DEVELOPMENT AND IMPLEMENTATION OF A LEAN MANUFACTURING FRAMEWORK AT A SELECTED SOUTH AFRICAN STEERING WHEEL MANUFACTURER

by

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DEDICATION

This thesis is dedicated to my cherished son, Thabo Aiden, and my treasured daughter, Kaboentle Zoe Nyathi. Through this work, I aim to highlight the significance of education, intrinsic motivation to pursue knowledge, and the potential to make meaningful contributions to society. To my precious children, education serves as the gateway to your future, and it is solely within your power to decide the extent of its impact and the opportunities it may create for you.

PLAGIARISM DECLARATION

Name: Kamukhelo Nyathi

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The exact wording of the title of the thesis as appearing on the electronic copy submitted for examination:

THE DEVELOPMENT AND IMPLEMENTATION OF A LEAN MANUFACTURING FRAMEWORK AT A SELECTED SOUTH AFRICAN STEERING WHEEL MANUFACTURER.

I declare that the above thesis is my work and that all the sources used or quoted have been indicated and acknowledged using complete references. I further declare that I submitted the thesis to originality-checking software and that it falls within the accepted requirements for originality. I further declare that I have not previously submitted this work, or part of it, for examination at DUT for another qualification or at any other higher education institution. Its only prior submission for publication was to the South African Journal of Industrial Engineering (SAJIE) for the journal articles shown in appendix 13 and 14.

(The thesis will not be examined unless this statement has been submitted.)

Name	KAMUKHELO NYATHI
Signature	
Date	28/10/2024

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<u>2 Corinthians 3:5</u>

Not that we are adequate in ourselves to consider anything as coming from ourselves, but our adequacy is from God.

ABBREVIATIONS AND ACRONYMS

ACM	: Automotive Component Manufacturer
BPR	: Business Process Re-engineering
CIM	: Cost In Manufacturing
EDI	: Electronic Data Interchange
ISM	: Interpretive Structural Modelling
JIT	: Just in Time
LM	: Lean Manufacturing
LWC	: Lost Work Case
LWCFR	: Lost Work Case Frequency Rate
MIFR	: Minor Injuries Frequency Rate
NAAMSA	: National Association of Automobile Manufacturers of South Africa
OE	: Original Equipment
OEM	: Original Equipment Manufacturer
R&D	: Research and Development
SLR	: Systematic Literature Review
SMED	: Single Minute Exchange of Dye
TOC	: Theory of Constraints
TPM	: Total Productive Maintenance
TPS	: Toyota Production Systems
TQM	: Total Quality Management

ABSTRACT

National and international market pressures have compelled South African local manufacturers to prioritise quality and productivity improvements to remain competitive and reduce product costs. This study examines a South African steering wheel manufacturer's process cost benchmarking against a European affiliate, highlighting significant cost variances. Using Lean Manufacturing principles, the research identifies and addresses inefficiencies across manufacturing processes, focusing on waste categories: overburden (muri), variation (mura), and waste (muda). Given the paucity of directly related South African literature, this research employs an exploratory qualitative methodology. Data collection involved focus group discussion, interviews, and participant observation, allowing the researcher to interact closely with participants and observe contextual details firsthand. The target population comprised managers, operators, and support staff directly involved in the manufacturing process at the steering wheel manufacturer. A purposive sample of 25 participants across these roles was selected to capture diverse perspectives and insights into the existing process inefficiencies. Thematic analysis, supported by the NVivo software was utilised to identify patterns and themes, which facilitated a detailed examination of the findings. Triangulation was used to ensure data consistency across the research instruments, supporting a well-rounded thematic proposition. The literature review provided insights into Lean Manufacturing's drivers and barriers, informing the creation of a Lean framework tailored to the South African context. The investigation uncovered that Lean Manufacturing is shaped not just by internal tools and cultural enablers, but by interconnected themes that collectively reveal the functioning of drivers and barriers throughout the value chain. The resulting Lean Manufacturing Framework represents a pivotal development for South Africa's automotive components sector, addressing competitive and operational challenges within the industry. It offers a replicable model for other component manufacturers facing similar market pressures. The research makes a significant contribution to the literature by providing a novel dual lens framework that combines themes, moving lean practices beyond a tool-centric perspective to strategically integrated operations, finance, and stakeholder relations.

Keywords: Cost, waste, lean manufacturing, lean drivers, lean barriers

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

CHAPTER 1

INTRODUCTION

This Chapter introduces the research problem and the rationale for the study, which is cascaded to objectives and research questions.

1.1 Context of research

The automotive industry in South Africa has experienced substantial transformations since the advent of democracy. Currently, the sector is primarily controlled by multinational automotive component manufacturers (ACMs) and is completely embedded within global value chains (Barnes *et al*. 2017). Multinational companies thrive with both horizontal and vertical investments in South Africa, the former and the latter are described by Subhanij and Annonjarn (2016) as when firms replicate production by investing in foreign companies in the same industry and on the same stage of the supply chain, while vertical investment occurs when firms often decentralize their production processes by investing in foreign enterprises that operate at various stages of the production cycle, yet remain within the same value chain. In both forms of investment, component manufacturers and (OEMs) strategically select diverse locations to ensure that each product is produced and distributed from the most economically advantageous sites.

