."

- **Company B:**

Responses were more evenly distributed, with 46.3% reporting "Many Areas were Successful" and an equal proportion indicating "Total Success."

A smaller percentage reported "Some Success" (7.3%), with no respondents reporting "Total Failure."

- **Statistical analysis**

Fisher's exact test was conducted to assess the significance of differences in perceived success levels between Company A and Company B.

The obtained p-value of $<.001$ indicates a highly significant difference in the success levels of Lean adoption between the two companies.

- **Implications**

The analysis suggests that Company B has achieved a higher level of success in Lean adoption compared to Company A. This finding has significant implications for both companies and broader organisational contexts:

Company B's approach to Lean adoption, characterised by a more balanced distribution of success levels, could serve as a potential model for improving Lean implementation in Company A or other organisations facing similar challenges.

Understanding the factors contributing to Company B's success could provide valuable insights for enhancing Lean initiatives in various organisational contexts.

4.3 Conclusion

A detailed interpretation and discussion of the findings of this study was presented in this chapter. The primary aim of the study was to investigate the level of effectiveness in the use of Lean Manufacturing Principles and compare the effectiveness within small and medium enterprises (SMEs). The data were captured and analysed using graphs and tables. The subsequent chapter will offer the findings and suggestions derived from the present study, alongside recommendations for future research undertakings.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The empirical study was conducted to compare the effectiveness of LMPs between a small and medium organisation in the apparel industry in KZN. This chapter presents the conclusions drawn from the rigorous examination of data gathered during the study, aiming to provide insights into the efficacy of Lean practices and their impact on SMEs. By analysing the findings, this section aims to clarify the effectiveness of Lean principles in enhancing operational efficiency, improving quality, reducing waste, and fostering continuous improvement within SMEs. Additionally, the chapter offers recommendations based on the identified strengths and weaknesses observed during the study, to provide actionable insights for SMEs aiming to implement or refine their Lean strategies. Furthermore, suggestions for future research directions are proposed to address any gaps identified and to further advance understanding in the field of LM within the context of SMEs.

5.2 Aims and Objectives

The aims and objectives of the conclusions and recommendations were to identify and assess the obstacles and challenges encountered by small and medium-sized enterprises (SMEs) when implementing LMPs. Additionally, the research sought to evaluate the effectiveness of LM practices within SMEs and compare the effectiveness across different-sized enterprises.

To accomplish the objectives, the study aimed to address the fundamental research questions of:

1. What are the LMPs adopted by the SMEs in the Apparel industry?
2. What are the similarities, differences, and best practices between SMEs in terms of LMPs?
3. What problems and challenges do SMEs encounter in implementing LMPs?

5.3 Summary of findings

A summary of findings from the empirical study is presented in this section.

5.3.1 Continuous Improvement variables analysis:

Both companies generally agree on the motivation aspect of continuous improvement.

Company B demonstrates significantly higher performance in various aspects, including employees' capabilities, feedback mechanisms, and recognition of employee contributions.

5.3.2 Total Quality/Zero Defects analysis:

Company A demonstrates significant agreement with maintaining quality control processes, but Company B consistently shows higher scores across all variables.

Company B exhibits a stronger commitment to Total Quality/Zero Defects principles, leading to better quality control and defect minimisation.

5.3.3 Just-in-Time (JIT) variables analysis:

Company B excels in JIT principles, demonstrating better inventory management, supplier performance, and production efficiency compared to Company A.

5.3.4 5S Methodology analysis:

Both companies prioritise maintaining tidy workspaces, but Company B shows better quality control and employee engagement through 5S practices.

5.3.5 Visual Boards analysis:

Company B effectively utilises visual boards for communication, recognition, and problem-solving, resulting in higher employee morale and engagement.

5.3.6 Multi-functional Teams analysis:

Company B's multi-functional teams exhibit superior performance in innovation, quality enhancement, and process efficiency compared to Company A.

5.3.7 Customer Input analysis:

Both companies value customer input, but Company B demonstrates slightly higher engagement in incorporating feedback into manufacturing processes.

5.3.8 Lean adoption success analysis:

Company B achieves a higher level of success in Lean adoption compared to Company A, with a more balanced distribution of success levels.

5.4 Conclusions

Conclusions and findings from the literature review and empirical study are presented in this chapter.

5.4.1 Conclusion from the literature review

The primary objective of adopting lean manufacturing practices is to enhance productivity, minimise lead times and costs, and elevate quality standards, thereby delivering maximum value to customers (Shah and Patel 2018).

The findings based on the literature review provide valuable insights into the LMPs adopted by SMEs in the Apparel industry, as well as the similarities, differences, best practices, problems, and challenges encountered in their implementation.

5.4.1.1 Lean manufacturing principles adopted by SMEs

The literature highlights key LMPs commonly adopted by SMEs in the Apparel industry, including 5S methodology, Just-in-Time (JIT) inventory management, Continuous Improvement (CI), Value Stream Mapping (VSM), and Visual Management (VM). These principles are integral to enhancing productivity, minimising waste, improving quality, and streamlining operations within the manufacturing process. (Reference: Literature Review Sections 2.14.10, 14.12, 14.13)

5.4.1.2 Similarities, differences, and best practices

Analysis of the literature reveals both commonalities and variations in the adoption and implementation of LMPs among SMEs. While core lean principles remain consistent across SMEs, differences arise in the approach to implementation based on factors such as company size, resource availability, and organisational culture. The best practices identified include strong leadership commitment, employee involvement, continuous training, effective communication channels, and a culture of continuous improvement. (Reference: Literature Review Sections 2.14.14, 2.14.15)

5.4.1.3 Problems and challenges in implementation

The literature highlights several challenges faced by SMEs in implementing LMPs, including limited resources, resistance to change, lack of expertise, and cultural barriers. These challenges hinder the successful adoption and sustainability of lean practices, posing significant hurdles to SMEs in the Apparel industry. (Reference: Literature Review Sections 2.14.14, 2.14.15)

In conclusion, while LMPs offer substantial benefits to SMEs in the Apparel industry, their effective adoption and implementation require careful consideration of contextual factors and proactive strategies to overcome challenges. Addressing these challenges and leveraging best practices can enhance the competitiveness and sustainability of SMEs from the dynamic manufacturing perspective.

5.4.2 Conclusion from the empirical study

5.4.2.1 Research Question 1: What are the lean manufacturing principles adopted by the SMEs in the Apparel industry?

Based on the empirical study, the LMPs adopted by SMEs in the Apparel industry include:

- Continuous Improvement: Both companies prioritise continuous improvement, with a focus on employee motivation, problem-solving capabilities, and feedback mechanisms.
- Total Quality/Zero Defects: Company B demonstrates a stronger commitment to total quality and zero defects principles compared to Company A, leading to better quality control and defect minimisation.
- Just-in-Time (JIT) Manufacturing: Company B excels in JIT principles, demonstrating better inventory management, supplier performance, and production efficiency compared to Company A.
- 5S Methodology: Both companies prioritise maintaining tidy workspaces, but Company B shows better quality control and employee engagement through 5S practices.
- Visual Management: Company B effectively utilises visual boards for communication, recognition, and problem-solving, resulting in higher employee morale and engagement.

- Multi-functional Teams: Company B's multi-functional teams exhibit superior performance in innovation, quality enhancement, and process efficiency compared to Company A.
- Customer Input: Both companies value customer input, but Company B demonstrates slightly higher engagement in incorporating feedback into manufacturing processes.

5.4.2.2 Research Question 2: What are the similarities, differences, and best practices between SMEs in terms of lean manufacturing principles?

- Similarities: Both SMEs prioritise continuous improvement and customer input, albeit with varying levels of implementation. They also emphasise the importance of maintaining tidy workspaces (5S methodology) and value visual management techniques for communication and problem-solving.
- Differences: Company B consistently demonstrates higher adherence and performance across various LMPs compared to Company A. These differences are particularly notable in areas such as total quality/zero defects, JIT manufacturing, and the effectiveness of multi-functional teams.
- Best Practices: The best practices observed include strong leadership commitment, employee involvement, effective visual management systems, and a culture of continuous improvement, which are more pronounced in Company B.

5.4.2.3 Research Question 3: What problems and challenges do SMEs encounter in implementing lean manufacturing principles?

- Challenges: While both companies show commitment to lean principles, Company A faces challenges such as lower employee involvement, weaker quality control measures, and less effective multi-functional teams compared to Company B. Additionally, Company A struggles with management/leadership style adaptation and employee acceptance of lean practices.
- Problems: Company A encounters difficulties in achieving the same level of success as Company B in lean adoption. These problems include lower levels of employee engagement, less effective management support, and a lack of clarity regarding lean principles and organisational direction.

In summary, the empirical study highlights the adoption, similarities, differences, and challenges faced by SMEs in implementing LMPs within the Apparel industry. Company B

emerges as a more successful adopter of lean practices, showcasing higher performance and stronger commitment across various lean principles compared to Company A.

5.5 Recommendations

The study concludes that LM positively impacts the manufacturing processes of small and medium organisations in the apparel industry in KZN. By comparing the effectiveness of LMPs between the two companies, it was found that Company B demonstrates a stronger commitment and higher performance across various lean principles compared to Company A. Specifically, Company B excels in areas such as total quality/zero defects, JIT manufacturing, 5S methodology, visual management, multi-functional teams, and customer input integration. The findings suggest that LMPs contribute to enhancing operational efficiency, quality control, inventory management, supplier performance, employee engagement, and customer satisfaction.

The following recommendations are made:

- **Embrace Lean Principles**

SMEs in the apparel industry in KZN should prioritise the adoption of LMPs to enhance operational efficiency and competitiveness.

- **Foster Continuous Improvement**

Establish a culture of continuous improvement by encouraging employee involvement, providing training on lean tools and techniques, and implementing feedback mechanisms.

- **Address implementation challenges**

Identify and address challenges such as lower employee involvement, weaker quality control measures, and management/leadership style adaptation issues to ensure successful lean implementation.

- **Learn from best practices**

Learn from the best practices observed in Company B, including strong leadership commitment, effective visual management systems, and a culture of continuous improvement.

- **Invest in employee training**

Provide comprehensive training to all employees on LMPs and techniques to enhance their understanding and ability to contribute to lean initiatives.