Innately, the local OEMs are required to enhance quality, improve styling, increase organizational efficiencies, and drive innovative features into their products to attract customers and expand markets globally (Maharaj *et al.* 2016). Consequently, OEMs are putting immense pressure on their tiered suppliers to reduce costs, increase output and improve quality.

This places the local component manufacturers under immense pressure to be competitive to also attract overseas investment. Therefore, the application of lean principles to improve process efficiency in a steering wheel manufacturing process that has been empirically analyzed through benchmarking will provide a theoretical framework for addressing process inefficiencies, thereby reducing costs, increasing output, and improving quality. The selection of lean manufacturing as an improvement methodology was carried out by analysis of the applicability of at least eight major process improvement methodologies outlined by Gershon (2010) with the case study company XYZ, namely lean manufacturing (LM), Toyota Production System (TPS)/JIT, Total Quality Management (TQM), Lean Six Sigma, ISO 9000/1, Six Sigma, Theory of Constraints (TOC), and Business Process Re-engineering (BPR). The results of the analysis are shown in Appendix 1.

Benchmarking was carried out by comparing the case study company's key performance indicators for the steering wheel manufacturing process that is, safety, quality (defects expressed in parts per million), delivery, and cost with the European affiliate's results for the same period, and then analyzing the variances. The benchmarking data (Company XYZ 2020) in Table 1 shows that the major gap between the European and South African operations is in the manufacturing process, specifically the quality output (measured in parts per million (ppm), Frame processing cost, Polyurethane process cost and the Full assembly cost.

Table 1: Bench marking against European affiliate.

	KPI	Detail	Target		Europe Affiliate to major customer	SA Affiliate to major customer
SAFETY	MIFR	Minor Injuries Frequency Rate Target	≤ 0		0.0	0.0
	LWCFR	Lost Work Case Frequency Rate Target	≤ 0		0.0	0.0
QUALITY	PPM	Parts Per Million	≤20		10.5	21.6
DELIVERY	SSN	Short Shipment Notifications	≥99,60%		99.40%	100%
Raw Material and Components	**Part Number**	**Detail**	**Qty (pc)**	**SA Cost**	**Europe Affiliate Cost**	**Ratio of SA Cost to Europe Affiliate Target (1,05)**
	Confidential Details		1	Confidential Details		1.06
			1			1.03
			3			1.00
			1			1.04
			3			1.04
			1			1.00
			1			1.00
			1			1.10
			1			0.99
Process	**Process Code**	**Detail**	**Cost**	**SA Cost**	**Europe Affiliate Cost**	**Ratio of SA Cost to Europe Affiliate Target (1,05)**
	Confidential Details	Frame Processing	Confidential Details			1.30
		Polyurethane Process				2.400
		Full Assembly				1.700
Other	**Process Code**	**Detail**	**Cost**	**SA Cost**	**Europe Affiliate Cost**	**Ratio of SA Cost to Europe Affiliate Target (1,05)**
	Confidential Details	Packaging	Confidential Details			1.07
		Mark-up				1.19
		Overheads				1.34

***Source**: Benchmarking report (company XYZ, 2020)*

1.2 South African OEM steering wheel manufacturers

In the article, Automotive Steering Wheel Market Size & Share Analysis - Growth Trends & Forecasts (2023 - 2028) (2023: para. 1 line 1), The Automotive Steering Wheel Market is segmented by Technology Type (Conventional and Control Embedded), Material Type (Aluminum, Steel, Magnesium, and Other Material Types), Vehicle Type (Passenger Cars and Commercial Vehicles), Sales Channel (Original Equipment Manufacturer and Aftermarket), and Geography (North America, Europe, Asia-Pacific, South America, and Middle East and Africa). The identified Steering Wheel Manufacturers in South Africa are Autoliv, Toyoda Gosei, Joyson Safety Systems and ZF. To ensure confidentiality, since company XYZ is mentioned in the list of these Suppliers, the rest shall be called Supplier 1, Supplier 2, and Supplier 3. The Toyota South Africa Motors Steering Wheel Strategy document (2022) depicts the South African Steering wheel manufacturers with regards to passenger vehicles steering wheel processing as follows:

Table 2: South African steering wheel manufacturers processing

Item	**Percentage of Cost**	**Supplier**			
		Company XYZ	**Supplier 1**	**Supplier 2**	**Supplier 3**
1. Magnesium Casting	36%	Import	Import	Import	Import
2. PVC Forming	32%	Local	Import	Import	Import
3. Leather Wrapping	21%	Local	Local	Import	Import
4. Steering Controls Assembly	11%	Local	Local	Import	Import

Source: Benchmarking report (Company XYZ, 2020)

Table 2 above shows that company XYZ has the highest level of local processing by total percentage of local cost, succeeded by Supplier 1. Both Suppliers 2 and 3 have 0% of local cost implying that they both import completed steering wheels on behalf of their customer OEMs.

1.3 The steering wheel manufacturing process flow

The Steering wheel manufacturing process flow adapted by company XYZ is depicted in Figure 2. Company XYZ uses the specifications depicted by the customer OEM for the type of the frame to manufacture. Hence, since 2020, Toyota South Africa Motors has been the sole OEM procuring steering wheels from the local OE component Manufacturers including company XYZ for their South African assembled models namely, Hilux, Fortuner, Corolla, Corolla Cross, Quantum and Hino Trucks. The Manufacturing process flow for company XYZ is depicted in Figure 1.

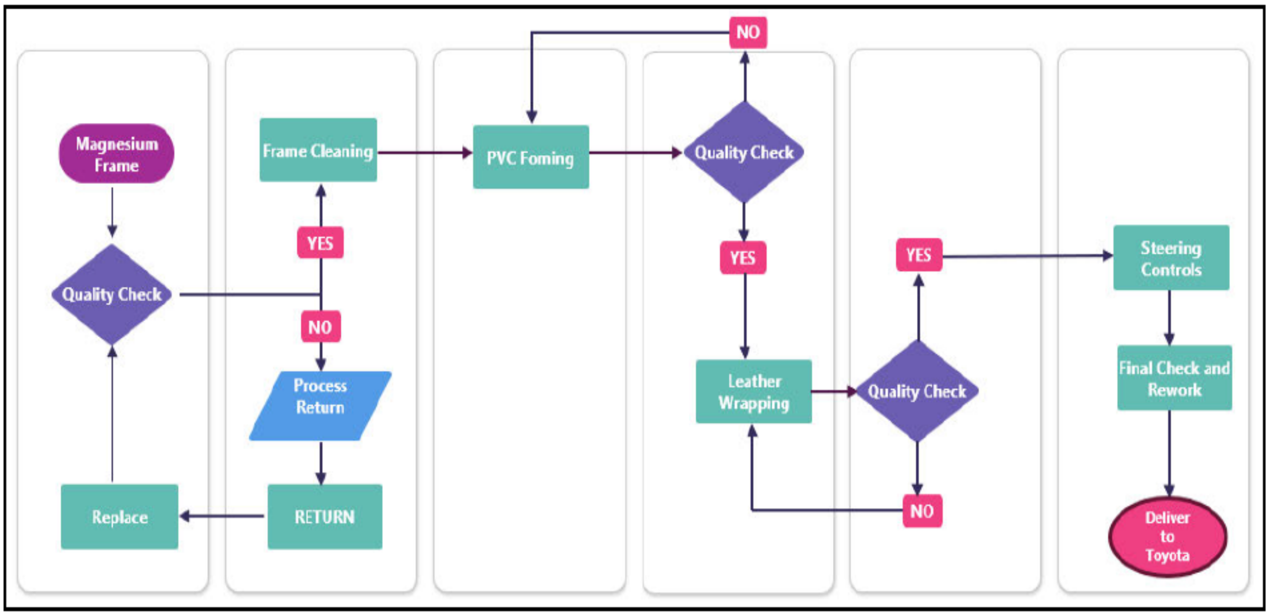


Figure 1: Steering wheel manufacturing process flow for company XYZ

Source: *Benchmarking report (Company XYZ 2020)*

1.3.1 Magnesium frame

Kawase *et al.* (1991) stated that the magnesium frame steering wheel has been in production for Toyota passenger vehicles that have driver airbags due to their light weight, stiffness, and strength characteristics of energy absorption. According to (Anon. 2023), Takata Petri was the only South African steering wheel Magnesium die casting manufacturer from 2005 until 2013 when the plant closed down most of its operations due to unprofitability and high manufacturing related costs and relocated the only three die casting machines that were used for the whole of the South African OEM market to its parent plant in Germany. Takata Petri relocated from Atlantis, Cape Town to Durban to be in closer proximity to its primary client, Toyota South Africa

Motors. Therefore, it can be inferred that all South African OEMs are importing the complete, solid magnesium frame that is utilized in automotive assembly.

***Source: P**hotograph obtained by researcher during participant observation*

1.3.1.1 The PVC foaming process

Before the foaming process, the Magnesium frame undergoes a pH-controlled rinsing procedure to remove any impurities and ensure its readiness. Polyurethane foam is synthesized by employing the injection molding process. The mixing of the two chemicals that are integral to polyurethane triggers a reaction, resulting in the creation of an expanding foam. De Souza *et al.* (2021) assert that the primary constituents in the synthesis of polyurethanes are polyols and isocyanates. The chemical structure and functionality of polyols and isocyanates are expected to affectthe properties of polyurethanes produced. A release agent is systematically applied to the mold before the injection of polyurethane, thereby inhibiting any potential sticking of the foam to the mold surface. The reaction occurs within a mold, as depicted in Figure 4, where the magnesium framework is situated inside the cavity ofthe mold. Injection molding is employed to release the combination of the polyol and the isocyanates onto the steering wheel frame making it a robust PVC coated steering wheel. After the UV forming process, the PVC coated steering wheel is sprayed with protective paint that dyes the foam into the required colour, in most cases black. In the article, *Steering Wheels: Manufacturing Concentrol Ranges* (2020: para. 5 line 2), the paint protects the foam against wear and damage from Ultraviolet rays. The operator then trims off excess polyurethane on the steering wheel and inspects the quality before progressing the steering wheel to the next process.