- **Enhance Multi-Functional Teams**

Strengthen multi-functional teams to drive innovation, quality enhancement, and process efficiency across the organisation.

- **Focus on Customer Input**

Increase engagement with customers and integrate their feedback into manufacturing processes to better meet their needs and preferences.

By implementing these recommendations, SMEs can optimise their manufacturing processes, improve productivity, reduce costs, and enhance overall competitiveness in the apparel industry in KZN.

5.6 Limitations

The study's focus on two specific companies, Company A (a small apparel company) and Company B (a medium-sized apparel company), may limit the generalisability of the findings to the broader apparel industry. The unique characteristics and circumstances of these companies may not fully represent the diversity of SMEs in the apparel industry, thereby restricting the applicability of the study's results to a larger target population.

The use of questionnaires as the primary method of data collection may have limitations. Questionnaires rely on participants' ability and willingness to accurately respond to survey items, which could introduce response bias or measurement errors. Additionally, questionnaires may not capture detailed or intricate information effectively, limiting the depth of understanding gained from the data.

Addressing these limitations in future research endeavors can contribute to the advancement of knowledge in the field and enhance the validity and reliability of study findings.

5.7 Suggestions for future study

Recommendations for future research:

- Investigate the long-term impact of applying LMPs on the performance and competitiveness of small and medium-sized apparel industries, extending the analysis over a more extended period to evaluate sustainability.
- Explore how LM practices differ between the apparel industry and other sectors like automotive or electronics through a comparative study across industries.
- Examine how advancements in digital technologies and Industry 4.0 contribute to the implementation and effectiveness of LMPs in small and medium-sized apparel industries.
- Investigate the cultural and organisational factors influencing the adoption and success of LM practices in various geographical regions or cultural contexts.
- Perform a study that tracks the advancement and continuous improvement efforts of small and medium-sized apparel industries as they apply LMPs over an extended duration.
- Explore the integration of sustainability and environmental management practices into LM initiatives within the apparel industry, focusing on waste reduction and environmental impact mitigation.
- Assess the potential for collaboration and knowledge exchange among small and medium-sized apparel industries to enhance their LM practices collectively.
- Evaluate different training and capacity-building programs designed to improve the LM capabilities of small and medium-sized apparel industries, considering factors such as effectiveness and adaptability.

These recommendations provide valuable paths for future research efforts, aiming to deepen the understanding of LM practices in the apparel sector and support the continuous improvement initiatives of small and medium-sized enterprises.

5.8 Conclusion

The study compares the effectiveness of LMPs between a small and medium-sized organisation in the apparel industry by integrating empirical observations with insights from relevant literature. The comparison between Company A and Company B yielded findings that align with existing research on LM, providing valuable context for understanding lean implementation in diverse organisational settings.

The findings reinforce established literature indicating the positive influence of LM on operational efficiency across industries, including apparel manufacturing. Company B's demonstrated proficiency in lean principles, such as total quality/zero defects, just-in-time manufacturing, 5S methodology, visual management, multi-functional teams, and customer input integration, mirrors established literature emphasising these principles' importance in lean implementation success. Furthermore, the study's identification of obstacles encountered by SMEs in lean implementation, such as limited employee engagement and management challenges, resonates with literature discussing common barriers and potential solutions. The study contributes to the body of knowledge on LM in the apparel sector by providing empirical evidence of its efficacy and highlighting both best practices and challenges. By combining empirical insights with existing literature, the study offers valuable guidance for apparel SMEs seeking to optimise their operations through lean principles. The findings underscore the importance of lean manufacturing principles in enhancing operational efficiency and competitiveness within the apparel industry.

REFERENCE LIST

- Aaker, D. A. and Moorman, C. 2023. *Strategic market management*. 12th ed. John Wiley & Sons.
- Abdelilah, B., El Korchi, A. and Amine Balambo, M. 2023. Agility as a combination of lean and supply chain integration: how to achieve a better performance. *International Journal of Logistics Research and Applications*, 26 (6): 633-661.
- Adinarayanan, A., Dinesh, S., Balaji, D. S. and Umanath, K. 2021. Design of machine cell in cellular manufacturing systems using PSO approach. *Materials Today: Proceedings*, 46: 3951-3955.
- Åhlström, P., Danese, P., Hines, P., Netland, T. H., Powell, D., Shah, R., Thürer, M. and van Dun, D. H. 2021. Is lean a theory? Viewpoints and outlook. *International Journal of Operations & Production Management*, 41 (12): 1852-1878.
- Ahmed, S. and Chowdhury, M. S. I. 2018. Increase the efficiency and productivity of sewing section through low performing operators improvement by using eight wastes of lean methodology. *Global Journal of Researches in Engineering*, 18 (2): 44-60.
- Akanle, O., Ademuson, A. O. and Shittu, O. S. 2020. Scope and limitation of study in social research. *Contemporary Issues in Social Research*, 105: 104-114.
- Al-Hakimi, M. A., Goail, M. M., Al-Hattami, H. M., Murshid, M. A., Saleh, M. H. and Moghalles, S. A. M. 2023. Improving operational performance of manufacturing SMEs: the interactive effect of technical and human lean practices. *International Journal of Quality & Reliability Management*, 40 (4): 1092-1110.
- Al-Zoubi, Z., Qablan, A., Issa, H., Bataineh, O. and Al Kaabi, A. 2023. The degree of implementation of total quality management in universities and its relationship to the level of community service from the perspectives of faculty members. *Sustainability*, 15: 1-14. Available: <https://doi.org/10.3390/su15032404> (Accessed 14 May 2023).
- Al Qayoudhi, S. 2022. A conceptual review of the adoption of lean philosophy tools in manufacturing companies. *International Journal of Research in Entrepreneurship & Business Studies*, 3 (1): 1-12.
- Alam, M. S., Selvanathan, E. A., Selvanathan, S. and Hossain, M. 2019. The apparel industry in the post-Multifiber Arrangement environment: A review. *Review of Development Economics*, 23 (1): 454-474.
- Alasbali, M. and Almaktoom, A. T. 2022. Impact of 5S method in apparel industry. In: Proceedings of *The International Research & Innovation Forum*. Springer, 145-153.
- Alasbali, M. and Almaktoom, A. T. 2023. Impact of 5S Method in Apparel Industry. In: Visvizi, A., Troisi, O. and Grimaldi, M. eds. *Proceedings of Research and Innovation Forum 2022*. Cham, Springer International Publishing, 145-153.

- Alefari, M., Almani, M. and Salonitis, K. 2020. Lean manufacturing, leadership and employees: the case of UAE SME manufacturing companies. *Production & Manufacturing Research*, 8 (1): 222-243.
- Ali, S. M., Haque, M. N., Sarker, M. R., Kandasamy, J. and Vlachos, I. 2024. Improving changeover techniques in apparel manufacturing through single minute exchange of die: implications for benchmarking. *Benchmarking: An International Journal*,
- Alimian, M., Ghezavati, V. and Tavakkoli-Moghaddam, R. 2020. New integration of preventive maintenance and production planning with cell formation and group scheduling for dynamic cellular manufacturing systems. *Journal of Manufacturing Systems*, 56: 341-358.
- Almeida Marodin, G. and Saurin, T. A. 2015. Managing barriers to lean production implementation: context matters. *International Journal of Production Research*, 53 (13): 3947-3962.
- Anil, A. P. and KP, S. 2019. TQM practices and its performance effects—an integrated model. *International Journal of Quality & Reliability Management*, 36 (8): 1318-1344.
- Anner, M. 2020. Squeezing workers' rights in global supply chains: Purchasing practices in the Bangladesh garment export sector in comparative perspective. *Review of international political economy*, 27 (2): 320-347.
- Antony, J., Psomas, E., Garza-Reyes, J. A. and Hines, P. 2021. Practical implications and future research agenda of lean manufacturing: a systematic literature review. *Production Planning & Control*, 32 (11): 889-925.
- Anwar, A., Jamil, K., Idrees, M., Atif, M. and Ali, B. 2023. An empirical examination of SMEs sustainable performance through lean manufacturing. *Knowledge and Process Management*, 30 (3): 227-329.
- Arca-Hernandez, M. A., Llagas-Llontop, S. E. and Khaburzaniya, I. 2022a. Implementation of lean manufacturing principles to increase productivity in SMEs in the manufacturing sector of clothing. In: *Proceedings of 2022 The 3rd International Conference on Industrial Engineering and Industrial Management*. 162-166.
- Arca-Hernandez, M. A., Llagas-Llontop, S. E. and Khaburzaniya, I. 2022b. Implementation of lean manufacturing principles to increase productivity in SMEs in the manufacturing sector of clothing. In: *Proceedings of The 3rd International Conference on Industrial Engineering and Industrial Management*. 162-166.
- Aripin, N. M., Nawanir, G., Mahmud, F., Fauzi, M. A., Hussain, S. and Lee, K. L. 2023. Systematic literature review: Theory perspective in lean manufacturing performance. *Management Systems in Production Engineering*, 31 (2): 230-241.
- Arora, N. and Gupta, S. 2020. Total quality management for employee engagement: a study. *Test Engineering and Management*, 82: 12769-12786.