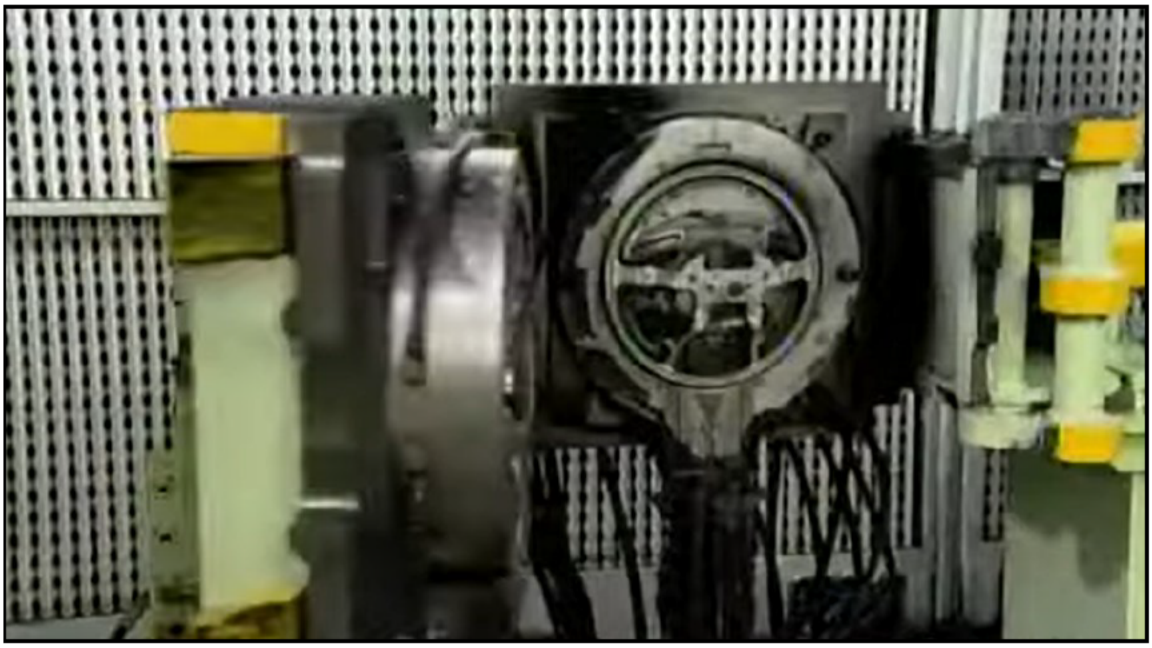


Figure 3: PVC Foaming process - mold cavity

Source: *DSC Documentaries (2012)*

Figure 4 illustrates the steering wheel frame, which has been coated with PVC and is prepared for the subsequent leather wrapping procedure.

Source: *Photograph obtained by researcher during participant observation*

1.4 Leather wrapping process

Authentic leather encases the polyurethane-molded steering wheel, providing a premium finish and enhanced grip. Company XYZ relies on leather imported from Austria for the creation of their steering wheels, due to the inadequacy of South African leather meets the requisite quality standards. Proficient leather crafters execute all the essential procedures required to encase the leather around the steering wheel. Primarily, the crafters prepare paper templates for designing the cut of the leather. Upon the conclusion of all preparatory activities, the process of attaching the leather to the polyurethane-coated frame commences. Company XYZ employs a systematic approach consisting of eight distinct stages in the leather wrapping process.