- Arumugam, V., Kannabiran, G. and Vinodh, S. 2022. Impact of technical and social lean practices on SMEs' performance in automobile industry: A structural equation modelling (SEM) analysis. *Total Quality Management & Business Excellence*, 33 (1-2): 28-54.
- Arunachalam, T. and Palanichamy, Y. 2017. Does the soft aspects of TQM influence job satisfaction and commitment? An empirical analysis. *The TQM Journal*, 29 (2): 385-402.
- Aryadoust, V., Ng, L. Y. and Sayama, H. 2021. A comprehensive review of Rasch measurement in language assessment: Recommendations and guidelines for research. *Language Testing*, 38 (1): 6-40.
- Aryarathne, S. and Galahitiyawe, N. 2020. Impact of Lean Manufacturing Practices on Operational Performance: A Study in Sri Lankan Apparel Sector. *Peradeniya Management Review*, 2 (2)
- Asgari, K. M. 2019. Development of an RFID-enabled serial Kanban Production System with real time order scheduling. M.Sc. (Systems Engineering), University of Rhode Island. Available: <https://digitalcommons.uri.edu/theses/1497> (Accessed 10 May 2023).
- Atz, U. 2020. *Using exact binomial tests*. Available: <http://dx.doi.org/10.2139/ssrn.4007711> (Accessed 13 September 2023).
- Azamfirei, V., Psarommatis, F. and Lagrosen, Y. 2023. Application of automation for in-line quality inspection, a zero-defect manufacturing approach. *Journal of Manufacturing Systems*, 67: 1-22.
- Balakauskaitė, I. 2020. Challenges of lean model implementation in a manufacturing company. Kauno technologijos universitetas.
- Bamisaye, O. S., Oroye, O. A., Farayibi, P. K., Adeitan, A. D. and Agbo, S. 2023. Assessment of lean practices in small and medium garment manufacturing companies in South-Western Nigeria. *Journal of Applied Research in Technology & Engineering*, 4 (2): 87-96.
- Bashar, A., Hasin, A. A. and Adnan, Z. H. 2021. Impact of lean manufacturing: evidence from apparel industry in Bangladesh. *International Journal of Lean Six Sigma*, 12 (5): 923-943.
- Bashar, A., Hasin, A. A., Ray, S., Sakib, M. N., Rahman, M. M. and Bashar, N. B. 2024a. From waste to worth: a mediation analysis of lean manufacturing and operational performance in developing country. *The TQM Journal*, ahead-of-print (ahead-of-print)
- Bashar, A., Hasin, A. A., Sakib, M. N. and Bashar, N. B. 2024b. Lean implementation barriers in the apparel industry in Bangladesh. *International Journal of Lean Six Sigma*, 15 (4): 906-924.
- Beraldin, A. R., Danese, P. and Romano, P. 2022. Employee involvement for continuous improvement and production repetitiveness: a contingency perspective for achieving organisational outcomes. *Production Planning & Control*, 33 (4): 323-339.

- Berhe, H. H., Gebremichael, H. S. and Beyene, K. T. 2024. Empirical investigation of integrated Kaizen philosophy (continuous improvement) practices application for enhancing sustainable competitiveness of manufacturing industries of Ethiopia. *International Journal of Quality Engineering and Technology*, 10 (1): 19-66.
- Berndt, A. E. 2020. Sampling methods. *Journal of Human Lactation*, 36 (2): 224-226.
- Bhadu, J., Kumar, P., Bhamu, J. and Singh, D. 2022. Lean production performance indicators for medium and small manufacturing enterprises: modelling through analytical hierarchy process. *International Journal of System Assurance Engineering and Management*, 13 (2): 978-997.
- Bhasin, S. and Burcher, P. 2006. Lean viewed as a philosophy. *Journal of manufacturing technology management*, 17 (1): 56-72.
- Biswas, A. 2023. Lean Practices in the Textile Industry-a Comparison of Cases from India, the US, and Bangladesh. Master of Industrial Management and Engineering, Vaasa. Available: <https://urn.fi/URN:NBN:fi:amk-2023052413769> (Accessed 15 May 2024).
- Börnfeldt, P. 2023. Total Quality Management (TQM) and Process Organisation. In: *Work Organisation in Practice: From Taylorism to Sustainable Work Organisations*. Springer, 61-91.
- Bozarth, C. C. H. and Robert, B. 2019. *Introduction to operations and supply chain management* 5th ed. Upper Saddle River, New Jersey: Pearson Education Limited.
- Bubber, D., Jain, R. K. and Babber, G. 2023. Transforming product development and production to be lean for improving business performance. *Benchmarking: An International Journal*, 30 (9): 3021-3039.
- Bugvia, S. A., Hameeda, K., Jamila, M. F., Irfana, A., Murtazaa, S., Qaisera, M. and Bilala, M. 2021. Performance improvement through value stream mapping–A manufacturing case study. *Jurnal Kejuruteraan*, 33 (4): 1007-1018.
- Buschle, C., Reiter, H. and Bethmann, A. 2022. The qualitative pretest interview for questionnaire development: outline of programme and practice. *Quality & Quantity*, 56 (2): 823-842.
- Cabilan, C., McRae, J., Learmont, B., Taurima, K., Galbraith, S., Mason, D., Eley, R., Snoswell, C. and Johnston, A. N. 2022. Validity and reliability of the novel three-item occupational violence patient risk assessment tool. *Journal of Advanced Nursing*, 78 (4): 1176-1185.
- Cavallone, M. and Palumbo, R. 2022. Delving into the soft side of TQM: an analysis of the implications of employee involvement on management practices. *The TQM Journal*, 34 (5): 1096-1115.
- Cespedes-Pino, R., Hurtado-Laguna, J., Macassi-Jaurequi, I., Raymundo-Ibañez, C. and Dominguez, F. 2020. Lean Production Management Model based on Organizational Culture to Improve Cutting Process Efficiency in a Textile and Clothing SME in Peru. *IOP Conference Series: Materials Science and Engineering*, 796 (1): 012004.

- Chan, C. O. and Tay, H. L. 2018. Combining lean tools application in kaizen: a field study on the printing industry. *International Journal of Productivity and Performance Management*, 67 (1): 45-65.
- Che Ani, M. N. and Abdul Azid, I. 2020. Solving the Production Bottleneck Through Minimizing the Waste of Motion for Manual Assembly Processes. In: Abu Bakar, M. H., Azwa Zamri, F. and Öchsner, A. eds. *Progress in Engineering Technology II*. Cham: Springer International Publishing, 185-197. Available: https://doi.org/10.1007/978-3-030-46036-5_17 (Accessed 20 October 2022).
- Chu, X., Gao, D., Cheng, S., Wu, L., Chen, J., Shi, Y. and Qin, Q. 2019. Worker assignment with learning-forgetting effect in cellular manufacturing system using adaptive memetic differential search algorithm. *Computers & Industrial Engineering*, 136: 381-396.
- Ciccarelli, M., Papetti, A., Cappelletti, F., Brunzini, A. and Germani, M. 2022. Combining World Class Manufacturing system and Industry 4.0 technologies to design ergonomic manufacturing equipment. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, 16 (1): 263-279.
- Cohen, L., Manion, L. and Morrison, K. 2018. *Research methods in education* 8th ed. New York: Routledge.
- Cortez, C., Di Laura, N., Viacava, G., Raymundo, C. and Dominguez, F. 2020. Lean Manufacturing Model Based on Knowledge Management to Increase Compliance in the Production Process in Peruvian SMEs in the Textile Garment Sector. In: Kantola, J. I. and Nazir, S. eds. *Proceedings of Advances in Human Factors, Business Management and Leadership*. Cham, 2020//. Springer International Publishing, 103-111.
- Creswell, J. W. 2019. *Educational research : planning, conducting, and evaluating quantitative and qualitative research*. New Jersey: Pearson.
- Creswell, J. W. and Poth, C. N. 2016. *Qualitative inquiry and research design: choosing among five approaches*. Los Angeles: Sage Publications.
- da Silva, A. 2023. Application of Kaizen methodologies to optimize after-sales services in the automotive industry. Master Industrial Engineering and Management. Available: <https://hdl.handle.net/10216/151124> (Accessed 10 January 2024).
- Dahlgaard, J. J., Pettersen, J. and Dahlgaard-Park, S. M. 2011. Quality and lean health care: A system for assessing and improving the health of healthcare organisations. *Total Quality Management & Business Excellence*, 22 (6): 673-689.
- Das, A. and Das, M. 2023. Productivity improvement using different lean approaches in small and medium enterprises (SMEs). *Management Science Letters*, 13 (1): 51-64.
- Dave, P. Y. 2020. The history of lean manufacturing by the view of Toyota-Ford. *International Journal of Scientific & Engineering Research*, 11 (8): 1598-1602.
- Davis, N., Companiwala, A., Muschard, B. and Petrusch, N. 2020. 4th Industrial Revolution Design Through Lean Foundation. *Procedia CIRP*, 91: 306-311.

- de Villiers, R. 2022. Highly Innovative Organizations: Entrepreneurs, Intrapreneurs, Teams & Crowds in Partnership. In: de Villiers, R. ed. *The Handbook of Creativity & Innovation in Business: A Comprehensive Toolkit of Theory and Practice for Developing Creative Thinking Skills*. Singapore: Springer Nature Singapore, 379-409. Available: https://doi.org/10.1007/978-981-19-2180-3_18 (Accessed 10 September 2023).
- Debnath, B., Shakur, M. S., Bari, A. M. and Karmaker, C. L. 2023. A Bayesian Best–Worst approach for assessing the critical success factors in sustainable lean manufacturing. *Decision Analytics Journal*, 6: 100157.
- Demir, S. and Paksoy, T. 2023. Just-in-time and lean management. In: *Smart and Sustainable Operations and Supply Chain Management in Industry 4.0*. CRC Press, 223-236.
- 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 System Assurance Engineering and Management*, 10: 792-800.
- Dieste, M., Panizzolo, R., Garza-Reyes, J. A. and Anosike, A. 2019. The relationship between lean and environmental performance: Practices and measures. *Journal of Cleaner Production*, 224: 120-131.
- Dorval, M., Jobin, M.-H. and Benomar, N. 2019. Lean culture: a comprehensive systematic literature review. *International Journal of Productivity and Performance Management*, 68 (5): 920-937.
- Durairatnam, S., Chong, S. C., Jusoh, M. and Dharmaratne, I. R. 2021. Does people-related total quality management “work” for people? An empirical study of the Sri Lankan apparel industry. *The TQM Journal*, 33 (6): 1183-1200.
- Eggleston, T. 2022. Capacity multipliers: rapidly scaling production through line balancing and critical path reduction. M.Sc., Massachusetts Institute of Technology.
- El-Khalil, R. 2022. Lean manufacturing alignment with respect to performance metrics multinational corporations case study. *International Journal of Lean Six Sigma*, 13 (4): 778-802.
- Emon, M. M. H., Khan, T. and Siam, S. A. J. 2024. Quantifying the influence of supplier relationship management and supply chain performance: an investigation of Bangladesh’s manufacturing and service sectors. *Brazilian Journal of Operations & Production Management*, 21 (2): 2015-2015.
- Faisal, A. M. and Singh, K. S. 2019. Implementing lean technique by using value stream mapping (vsm) in a labourintensive small and medium enterprise (sme): case study of goods manufacturing company. *International Journal of Research in Engineering, IT and Social Sciences*, 9: 567-572.
- Fernandez-Diaz, L., Vera-Rojas, N. and Quiroz-Flores, J. C. 2024. Productivity Enhancement by Layout Redesign and Application of Lean Principles in the Apparel