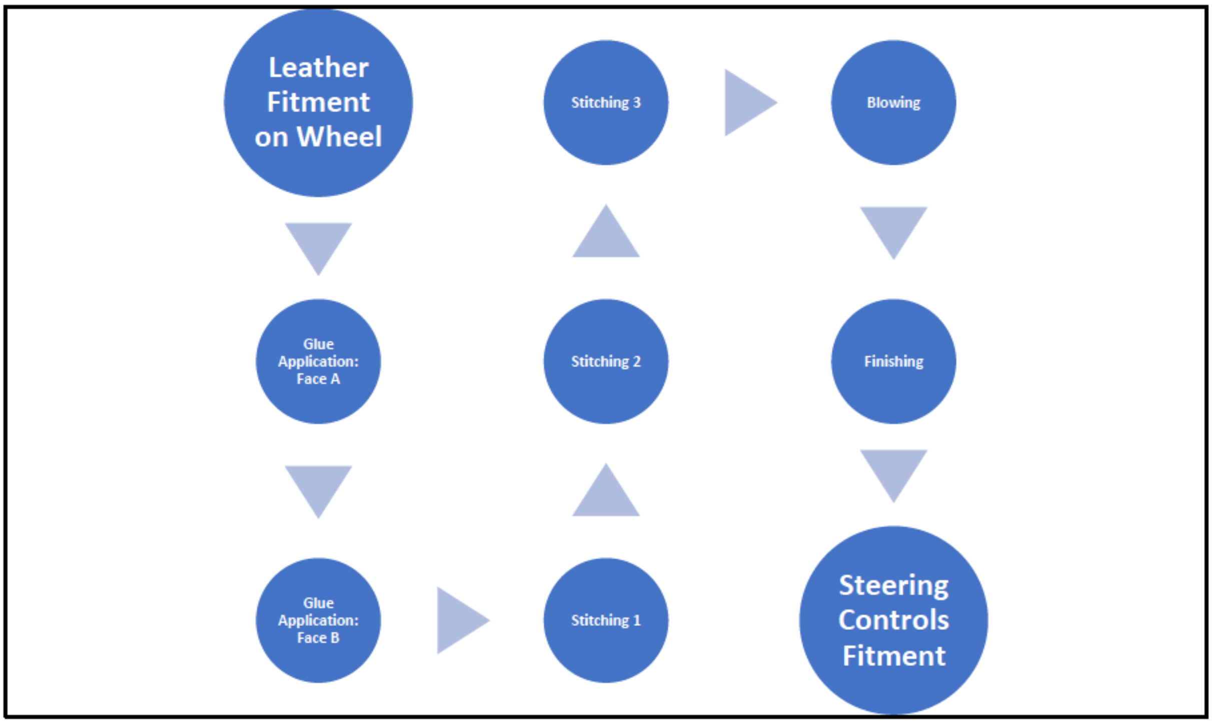


Figure 5: Leather wrapping process flow

***Source**: Researcher's own construction based on participant observation*

The stitching is executed in a manner that places the stitches within the interior of the steering wheel, thereby improving the tactile experience for the vehicle's driver. Different stitching patterns are employed by company XYZ to fulfil the OEM customer requirements for aesthetic and to conform to the different leathers stretch properties. According to Cava (2015), the principal methods of stitching are the Baseball stitch, the Z stitch and the Zigzag stitch. The primary methods employed by Company XYZ consist of Basting, X-Stitch, and M-3 stitch, which are depicted in Figure 6 below.

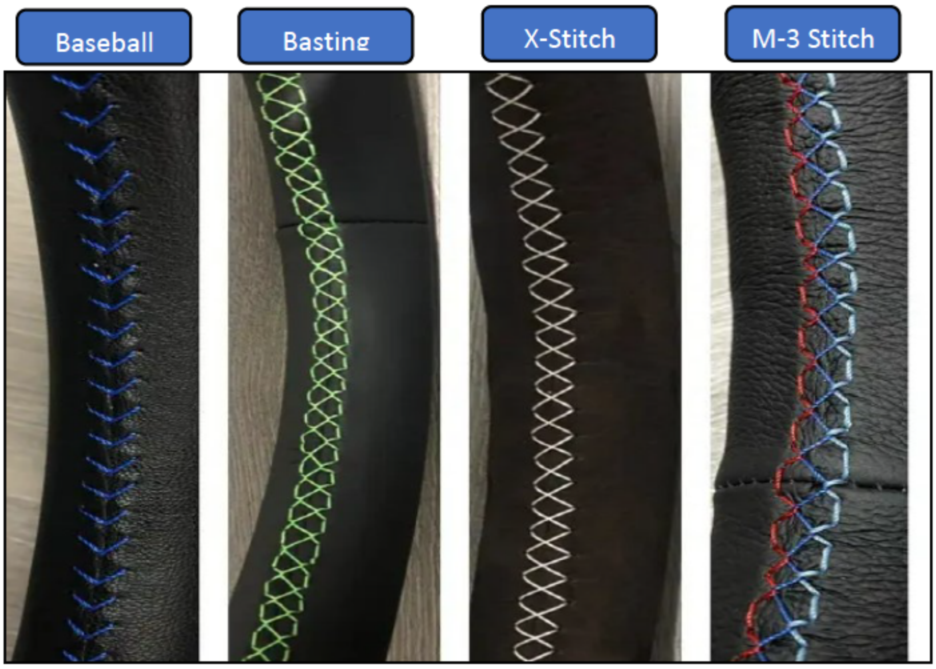


Figure 6: Main steering wheel stich patterns

***Source**: Craft Customs*

Figure 7 shows the picture of the company XYZ steering wheel.

Figure 7: Leather wrapped steering wheel

***Source:** Photograph obtained by researcher during participant observation*

1.5 Steering controls and driver air bag

Wei (2016: para 1 line 1) emphasized eyes and hands to be of utmost attention to driving and that drivers should keep their eyes on the road and their hands on the steering wheel to increase safety for everyone. This alludes to the advancement of the steering wheel technology of incorporating steering wheel controls on the wheel. The steering controls that company XYZ install on the steering wheels are as directed by the OEM customer but incessantly include steering switches, cruise control, sound system, phone answering system, and blue tooth controls. Before the steering wheel undergoes quality verification and receives clearance for shipment to the OEM customer, the installation of the driver airbag constitutes the final stage of the assembly process. Figure 8 illustrates a fully assembled steering wheel, which includes the integrated steering wheel controls and the driver airbag.