- Industry. In: Proceedings of *International Conference on Industrial Engineering and Industrial Management*. Springer, 142-154.
- Fernando, T. D. and Ratnayake, V. 2021. Barriers for lean implementation in apparel industry. In: Proceedings of *2021 Moratuwa Engineering Research Conference (MERCon)*. IEEE, 620-625.
- Firchow, P. and Mac Ginty, R. 2020. Including hard-to-access populations using mobile phone surveys and participatory indicators. *Sociological Methods & Research*, 49 (1): 133-160.
- Flores-Meza, S., Limaymanta-Perales, J., Eyzaguirre-Munarriz, J., Raymundo-Ibañez, C. and Perez, M. 2020. Lean Manufacturing Model for production management to increase SME productivity in the non-primary manufacturing sector. *IOP Conference Series: Materials Science and Engineering*, 796 (1): 012019.
- Florescu, A. and Barabas, S. 2022. Development trends of production systems through the integration of lean management and industry 4.0. *Applied Sciences*, 12 (10): 4885-4911.
- Garza-Reyes, J. A., Kumar, V., Chaikittisilp, S. and Tan, K. H. 2018. The effect of lean methods and tools on the environmental performance of manufacturing organisations. *International Journal of Production Economics*, 200: 170-180.
- Gazzola, P., Pavione, E., Pezzetti, R. and Grechi, D. 2020. Trends in the fashion industry. The perception of sustainability and circular economy: A gender/generation quantitative approach. *Sustainability*, 12 (7): 2809.
- Gelmez, E., Özceylan, E., Mete, S. and Durmuşoğlu, A. 2020. An empirical research on Lean production awareness: The sample of gaziantep. *International Journal of Global Business and Competitiveness*, 15 (1): 10-22.
- George, M., Tung, V. N. D., Truc, L. P. T., Ngoc, N. M. and Nhi, L. K. Y. 2022. Kaizen Applications in Fashion and Textile Industries. In: Nayak, R. ed. *Lean Supply Chain Management in Fashion and Textile Industry*. Singapore: Springer Nature Singapore, 145-175. Available: https://doi.org/10.1007/978-981-19-2108-7_7 (Accessed 06 July 2023).
- Georgiev, S. and Ohtaki, S. 2020. Critical success factors for TQM implementation among manufacturing SMEs: Evidence from Japan. *Benchmarking: An International Journal*, 27 (2): 473-498.
- Gherghina, Ş. C., Botezatu, M. A., Hosszu, A. and Simionescu, L. N. 2020. Small and medium-sized enterprises (SMEs): The engine of economic growth through investments and innovation. *Sustainability*, 12 (1): 347.
- Ghobadian, A., Talavera, I., Bhattacharya, A., Kumar, V., Garza-Reyes, J. A. and O'Regan, N. 2020. Examining legitimatisation of additive manufacturing in the interplay between innovation, lean manufacturing and sustainability. *International Journal of Production Economics*, 219: 457-468.

- Gobert, C., Reutzel, E. W., Petrich, J., Nassar, A. R. and Phoha, S. 2018. Application of supervised machine learning for defect detection during metallic powder bed fusion additive manufacturing using high resolution imaging. *Additive Manufacturing*, 21: 517-528.
- Goshime, Y., Kitaw, D. and Jilcha, K. 2019. Lean manufacturing as a vehicle for improving productivity and customer satisfaction. *International Journal of Lean Six Sigma*, 10 (2): 691-714.
- Govender, C. M. and Jasson, C. C. 2018. Lean practices for efficiency in the South African hospitality sector. *African Journal of Hospitality, Tourism and Leisure*, 7 (2): 1-14.
- Govender, P. 2023. The effects of consumer protection legislation on challenges pertaining to student loan debt: a case study of the Durban University of Technology. MTech, Durban University of Technology.
- Gupta, A. and Gupta, N. 2022. *Research methodology*. Agra, India: SBPD Publications.
- Gupta, S. and Chandna, P. 2022. Implementation of kaizen a lean manufacturing tool in a surgical equipment manufacturing industry. *International Journal of Services and Operations Management*, 41 (4): 431-443.
- Gurahoo, N. and Salisbury, R. H. 2018. Lean and agile in small- and medium-sized enterprises: Complementary or incompatible? *South African Journal of Business Management*, 49 (1): 1-1-9.
- Gurumurthy, A., Nair, V. K. and Vinodh, S. 2021. Application of a hybrid selective inventory control technique in a hospital: a precursor for inventory reduction through lean thinking. *The TQM Journal*, 33 (3): 568-595.
- Hanson, G. H. 2021. *Who will fill China's shoes? The global evolution of labor-intensive manufacturing*. National Bureau of Economic Research.
- Haque, A., Jubair, T., Khan, K. and Saif, S. M. 2017. Prospect of implementation of lean manufacturing for apparel industries in Bangladesh. *American Journal of Engineering Research*, 6 (9): 86-96.
- Hardcopf, R., Liu, G. and Shah, R. 2021. Lean production and operational performance: The influence of organizational culture. *International Journal of Production Economics*, 235: 108060.
- Hassan, N., Elgamal, G. and Abdelaziz, I. 2018. The impact of applying visual management policies and 5S's on improving productivity within garment factories *Journal of Architectural Arts and Humanistic Sciences*, 4 (13): 529-544.
- Hatif, H., Lee, K. L. and Nawansir, G. 2024. Improving employee and workplace performance via lean manufacturing practices: a case study in textile company. *International Journal of Industrial Management*, 18 (1): 43-59.
- Hoque, I. 2022. Buyer-assisted lean intervention in supplier firms: a supplier development approach. *Journal of Manufacturing Technology Management*, 33 (1): 146-168.

- Hoque, I., Hasle, P. and Maalouf, M. M. 2020. Lean meeting buyer's expectations, enhanced supplier productivity and compliance capabilities in garment industry. *International Journal of Productivity and Performance Management*, 69 (7): 1475-1494.
- Hoque, I., Maalouf, M. M., Tanha, M., Islam, M. S., Alam, M. Z. and Sarker, M. 2023. Implementing and sustaining lean, buyer-supplier role, and COVID-19 pandemic: insights from the garment industry of Bangladesh. *International Journal of Lean Six Sigma*, ahead-of-print (ahead-of-print)
- Hou, J., Gelb, S. and Calabrese, L. 2017. *The shift in manufacturing employment in China*. London: Overseas Development Institute
- Huang, Z., Kim, J., Sadri, A., Doweiy, S. and Dargusch, M. S. 2019. Industry 4.0: Development of a multi-agent system for dynamic value stream mapping in SMEs. *Journal of Manufacturing Systems*, 52: 1-12.
- Huo, B., Gu, M. and Wang, Z. 2019. Green or lean? A supply chain approach to sustainable performance. *Journal of Cleaner Production*, 216: 152-166.
- Indriati, M. Y., Rasi, R. Z., Setiaji, B. and Hadiwinata, S. D. 2023. Identifying and eliminating waste in a coal mining industry: The value stream mapping analysis. *International Journal of Sustainable Construction Engineering and Technology*, 14 (5): 290-304.
- Iqbal, T., Huq, F. and Bhutta, M. K. S. 2018. Agile manufacturing relationship building with TQM, JIT, and firm performance: An exploratory study in apparel export industry of Pakistan. *International Journal of Production Economics*, 203: 24-37.
- Işık, E. E. and Yildiz, S. T. 2024. Integer and constraint programming models for the straight and U-shaped assembly line balancing with hierarchical worker assignment problem. *International Journal of Production Research*, 62 (14): 5269-5292.
- Islami, X. 2023. Lean manufacturing and firms' financial performance: The role of strategic supplier partnership and information sharing. *Benchmarking: An International Journal*, 30 (9): 2809-2831.
- Jana, P. and Tiwari, M. 2021. 1 - Lean management in apparel manufacturing. In: Jana, P. and Tiwari, M. eds. *Lean Tools in Apparel Manufacturing*. Woodhead Publishing, 1-16. Available: <https://www.sciencedirect.com/science/article/pii/B978012819426300014X> (Accessed 02 November 2022).
- Janasekaran, S., Vijayasree, V. P. and Chong, M. K. 2020. Cycle time reduction for coating process in manual assembly manufacturing towards economic sustainability. In: Proceedings of *IOP Conference Series: Materials Science and Engineering*. IOP Publishing, 012017.
- Järvenpää, E. and Lanz, M. 2020. Lean manufacturing and sustainable development. *Responsible Consumption and Production*: 423-432.
- Jayakumar, A. and Krishnaraj, A. K. 2017. Productivity improvement in stitching section of a garment manufacturing company. *International Journal of Innovative Research in Advanced Engineering*, 4 (12): 8-11.

- Jayawardane, K., Musthaffa, S. and Dias, M. 2022. Impact of Lean Manufacturing on Inventory Turnover Performances: Evidence From the Sri Lankan Apparel Industry. In: Proceedings of *2022 Moratuwa Engineering Research Conference (MERCon)*. IEEE, 1-6.
- Juarez, P. and Gregory, E. 2021. In situ thermal inspection of automated fiber placement for manufacturing induced defects. *Composites Part B: Engineering*, 220: 109002.
- Junior, R. G. P., Inácio, R. H., da Silva, I. B., Hassui, A. and Barbosa, G. F. 2022. A novel framework for single-minute exchange of die (SMED) assisted by lean tools. *The International Journal of Advanced Manufacturing Technology*, 119 (9-10): 6469-6487.
- Kankkunen, T. J. 2023. Resistance as part of 5S standard implementation at case company: Theory of Constraints and Layers of Resistance.
- Kapuria, T. K., Rahman, M. and Haldar, S. 2017. Root cause analysis and productivity improvement of an apparel industry in Bangladesh through kaizen implementation. *Journal of Applied Research on Industrial Engineering*, 4 (4): 227-239.
- Karunaratne, N. and Samarasinghe, H. 2019. Impact of lean implementation on employees' job satisfaction in the ABC Apparel manufacturing firm. *International Business Research*, 12 (11): 48-56.
- Kebede Adem, M. and Viridi, S. S. 2021. The effect of TQM practices on operational performance: an empirical analysis of ISO 9001: 2008 certified manufacturing organizations in Ethiopia. *The TQM Journal*, 33 (2): 407-440.
- Kesen, S. E. and Sert, M. 2020. A simulation analysis of a serial line pull system producing orders with various part types and volumes. *International Journal of Modelling and Simulation*, 40 (3): 184-200.
- Khan, M. A., Shaikh, S. A., Lakho, T. H. and Mughal, U. K. 2020. Potential of lean tool of value stream mapping (VSM) in manufacturing industries. In: Proceedings of *Proceedings of the International Conference on Industrial Engineering and Operations Management*. 3064-3074.
- Khan, S. A., Kaviani, M. A., J. Galli, B. and Ishtiaq, P. 2019. Application of continuous improvement techniques to improve organization performance: A case study. *International Journal of Lean Six Sigma*, 10 (2): 542-565.
- Khanuja, A. and Jain, R. K. 2023. The conceptual framework on integrated flexibility: an evolution to data-driven supply chain management. *The TQM Journal*, 35 (1): 131-152.
- Kharub, M., Gupta, H., Rana, S. and McDermott, O. 2023. Employee's performance and Kaizen events' success: does supervisor behaviour play a moderating role? *The TQM Journal*, 35 (8): 2336-2366.
- Kim, E. T. and Kim, S. 2020. Development of a modular garment assembly line simulator. *International Journal of Clothing Science and Technology*, 32 (5): 645-659.

- Kim, H.-Y. 2019. Statistical notes for clinical researchers: the independent samples t-test. *Restorative Dentistry & Endodontics*, 44 (3)
- Kovács, T., Kö, A. and Demeter, K. 2020. Measuring the impact of lean practices on manufacturing performance – case study from the process industry. *International Journal of Lean Six Sigma*, 11 (6): 1193-1218.
- Krdžalić, A. and Hodžić, L. 2019. Sustainable engineering challenges towards Industry 4.0: A comprehensive review. *Sustainable Engineering and Innovation*, 1 (1): 1-23.
- Kuknor, S. and Bhattacharya, S. 2021. Organizational inclusion and leadership in times of global crisis. *Australasian Accounting, Business and Finance Journal*, 15 (1): 93-112.
- Kulasekara, G. and Ranaweera, W. 2023. Impact of Lean Manufacturing Practices on Sustainability Performances in SMEs in Sri Lanka Special reference to apparel industry: Concept Paper. *Accelerating Societal Change Through Digital Transformation*: 387.
- Kumar, D. V., Mohan, G. M. and Mohanasundaram, K. 2019. Lean tool implementation in the garment industry. *Fibres & Textiles in Eastern Europe*,
- Kumar, K. S., Akila, K., Arun, K., Prabhu, S. and Selvakumar, C. 2022. Implementation of 5S practices in a small scale manufacturing industries. *Materials Today: Proceedings*, 62: 1913-1916.
- Kumar, M., Antony, J. and Douglas, A. 2009. Does size matter for Six Sigma implementation? Findings from the survey in UK SMEs. *The TQM journal*, 21 (6): 623-635.
- Kumar, T. S., Soumya, P., Manjari, V. M., Aishvariya, R. and Akalya, N. 2017. Implementation of lean manufacturing tools in garment industry. *IJLTEMAS VI (iii)*: 39-43.
- Latif, M. A., Vang, J. and Sultana, R. 2023. Individuals' psychosocial voice barriers in lean problem-solving teams. *International Journal of Productivity and Performance Management*, 72 (5): 1321-1337.
- Li, Y. and Zhang, S. 2022. Qualitative data analysis. In: *Applied Research Methods in Urban and Regional Planning*. Basel, Switzerland: Springer, 149-165.
- Lingkon, M. L. R., Saha, P. K., Manzid, A. A., Hasan, M. N. and Mahalanobish, S. K. 2024. Reducing sewing defects to increase productivity in the apparel industry of Bangladesh by integrating lean methodology. *International Journal of Research in Industrial Engineering*, 13 (2): 166-187.
- Losonci, D., Demeter, K. and Jenei, I. 2011. Factors influencing employee perceptions in lean transformations. *International Journal of Production Economics*, 131 (1): 30-43.
- Lugert, A., Batz, A. and Winkler, H. 2018. Empirical assessment of the future adequacy of value stream mapping in manufacturing industries. *Journal of Manufacturing Technology Management*, 29 (5): 886-906.

- Maia, L. C., Alves, A. C. and Leão, C. P. 2019. Implementing lean production to promote textile and clothing industry sustainability. *Lean engineering for global development*: 319-343.
- Makhija, A., Wickramasinghe, C. and Tiwari, M. 2021. 5 - Visual management. *Lean Tools in Apparel Manufacturing*: 131-208.
- Manurung, M., Anizar, A. and Ishak, A. 2024. Implementation of Lean Manufacturing Methodology and Its Application: A Literature Review. *Jurnal Sistem Teknik Industri*, 26 (1): 35-46.
- Manzanares-Cañizares, C., Sánchez-Lite, A., Rosales-Prieto, V. F., Fuentes-Bargues, J. L. and González-Gaya, C. 2022. A 5S lean strategy for a sustainable welding process. *Sustainability*, 14 (11): 6499.
- Masood, R., Lim, J. B., González, V. A., Roy, K. and Khan, K. I. A. 2022. A systematic review on supply chain management in prefabricated house-building research. *Buildings*, 12 (1): 40.
- Mathiyazhagan, K., Gnanavelbabu, A. and Agarwal, V. 2022. A framework for implementing sustainable lean manufacturing in the electrical and electronics component manufacturing industry: An emerging economies country perspective. *Journal of Cleaner Production*, 334: 130169.
- Maware, C. and Adetunji, O. 2019. Lean manufacturing implementation in Zimbabwean industries: Impact on operational performance. *International Journal of Engineering Business Management*, 11
- Mbatha, S. 2018. *Competitive Advantage, Threats and Opportunities in the South African Clothing, Textiles, Leather and Footwear (SACTLF) Industry*.
- Mbewe, J. K. 2022. Assessment of the lean frameworks and barriers in implementing lean manufacturing in South African manufacturing industries. University of Pretoria.
- McKim, C. A. 2017. The value of mixed methods research: A mixed methods study. *Journal of Mixed Methods Research*, 11 (2): 202-222.
- Mehta, V. B. and Dave, P. Y. 2020. Impact of 5S and lean manufacturing techniques in various organisations to enhance the productivity. *International Journal of Advances in Engineering and Management*, 2 (1): 421-436.
- Mkhize, D. M. 2022a. Factors influencing the competitiveness of small and medium clothing manufacturing enterprises in the eThekweni Municipal District in KwaZulu-Natal.
- Mkhize, D. M. 2022b. Factors influencing the competitiveness of small and medium clothing manufacturing enterprises in the eThekweni Municipal District in KwaZulu-Natal. Master of Management Sciences, Durban University of Technology.
- Mohammad, A., Hamja, A. and Hasle, P. 2024. Reduction of changeover time through SMED with RACI integration in garment factories. *International Journal of Lean Six Sigma*, 15 (2): 201-219.

- Mohan Prasad, M., Dhiyaneswari, J. M., Ridzwanul Jamaan, J., Mythreyan, S. and Sutharsan, S. M. 2020. A framework for lean manufacturing implementation in Indian textile industry. *Materials Today: Proceedings*, 33: 2986-2995.
- Mokwana, R. 2021. Exploring the sustainability of SMEs in the textile and clothing industry to create employment in South Africa. North-West University (South Africa).
- Monden, Y. 2011. *Toyota production system: an integrated approach to just-in-time*. CRC Press.
- Mthembu, Q. N. 2018. Employment practices of student library assistants in academic libraries in KwaZulu-Natal.
- Mukherjee, S. P. 2019. *A guide to research methodology: An overview of research problems, tasks and methods*. CRC Press.
- Mulugeta, L. 2021. Productivity improvement through lean manufacturing tools in Ethiopian garment manufacturing company. *Materials Today: Proceedings*, 37: 1432-1436.
- Naicker, V. 2017. The adoption of lean manufacturing principles in electronic manufacturing : a case of Altech UEC / Vanesh Naicker. Masters of Philosophy, Durban University of Technology.
- Nallusamy, S. and Saravanan, V. 2018. Optimization of process flow in an assembly line of manufacturing unit through lean tools execution. *International Journal of Engineering Research in Africa*, 38: 133-143.
- Odeyinka, O. F. and Nwoye, C. 2019. A Principal Component Analysis of Lean Six Sigma Tools and Techniques.
- Ojha, R. S., Kumar, V. and Singh, S. 2023. Impact of 5S on productivity and quality in an Indo-Japanese auto-component manufacturing company: An empirical study. In: Proceedings of *E3S Web of Conferences*. EDP Sciences, 01241.
- Olszewski, M. 2023. Agile project management as a stage for creativity: a conceptual framework of five creativity-conducive spaces. *International Journal of Managing Projects in Business*, 16 (3): 496-520.
- Padilha, C. K. and Gomes, G. 2016. Innovation culture and performance in innovation of products and processes: a study in companies of textile industry. *RAI Revista de Administração e Inovação*, 13 (4): 285-294.
- Palange, A. and Dhattrak, P. 2021. Lean manufacturing a vital tool to enhance productivity in manufacturing. *Materials Today: Proceedings*, 46: 729-736.
- Pandey, P. and Pandey, M. M. 2021. *Research methodology tools and techniques*. Bridge Center.
- Patel, M. and Patel, N. 2019. Exploring research methodology. *International Journal of Research and Review*, 6 (3): 48-55.