Figure 8: Completed steering wheel

Source: *Photograph obtained by researcher during participant observation*

1.6 Research opportunity

The impetus for this research arises from the absence of a worldwide study that provides an adaptable framework for optimizing steering wheel manufacturing processes in the context of South Africa. Innumerable organizations have attempted to adopt Lean Manufacturing globally and locally and copious frameworks have been adapted. The subsequent chapter's literature review indicates that none of the frameworks utilized have been implemented in the global manufacturing process of steering wheels. Many of these frameworks are generic rather than industry-specific, which accounts for the absence of LM frameworks designed to address the complexities inherent in steering wheel processes. Consequently, there exists a significant demand for an LM framework that will be explicitly permitted to conduct investigations and address problems within the financially unstable South African steering wheel manufacturing company, XYZ.

1.7 Introduction to the problem statement

Multinational component manufacturing companies have shown a decline in investing in their South African units, and this has resulted in local OEMs resorting to importing the same components from the same overseas component manufacturers as depicted by the decline in component and vehicle manufacturing in South Africa as shown in a publication by in the National Association of Automobile Manufacturers of South Africa (NAAMSA) Fuelling the economy publication of 2021, (Anon, 2021).

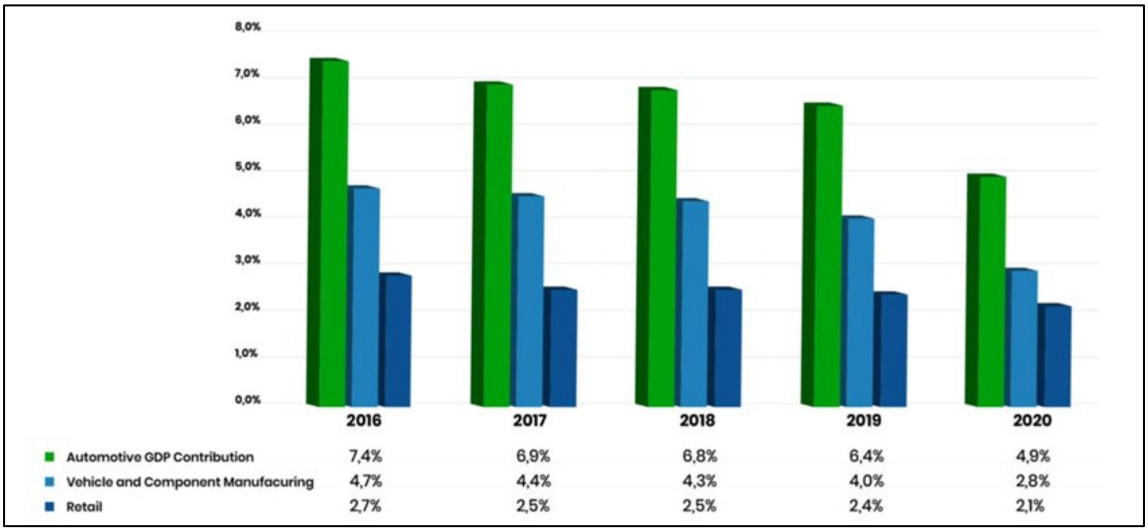


Figure 9: SA automotive decline

Source: *Adapted from (Anon, 2021)*

Figure 9 above therefore depicts a national trend of OEMs reducing their dependency on local ACMs. This phenomenon is further elaborated in section 3.2.

1.8 Problem statement

In line with the empirical NAAMSA evidence in section 3.1, Figure 1, the Managing Director of XYZ advised that in 2020 one of the OEMs withdrew their steering wheel contract with company XYZ citing uncompetitive pricing in comparison with oversees import pricing and that OEM resorted to importing the steering wheels from an undisclosed cheaper overseas source impelling company XYZ to retrench staff and restructure their operations. The Managing Director of company XYZ disclosed that the internal benchmarking of steering wheel pricing for the 2020 fiscal year indicated a manufacturing cost that was 80% higher than that of the organization’s affiliate. Consequently, company XYZ faces the potential risk of losing its remaining OEMs and ultimately facing closure by headquarters within the next five years if this situation does not improve. The imminent risk of closure is exacerbated by the volatility of the South African Rand exchange rate, particularly considering the elevated import processing illustrated in Table 2, along with substantial import levels of components for assembly. Chikwira and Jahed (2024) assert that the South African exchange rate has not displayed any stability since the advent of democracy in 1994. Their experimental analysis has shown that the exchange rate is among the factors that hinder foreign investment and contribute to the uncompetitiveness of the manufacturing sector in South Africa. According to Naamsa (AIEC, 2023), the South African .

Naamsa (AIEC, 2023) indicates that the majority of component imports originate from Asia (mostly Thailand and China), Europe (primarily Germany and the United Kingdom), and partially from the United States. Trade agreements are negotiated between countries that enjoy mutual advantages, generally resulting in higher prices when selling to nations without such benefits. Consequently, South African automotive component manufacturers are significant beneficiaries of these agreements, which adversely affects company XYZ in comparison to its European peers.

According to Anon (2020), the market for automotive components encompasses a multifaceted supply chain characterized by various tiers of suppliers, which include global OEMs (Original Equipment Manufacturers), specialized component manufacturers, and suppliers of raw materials. Effective management of the supply chain is essential for achieving cost efficiency and ensuring timely deliveries.