- Peças, P., Faustino, M., Lopes, J. and Amaral, A. 2022. Lean methods digitization towards lean 4.0: a case study of e-VMB and e-SMED. *International Journal on Interactive Design and Manufacturing (IJIDeM)*, 16 (4): 1397-1415.
- Peralta, C. B. d. L., Echeveste, M. E., Lermen, F. H., Marcon, A. and Tortorella, G. 2020. A framework proposition to identify customer value through lean practices. *Journal of Manufacturing Technology Management*, 31 (4): 725-747.
- Pereira, B. A. 2023. Digital transformation: Digital performance assessment approach in the industry. M.Eng., Universidade Do Porto. Available: https://sigarra.up.pt/feup/en/pub_geral.pub_view?pi_pub_base_id=635467 (Accessed 20 January 2024).
- Perera, D., Wickramarachchi, R., Abeysekara, N. and Vidanagamachchi, K. 2020. Moving from Lean to Leagile: A Framework to Improve Supply Chain Performance of Fashion Garment Manufacturing. In: Proceedings of *International Conference on Industrial Engineering and Operations Management Dubai, UAE*. 10-12.
- Pharaon, J. W. 2022. An agilized total productive maintenance framework to reduce unplanned downtime. The George Washington University.
- Pinedo, D. A. C., Valladolid, A. C. C. and Padilla, R. D. P. L. 2022. Study of the 5'S methodology and its performance in manufacturing organizations: a literature review. *Journal of Scientific and Technological Research Industrial*, 3 (2): 02-14.
- Powell, D., Magnanini, M. C., Colledani, M. and Myklebust, O. 2022. Advancing zero defect manufacturing: A state-of-the-art perspective and future research directions. *Computers in Industry*, 136: 103596.
- Prakash, C. and Mothilal, B. 2018. Implementation of lean tools in apparel industry to improve productivity and quality. *Current Trends in Fashion Technology & Textile Engineering*, 4 (1): 9-14.
- Psarommatis, F., Vuichard, M. and Kiritsis, D. 2020. Improved heuristics algorithms for re-scheduling flexible job shops in the era of Zero Defect manufacturing. *Procedia Manufacturing*, 51: 1485-1490.
- Psomas, E. and Antony, J. 2019. Research gaps in Lean manufacturing: a systematic literature review. *International Journal of Quality & Reliability Management*, 36 (5): 815-839.
- Raabe, H., Myklebust, O. and Eleftheriadis, R. 2018. Vision based quality control and maintenance in high volume production by use of zero defect strategies. In: Proceedings of *Advanced Manufacturing and Automation VII 7*. Springer, 405-412.
- Raaz, M. N. N. and Aman, A. 2020. Study on 7 Wastes of Lean in Garments Manufacturing. *International Journal of Multidisciplinary Informative Research and Review* 1(1): 49-60.
- Rahman, M. M. 2023. Sample size determination for survey research and non-probability sampling techniques: A review and set of recommendations. *Journal of Entrepreneurship, Business and Economics*, 11 (1): 42-62.

- Rahman, S. S., Abdul, B., Manjurul, H. and Mahmud, M. I. 2023. Impact of lean manufacturing on productivity and layout design in sewing section of a garment industry. *International Journal of Industrial Management*, 17 (3): 152 - 161.
- Rahmanasari, D., Sutopo, W. and Rohani, J. M. 2021. Implementation of Lean Manufacturing Process to Reduce Waste: A Case Study. *IOP Conference Series: Materials Science and Engineering*, 1096 (1): 012006.
- Raj, D., Ma, Y. J., Gam, H. J. and Banning, J. 2017. Implementation of lean production and environmental sustainability in the Indian apparel manufacturing industry: a way to reach the triple bottom line. *International Journal of Fashion Design, Technology and Education*, 10 (3): 254-264.
- Raja Santhi, A. and Muthuswamy, P. 2022. Influence of blockchain technology in manufacturing supply chain and logistics. *Logistics*, 6 (1): 15.
- Ramasubramaniam, P. 2020. Productivity improvement by reducing waiting time and over production using lean manufacturing technique. *International Journal of Recent Engineering Science*, 7 (4): 20-26.
- Rana, M., Hoque, I. and Allen, M. 2019. Multinational's business model, governance and relationship, and suppliers' capability development in cross-border dyads. In: *Proceedings of Proceedings of the 45th European International Business Academy (EIBA) Annual Conference*. Leeds, UK,
- Rashid, A., Shah, A., Ain, H. N. U., Khan, S. and Adamjee, A. 2024. Benefits of using data-driven lean manufacturing in textile and apparel manufacturing units in pakistan. *The Asian Bulletin of Big Data Management*, 4 (02): 4(2),115-132.
- Rathilall, R. 2011. Improving quality and productivity through lean manufacturing at an automotive manufacturing organisation in Durban. M.Tech Quality, Durban University of Technology.
- Realyvásquez-Vargas, A., Arredondo-Soto, K. C., Carrillo-Gutiérrez, T. and Ravelo, G. 2018. Applying the Plan-Do-Check-Act (PDCA) cycle to reduce the defects in the manufacturing industry. A case study. *Applied Sciences*, 8 (11): 2181.
- Reddy, N. 2021. Lean manufacturing strategies in small and medium enterprises: a case of a Durban shoe manufacturer. Master of Commerce, University of KwaZulu-Natal.
- Rini, S. 2021. Implementation of lean thinking through A3 report in plastic injection company. *International Journal of Industrial Optimization*, 2 (1): 63.
- Ross, A. and Willson, V. L. 2017. One-sample T-test. In: *Basic and advanced statistical tests*. Brill, 9-12.
- Sadiku, M. N., Olaleye, O. D. and Musa, S. M. 2019. Smart manufacturing: A primer. *International Journal of Trend in Research and Development*, 6 (6): 9-12.

- Saffar, N. and Obeidat, A. 2020. The effect of total quality management practices on employee performance: The moderating role of knowledge sharing. *Management Science Letters*, 10 (1): 77-90.
- Sahoo, S. and Yadav, S. 2018a. Lean implementation in small-and medium-sized enterprises: An empirical study of Indian manufacturing firms. *Benchmarking: An International Journal*, 25 (4): 1121-1147.
- Sahoo, S. and Yadav, S. 2018b. Total quality management in Indian manufacturing SMEs. *Procedia Manufacturing*, 21: 541-548.
- Sangwa, N. R. and Sangwan, K. S. 2023. Leanness assessment of a complex assembly line using integrated value stream mapping: a case study. *The TQM Journal*, 35 (4): 893-923.
- Santosa, W. and Sugarindra, M. 2018. Implementation of lean manufacturing to reduce waste in production line with value stream mapping approach and Kaizen in division sanding upright piano, case study in: PT. X. In: *Proceedings of MATEC Web of Conferences*. EDP Sciences, 01095.
- Saunders, M. N., Lewis, P. and Thornhill, A. 2023. *Research Methods for Business Students*. 9th ed. Harlow: Pearson Education.
- Schmitt, T., Wolf, C., Lennerfors, T. T. and Okwir, S. 2021. Beyond “Leaneer” production: A multi-level approach for achieving circularity in a lean manufacturing context. *Journal of Cleaner Production*, 318: 128531.
- Schulze, F. and Dallasega, P. 2023. Barriers to lean implementation in engineer-to-order manufacturing with subsequent assembly on-site: state of the art and future directions. *Production Planning & Control*, 34 (1): 91-115.
- Sekaran, U. and Bougie, R. 2013. *Research methods for business : a skill-building approach*. 6th ed. Chichester, West Sussex: Wiley.
- Sekaran, U. and Bougie, R. 2016. *Research methods for business: a skill building approach*. West Sussex: John Wiley & Sons.
- Shafie, S., Majid, F., Damio, S. M. and Hoon, T. S. 2020. Evaluation on the face and content validity of a soft skills transfer of training instrument. *International Journal of Academic Research in Business and Social Sciences*, 10 (10): 1054-1065.
- Shah, D. and Patel, P. 2018. Productivity improvement by implementing lean manufacturing tools in manufacturing industry. *International Research Journal of Engineering and Technology*, 5 (3): 3-7.
- Shah, R. and Ward, P. T. 2007. Defining and developing measures of lean production. *Journal of operations management*, 25 (4): 785-805.
- Shahriar, M., Parvez, M., Islam, M. and Talapatra, S. 2022. Implementation of 5S in a plastic bag manufacturing industry: A case study. *Cleaner Engineering and Technology*, 8: 100488.
- Showkat, N. and Parveen, H. 2017. Non-Probability and Probability Sampling. In. 1-9.

- Shrimali, A. K. and Soni, V. K. 2017. A review on issues of lean manufacturing implementation by small and medium enterprises. *International Journal of Mechanical and Production Engineering Research and Development (IJMPERD)*, 7 (3): 283-300.
- Siedlecki, S. L. 2020. Understanding Descriptive Research Designs and Methods. *Clinical Nurse Specialist*, 34 (1)
- Singh, J., Gupta, A. and Trehan, R. 2022. Productivity improvement using value stream mapping and simulation-case studies. *International Journal of Business Process Integration and Management*, 11 (2): 109-128.
- Singh, S. and Kumar, K. 2021. A study of lean construction and visual management tools through cluster analysis. *Ain Shams Engineering Journal*, 12 (1): 1153-1162.
- South African Market Insights. 2019. *South Africa's Manufacturing Industry*. Available: <https://www.southafricanmi.com/south-africas-manufacturing-industry.html> (Accessed 20 April 2023).
- Srinivasan, R., Lohith, C., Srinivasan, R. and Lohith, C. 2017. Pilot Study—Assessment of validity and reliability. *Strategic marketing and innovation for Indian MSMEs*: 43-49.
- Steinberg, M. 2021. Management's mediations: The case of toyotism. *Media and Management*: 1-30.
- Stoecker, R. and Avila, E. 2021. From mixed methods to strategic research design. *International Journal of Social Research Methodology*, 24 (6): 627-640.
- Stratton, S. J. 2021. Population Research: Convenience Sampling Strategies. *Prehospital and Disaster Medicine*, 36 (4): 373-374.
- Subramanian, N. and Suresh, M. 2024. Lean HRM practices in manufacturing SMEs: exploring the interplay among the influencing factors. *International Journal of Organizational Analysis*, ahead-of-print (ahead-of-print)
- Taçoğlu, C., Ceylan, C. and Kazançoğlu, Y. 2019. Analysis of variables affecting competitiveness of SMEs in the textile industry. *Journal of Business Economics and Management*, 20 (4): 648-673.
- Tahiduzzaman, M., Rahman, M., Dey, S. K. and Kapuria, T. K. 2018. Minimization of sewing defects of an apparel industry in Bangladesh with 5S & PDCA. *American Journal of Industrial Engineering*, 5 (1): 17-24.
- Tesfay, Y. Y. 2021. Models of Continuous Improvement. In: Tesfay, Y. Y. ed. *Developing Structured Procedural and Methodological Engineering Designs: Applied Industrial Engineering Tools*. Cham: Springer International Publishing, 239-269. Available: https://doi.org/10.1007/978-3-030-68402-0_8 (Accessed 03 July 2023).
- The Banking Association Of South Africa. 2019. *Small and medium enterprise*. Available: <https://www.banking.org.za/what-we-do/sme/> (Accessed 12 February 2023).