This market is shaped by regional economic factors, consumer preferences, and governmental regulations pertaining to automotive manufacturing and trade.
Although various sectors may gain from enhanced strategies for optimizing market dynamics, the automotive component manufacturing industry does not easily experience this advantage due to ongoing part shortages, complex supply chains, and the necessity for swift reactions to any alterations. This situation has led to a phenomenon of rising import costs for automotive components, which further contributes to the lack of competitiveness of South African steering wheels.

1.9 Research aim and objectives

The study aims to develop and implement a lean manufacturing framework at a selected South African steering wheel manufacturer. To accomplish the aim, the following research objectives must be fulfilled:

1. To explore the key drivers for implementing LM.
2. To explore the possible barriers to implementing LM with reference to a systematic literature review.
3. To investigate the manufacturing performance of the current steering wheel manufacturing process with regards to LM drivers and barriers by using focus groups, one on one interviews, and participant observation.
4. To explore the prevalence of overcoming the LM barriers and challenges.
5. To develop a conceptual LM implementation framework based on the drivers and barriers.
6. To empirically validate the LM implementation framework.

The objectives discussed earlier prompt the emergence of pertinent research questions that must be explored:

Table 3: Research questions-based arising from objectives

Objective Number	Objective	Research Questions
1	To identify the key drivers for implementing LM	How do the identified drivers influence LM implementation?
2	To identify the possible barriers for implementing LM with reference to a systematic literature review.	How do the identified barriers impede LM implementation?
3	To investigate the manufacturing performance of the current steering wheel manufacturing process with regards to LM drivers and barriers by using focus groups, one on one interviews, and participant observation.	How do the identified LM drivers and barriers affect the current manufacturing performance?
4	To identify the prevalence of overcoming the LM barriers and challenges.	How does the identified prevalance assist in resolving the barriers and challenges?
5	To develop a conceptual LM implementation framework based on the drivers and barriers.	Why is the conceptual framework preferred?
6	To empirically validate the LM implementation framework.	Does the research output address the research problem?

Source: *Researcher's own construction*

According to Badgujar (2016), numerous frameworks have been developed across various industries globally. However, many companies still struggle to adopt these frameworks due to various barriers that hinder their implementation. Hence the development of the LM framework from this study intimately with a South African case will assist the South African steering wheel manufacturers and other ACMs to easily adopt it and implement it in their operations.

1.10 Thesis structure

Chapter 1: Introduction

This chapter introduces the problem, the background, and the scope of the study.

Chapter 2: Literature review

This chapter serves the purpose of supporting the theory of the research by reviewing the academic references about a similar problem.

Chapter 3: Research methodology

This chapter describes the specific procedures, techniques, and methods that were used to select, process, and analyse the data used during the project.

Chapter 4: Results and discussion

The purpose of this chapter is to report the findings of the research.

Chapter 5: Triangulation

This chapter articulates the importance of integrating various research instruments to strengthen the validity and credibility of research findings. The concept of triangulation is employed to facilitate a deeper understanding of the phenomenon being examined by identifying consistent and diverging elements.

Chapter 6: Conceptual model and theoretical framework

This chapter utilizes the research findings to construct the conceptual framework, providing an in-depth discussion of its development and interpretation.

Chapter 7: Empirical validation of the developed lean framework

In this chapter, the concept of empirical validation is realized by drawing on the expertise of seasoned industry and academic professionals before the framework is introduced into practical applications.

Chapter 8: Recommendations and conclusion

This chapter encapsulates the content of the previous chapters and employs the derived results along with the validated framework to conclude the investigation, thereby responding to the research questions.

List of references

This section lists all the resources that were used to create the thesis.

Appendices

This section provides additional supporting information that can be referenced in the thesis.

1.11 Chapter summary

South African original equipment manufacturers (OEMs) exert tremendous pressure on component suppliers and their tier suppliers to lower costs, boost output, and enhance quality in addition to the requirement from their worldwide multinational parent companies to be profitable. As the only company in South Africa still producing steering wheels with the highest standards of achievement, company XYZ was the focus of this research, and LM was chosen as the improvement methodology over eight other methods that were investigated. Benchmarking is used to show where the company is not competitive, and the LM implementation aims to strengthen and address those areas.

CHAPTER 2

LITERATURE REVIEW

This Chapter identifies areas of prior scholarship work apropos the literature that is relevant to this study. The literature review will examine the research objectives and corresponding research questions.

2.1 Systematic literature review

Tranfield *et al.* (2003), as cited in Snyder (2019), argue that conventional methodsof describing and presenting literature often lack comprehensiveness and are not carried out systematically. This leads to a deficiency in understanding the subject matter of the compilation of studies. Pati and Lorusso (2017) defined a Systematic Literature Review (SLR) as a methodical approach to gathering, assessing, combining, and presenting findings from various research studies on a specific research question or topic of interest. SLR offer a method for evaluating boththe quality and extent of the available evidence regarding a specific question or area of interest. Dewey and Drahot (2016) asserted that a systematic literature review (SLR) serves to identify, select, and critically evaluate research in response to a precisely articulated question. The systematic review needs to adhere to a well-defined protocol or plan, wherein the criteria are explicitly outlined before the commencement of the review process.