- Thulasi, M., Faieza, A., Azfanizam, A. and Leman, Z. 2022. State of the Art of Dynamic Value Stream Mapping in the Manufacturing Industry. *Journal of Modern Manufacturing Systems and Technology*, 6 (1): 41-52.
- Toki, G. F. I., Ahmed, T., Hossain, M. E., Alave, R. K. K., Faruk, M. O., Mia, R. and Islam, S. R. 2023. Single Minute Exchange Die (SMED): A sustainable and well-timed approach for Bangladeshi garments industry. *Cleaner Engineering and Technology*, 12: 100592.
- Touriki, F. E., Benkhati, I., Kamble, S. S. and Belhadi, A. 2021. An integrated smart, green, resilient, and lean manufacturing framework: A literature review and future research directions. *Journal of Cleaner Production*, 319: 128691.
- Tseng, M.-L., Bui, T.-D., Lim, M. K., Fujii, M. and Mishra, U. 2022. Assessing data-driven sustainable supply chain management indicators for the textile industry under industrial disruption and ambidexterity. *International Journal of Production Economics*, 245: 108401.
- Turhan, N. S. 2020. Karl Pearson's Chi-Square Tests. *Educational Research and Reviews*, 16 (9): 575-580.
- Ünal, C. and Bilget, S. 2021. Examination of lean manufacturing systems by simulation technique in apparel industry. *The Journal of The Textile Institute*, 112 (3): 377-387.
- Valamede, L. S. and Akkari, A. C. S. 2020. Lean 4.0: A new holistic approach for the integration of lean manufacturing tools and digital technologies. *International Journal of Mathematical, Engineering and Management Sciences*, 5 (5): 851.
- Vanichchinchai, A. 2020. Exploring organizational contexts on lean manufacturing and supply chain relationship. *Journal of Manufacturing Technology Management*, 31 (2): 236-259.
- Veres, C. 2020. Conceptual Model for Introducing Lean Management Instruments. *Procedia Manufacturing*, 46: 233-237.
- Verma, R., Verma, S. and Abhishek, K. 2024. *Research Methodology*. Booksclinic Publishing.
- Vinodh, S. 2022. *Lean manufacturing: fundamentals, tools, approaches, and industry 4.0 integration*. CRC Press.
- Wickramasinghe, G. L. D. and Wickramasinghe, V. 2017. Implementation of lean production practices and manufacturing performance. *Journal of Manufacturing Technology Management*, 28 (4): 531-550.
- Womack, J. P. and Jones, D. T. 1994. From lean production to the lean enterprise. *Harvard Business Review*, 72: 93-103.
- Womack, J. P. and Jones, D. T. 1996. *Lean thinking : banish waste and create wealth in your corporation*. New York: Simon and Schuster.
- Womack, J. P., Jones, D. T. and Roos, D. 2007. Machine That Changed the World. *Bloomsbury Business Library - Management Library*: 50-50-50.

- Wood, G. and Bischoff, C. 2020. Challenges and progress in integrating knowledge: cases from clothing and textiles in South Africa. *Journal of Knowledge Management*, 24 (1): 32-55.
- Xu, Y. and Chen, M. 2018. An Internet of Things based framework to enhance just-in-time manufacturing. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture*, 232 (13): 2353-2363.
- Xu, Y., Thomassey, S. and Zeng, X. 2018. AI for Apparel Manufacturing in Big Data Era: A Focus on Cutting and Sewing. *Artificial Intelligence for Fashion Industry in the Big Data Era*: 125-151.
- Yadav, V., Jain, R., Mittal, M. L., Panwar, A. and Sharma, M. K. 2019. An appraisal on barriers to implement lean in SMEs. *Journal of Manufacturing Technology Management*, 30 (1): 195-212.
- Yamamoto, K., Milstead, M. and Lloyd, R. 2019. A review of the development of lean manufacturing and related lean practices: The case of Toyota Production System and managerial thinking. *International Management Review*, 15 (2): 21-90.
- Yelles-Chaouche, A. R., Gurevsky, E., Brahim, N. and Dolgui, A. 2021. Reconfigurable manufacturing systems from an optimisation perspective: a focused review of literature. *International Journal of Production Research*, 59 (21): 6400-6418.
- Yilmaz, O. F., Ozcelik, G. and Yeni, F. B. 2020. Lean holistic fuzzy methodology employing cross-functional worker teams for new product development projects: A real case study from high-tech industry. *European Journal of Operational Research*, 282 (3): 989-1010.
- Yu, D. and Ye, T. 2023. Tracing the lean thinking in supply chain management: a comprehensive main path analysis. *International Journal of Lean Six Sigma*, 14 (2): 483-513.
- Zhang, Q. and Cao, M. 2018. Exploring antecedents of supply chain collaboration: Effects of culture and interorganizational system appropriation. *International journal of Production economics*, 195: 146-157.

APPENDICES

Appendix A - Gatekeeper letter

Durban University of Technology
Faculty of Management Sciences
Department of Operations and Quality Department
ML Sultan Campus

14 May 2024 Re: Pushpa Govender permission to conduct research

This is to confirm that Pushpa Govender, a DUT graduate student, has permission to conduct research at [redacted] master's qualification, a study on: "Comparing the effectiveness of Lean Manufacturing Principles between a small and medium organisation in the apparel industry in KZN"

Kind Regards,



Durban University of Technology.
Faculty of Management Sciences
Department of Operations and Quality Department

15 May 2024

To whom it may concern

This letter serves to confirm that Pushpa Govender, student of Durban University of Technology (DU T), has permission to conduct research at for the below mentioned topic "Comparing the effectiveness Manufacturing Principles between a small and medium organisation in the apparel industry in KZN."

Please contact me should there be any queries.

Yours Sincerely

Appendix B - Letter Of Information



Faculty of Management Science

Department of Operations and Quality Management

Dear Participant

Thank you for participating in my study titled: Comparing the effectiveness of Lean Manufacturing Principles between a small and medium organisation in the apparel industry in KZN.

Attached is a letter of information together with a consent form. Kindly sign and return the completed questionnaire to the researcher.

I humbly request your assistance in completing this study. Should you require further information do not hesitate to contact either my supervisor or me.

Yours Sincerely

Pushpa Govender

0793104626

Supervisor:
Dr R Naidoo

Contact no: 0313735352

Appendix C – Letter Of Consent



CONSENT

Full Title of the Study: Comparing the effectiveness of Lean Manufacturing Principles between a small and medium enterprise in the apparel industry in KZN

Names of Researcher/s: Pushpa Govender

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Mrs. Pushpa Govender, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____,
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

_____	_____	_____	_____
Full Name of Participant	Date	Time	Signature / Right
Thumbprint			

I, Pushpa Govender herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full Name of Researcher
Mrs Pushpa Govender
Tel: 0313732417
Cell: 0793104626
Email: Priscillag@dut.ac.za

Date

Signature

Full Name of Witness (If applicable) **Date**

Signature

Full Name of Legal Guardian (If applicable) **Date**

Signature

Appendix D – Ethics Clearance Report



Institutional Research Ethics Committee

Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court

Gate I, Steve Biko Campus

Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 0313732375

Email: lavishad@dut.ac.za

http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

7 September 2023

Ms P Govender
54 Redcliffe Drive
Redcliffe Community
Verulam
4339

Dear Ms Govender

Comparing the effectiveness of Lean Manufacturing Principles between a small and medium organisation in the apparel industry in KZN

Ethical Clearance number IREC 047/23

The DUT-Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

Please note that **FULL APPROVAL** is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the DUT-IREC according to the DUT-IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the DUT-IREC as outlined in the DUT-IREC SOP's.

It is compulsory for a student or researcher to apply for recertification on an annual basis. The failure to do so will result in withdrawal of ethics clearance. It is the responsibility of the researcher and the supervisor to apply for recertification.

Please note that you are required to submit a Notification of Completion of Study form together with an abstract to the DUT-IREC office on completion of your study.

A handwritten signature in black ink, appearing to be 'J. K. A.', written over a horizontal line.

Chairperson: DUT-IREC

Appendix E - Questionnaire

DURBAN UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF OPERATIONS AND QUALITY MANAGEMENT

TOPIC: Comparing the effectiveness of Lean Manufacturing Principles between a small and medium organisation in the apparel industry in KZN

This questionnaire was designed to gather factual information that could provide a profile for the apparel industry and give more insight into the factors that can influence the development of Lean manufacturing strategies.

The information provided in the questionnaire will remain confidential and will only be used for the purpose of the study.

Where applicable please place an (x) in the appropriate response.

Section 1:

Please mark a cross indicating the department you work in	
Design Department	
Fabric store	
Fabric testing laboratory	
Fabric inspection	
Trims store	
Cutting room	
Production department	
Final inspection	
Despatch and delivery	

Section 2:

Job Title	
Manager	
Section Manager	
Supervisor	

Training manager	
Team leader	
Quality control inspector	
Quality Manager	

Section 3:

1.	Continuous Improvement: This is an ongoing process to make improvements and identify areas of waste.	Strongly disagree	Disagree	Not sure	Strongly agree	Agree
1.1	All employees are motivated by being involved in continuous improvement					
1.2	Employee training plays a positive role in continuous improvement					
1.3	Employees are capable of identifying problems and making suggestions.					
1.4	Feedback on performance is continuous					
1.5	Employee recommendations and problem-solving are recognised					
1.6	Continuous improvement relates to the capabilities of employees					

2.	Total Quality/ Zero Defects: A manner of thinking and acting that promotes the idea that errors are unacceptable. A continuous process of detecting and reducing errors in manufacturing.	Strongly disagree	Disagree	Not sure	Strongly agree	Agree
2.1	We maintain well-defined quality control processes at various stages of our operations					
2.2	Operators are responsible for identifying defective parts at the source of the operation.					
2.3	We actively monitor and analyse defect rates to drive continuous improvement					
2.4	All steps of fabric testing are done					
2.5	Sample seals are related to the specification of style details					

2.6	We collaborate with suppliers to ensure high quality fabric in production					
2.7	Customer feedback on product quality significantly influences our quality improvement efforts.					
2.8	All changes are amended on the specification of the order.					
2.9	Continuous employee training is provided to maintain a strong focus on quality across all our operations					
2.10	Roving Quality does inspections from the preparation stage continuously.					
2.11	We conduct regular quality audits to identify and rectify any issues in our processes					

3.	Just in Time: JIT is a form of inventory management that requires a minimum amount of inventory on hand to meet demand.	Strongly disagree	Disagree	Not sure	Strongly agree	Agree
3.1	All fabrics are ordered according to the correct quantity					
3.2	All components that are required are ordered in the correct quantity at the correct time.					
3.3	Work in process is at reduced levels					
3.4	Suppliers deliver on time					
3.5	Inventory of fabric is kept to a minimum					
3.6	Reduced set-up time and lead time					

4.	The Role of 5S: Reduction of waste whilst maintaining an orderly workforce.	Strongly disagree	Disagree	Not sure	Strongly agree	Agree
4.1	Production areas are kept tidy and organised and free from clutter					
4.2	Reduced waiting time and motion time when searching for tools					
4.3	Quality problems are more easily detected and prevented.					
4.4	Employees actively participate in maintaining 5S to enhance workplace effectiveness.					

4.5	We have implemented 5S to organise and optimise our workspace for efficiency and safety					
-----	---	--	--	--	--	--

5.	Visual Performance Management: Visual management enables the firm to see the wastes, to see the problems, and to see the things needing improvement. Visual management enables recognition of improvements and successes on visual boards.	Strongly disagree	Disagree	Not sure	Strongly agree	Agree
5.1	Visual displays assist in conveying production targets and progress effectively to the team					
5.2	Recognition is given to best performing employees and sections and displayed on visual boards					
5.3	Our visual management system aids in maintaining consistent quality across different processes.					
5.4	Visual boards help identify bottlenecks and areas for improvement at a glance.					
5.5	Visual boards boost team morale and instill a sense of ownership and accomplishment as progress is visible to all					

6.	Multi-Functional Teams: A team of workers who are structured within a specific workspace and possess the capability to perform various tasks. These groups are frequently organised along a segment of the product flow that follows a cell-based approach	Strongly disagree	Disagree	Not sure	Strongly agree	Agree
6.1	Our multifunctional teams are composed of members with diverse skill sets and expertise.					
6.2	Teamwork leads to innovative solutions and new ideas. They are responsible for planning, maintenance, inspection, and quality to prevent the disruption of product flow					
6.3	Multi-functional teams enhance quality by sharing knowledge and effective quality strategies					

6.4	Multifunctional teams enhance quality by driving continuous improvement efforts across departments					
6.5	Multifunctional teams embrace responsibility for quality and efficiency by taking ownership of the end-to-end process from planning to delivery					
6.6	Multifunctional teams manage supervisory responsibilities by rotating leadership roles among employees who are specially trained for those specific tasks.					
7.	Customer Relations: Interactions with customers	Strongly disagree	Disagree	Not sure	Strongly agree	Agree
7.1	We maintain regular communication with our customers					
7.2	We value and gather feedback from our customers to improve our clothing products.					
7.3	Customer input on aspects like product quality and delivery timelines is considered essential to our manufacturing process.					

Section 4

1.1 For how long is your organisation practicing Lean?

Less than 1 year		1 to 2 years		2 to 5 years		5 to 10 years		Greater than 10 years	
------------------	--	--------------	--	--------------	--	---------------	--	-----------------------	--

1.2 What was the reason for Lean deployment in your organisation? Please select one.

Increase in revenue		Enhance improvements	
Reduce costs		Improve quality and productivity	
Become more competitive		Prescribed by head office	
Other (please specify):			

1.3 Did the management/leadership style change to accommodate Lean?

Yes		No	
-----	--	----	--

Explain:

1.4 Was Lean accepted by the diversity of employees in the organisation?

Yes		No	
-----	--	----	--

Explain:

1.5 On a scale of 1 – 5 how would you rate the level of management/leadership commitment within the organisation to drive, live, and demonstrate Lean behaviour.

1– Very little Commitment; 2 - Commitment; 3 – Average Commitment; 4 – High level of Commitment; 5 – Very high level of Commitment

1.6 On a scale of 1 – 5 how would you rate the level of employee involvement to achieve the Lean goals?

1– Very little involvement; 2 – Little involvement; 3 – Average participation; 4 – High level of involvement; 5 – Very high level of involvement

1.7 On a scale of 1 – 5 how would you rate the level of the employees understanding towards Lean and where the business is heading?

1– Very little understanding; 2 – Little understanding; 3 – Average understanding; 4 – High level of understanding; 5 – Very high level of understanding

1.7.1 How would you rate employees using Lean and where the business is heading?

1– Very little understanding; 2 – Little understanding; 3 – Average understanding; 4 – High level of understanding; 5 – Very high level of understanding

1.8 On a scale of 1 – 5 how would you rate the methods that the organisation has in place to continuously develop and sustain the Lean culture?

1– Very insufficient; 2 - Insufficient; 3 - Average; 4 – Sufficient; 5 – Very sufficient

1.9 Please select from the list of improvements presented in the table below all those that occurred within the organisation since the adoption of the Lean technique.

Elimination of waste		Reduction in cycle times	
Reduction in lead time		Reduction in manufacturing costs	
Improved staff morale		Improvement in quality	
Improvement in space utilisation		Improvement to the flow of materials	
Reduction in WIP and finished goods inventory		Improvement in working capital and employee productivity	
System interaction considered for all processes to be improved together		Improved speed and responsiveness to customer needs	
Established visual management techniques		Created a continuous improvement culture	
Questions if all processes are adding value		Continuously challenge the way we work	

1.10 What else would you like to see other than the above improvements?

1.11 How would you rate the success level of Lean adoption within the organisation?

Total Failure		Some success	
Many areas were successful		Total success	
Other (please specify):			

1.12 What deficiencies have been identified with the Lean technique since its inception?

1.13 What is your overall perception of Lean?

Thank you for your participation.

Appendix F- Statisticians Certificate

Gill Hendry B.Sc. (Hons), M.Sc. (Wits), PhD (UKZN)

Mathematical and Statistical Services

Cell: 083 300 9896

Email: gillhendrystats@gmail.com

8 April 2024

Re: Statistical assistance

Please be advised that I assisted Pushpa Govender (Student number 20203839), who is currently studying for a Master of Philosophy in Quality Management at the Durban University of Technology, with the statistical aspects of her study including sampling and the statistical analysis of her data.

Yours sincerely

Dr Gill Hendry

Private Consulting Statistician

Appendix G – Research Ethics Certificate



Zertifikat Certificat Certificado Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Pushpa Govender

a complété avec succès - has successfully completed

Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2022/08/20
CD : DUJQq8Ae

Coordonateur TRREE
Coordinator

APPROVED BY
SIWF
ISFM
Programme de formation continue (2 crédits)
Continuing Education Program (2 credits)

Fédération
Pharmaceutica
Helvétique
FPH
Programmes de formation
postgraduée continue

Ce programme est soutenu par - This program is supported by :

European and Developing Countries Clinical Trials Partnership (EDCTP) (www.edctp.org) - Swiss National Science Foundation (www.snf.ch) - Canadian Institutes of Health Research (<http://www.cihr-irsc.gc.ca/2011.html>) -
Swiss Academy of Medical Sciences (SAMS/ASMS/AMW) (www.sams.ch) - Commission for Research Partnerships with Developing Countries (www.fph.ch)

[REV : 20220217]

Appendix H- Turnitin Report

Turnitin chapter 1-5 masters thesis P.Govender student
no.20203839.docx

ORIGINALITY REPORT

15%

SIMILARITY INDEX

9%

INTERNET SOURCES

4%

PUBLICATIONS

8%

STUDENT PAPERS

PRIMARY SOURCES

1

researchspace.ukzn.ac.za

Internet Source

1%

2

ir.dut.ac.za

Internet Source

1%

3

dspace.daffodilvarsity.edu.bd:8080

Internet Source

1%

4

Submitted to Durban University of
Technology

Student Paper

<1%

5

www.researchgate.net

Internet Source

<1%

6

Submitted to Harrisburg University of Science
and Technology

Student Paper

<1%

7

Submitted to RMIT University

Student Paper

<1%

8

Submitted to National School of Business
Management NSBM, Sri Lanka

Student Paper

<1%

Internet Source

<1 %

125 **dokumen.pub**
Internet Source

<1 %

126 **economictimes.indiatimes.com**
Internet Source

<1 %

127 **www.marketsandmarkets.com**
Internet Source

<1 %

128 **www2.mdpi.com**
Internet Source

<1 %

Exclude quotes On

Exclude matches < 10 words

Exclude bibliography On

1st November 2024

Prof P. Moodley

EDITING SERVICES

Cell: 084 711 3864

email: Samantha.matesa@gmail.com

Date: 06 October 2024

Re: Editing Masters Dissertation: Ms. P.GOVENDER (20203839)

This serves to confirm the dissertation entitled, *Comparing The Effectiveness Of Lean Manufacturing Principles Between A Small And Medium Organisation In The Apparel Industry In Kzn* was proofread and edited for the following:

- Spelling
- Punctuation
- Grammar
- Sentence Structure
- Word reduction
- Cross-reference citations
- Reference check
- Formatting basics
- Presentation style
- Other mechanics of the English language.

Corrections were made using track changes which are clearly outlined for your reference.

Please contact me should you require any further details.

Yours Faithfully

....

Prof P. Moodley

(PhD Communications (UNIZUL), Master of Arts (UNIZUL), Honors Communication Culture and Media Studies- Cum Laude (UKZN), Bachelor of Arts (UNISA)

Associate Professor, Department of Strategic Communications,

Faculty of Humanities, University of Johannesburg