2.1.1 Rationale for adopting systematic literature review

According to Mallett *et al.* (2012), SLR abates implicit researcher bias. SLR compels researchers to expand their search for studies beyond their subject areas and usual networks by implementing comprehensive search strategies, predefined search strings, and consistent inclusion and exclusion criteria. Mallett *et al.* (2012) further argued that traditional literature reviews frequently concentrated solely on the outcomes of other studies, neglecting to consider the study's design, data, and analytical methods employed. Systematic reviews place greater emphasis on evidence, impact, validity, and causality when compared to other approaches..

2.1.2 The process of SLR

According to Owens (2021), a systematic literature review (SLR) commonly commences with an articulated research statement or inquiry. Frequently, this inquiry encompasses the components of Population, Intervention, Comparison, Outcome, and occasionally Time frame, denoted by the acronym PICO(T). Owens (2016) proposed a series of essential procedures for carrying out a SLR:

1. Owens (2016) proposed a series of essential procedures for the execution of SLR, recommending the preliminary determination of pertinent databases and the identification of specific terms to be searched within the keywords, title, and abstract sections of each respective database.
2. Retrieve search keywords and index terms from the literature search conducted on all relevant databases.
3. Enhance the scope of the investigation by including an examination of the bibliography cited in the research findings gathered during the preceding phases.

Khan *et al.* (2003) outlined the five primary stages to follow when conducting a Systematic Literature Review (SLR) as follows:

1. Formulating the inquiries for the SLR.
2. Exploring the pertinent research based on the inquiries in question 1.
3. Assessing the calibre of the research conducted.
4. Evidence summary.
5. Interpretation of the findings.

Rathi *et al.* (2022) suggested that when conducting a SLR, one of the methods is to search references based on three categories, namely place, time and research category as depicted and further broken down in Figure 10 below:

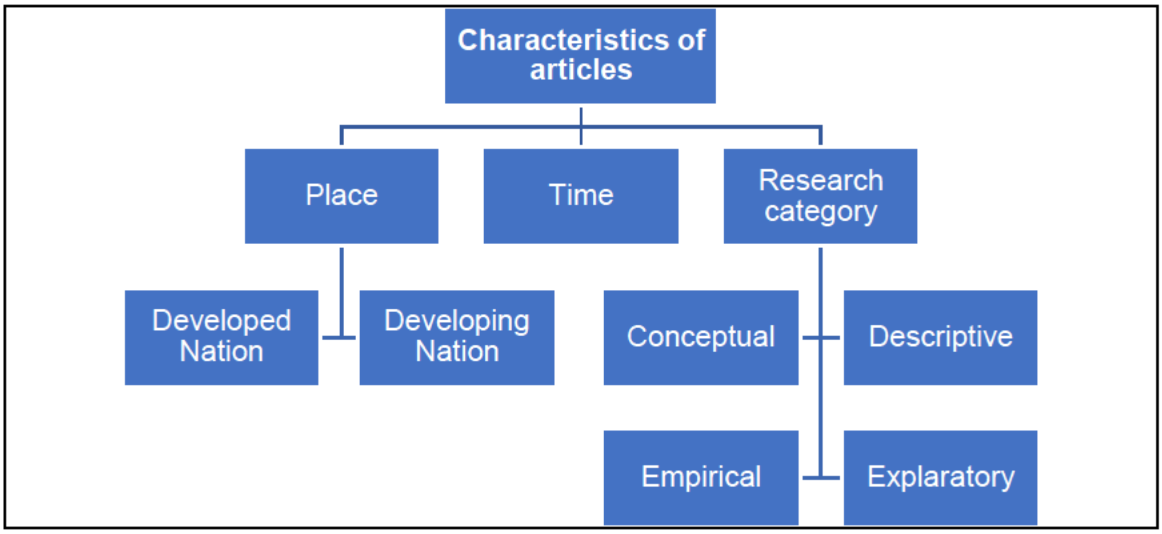


Figure 10: Characteristics of research articles

Source: *Adapted from Rathi et al. (2022)*

2.1.3 Conducting the search

Saez *et al.* (2010) emphasized that to effectively tackle the research topic, it is essential to pinpoint the relevant search queries, develop a strategic approach to the search process, and systematically record the findings. This ensures clarity and organization while maintaining a focus on the key aspects of the research. Bramer *et al.* (2018) enumerated the following steps for conducting a SLR search:

1. Formulate a precise and focused inquiry.
2. Identify the scholarly articles that can address this inquiry.
3. Recognize the fundamental concepts associated with the different elements of the inquiry.
4. Ascertain which elements will produce the most beneficial outcomes.
5. Choose an appropriate database and interface to commence the search.
6. Document the search process in a written format.
7. Identify pertinent index terms within the thesaurus of the selected database.
8. Discover synonyms provided in the thesaurus.
9. Integrate variations of the search terms.
10. Utilize database-specific syntax, including parentheses, Boolean operators, and field codes.

11. Refine the search to enhance relevance.
12. Evaluate the initial results

2.2 Steering wheel history literature review

According to Geeks (2023), the steering wheel is an essential component of any vehicle, allowing the driver to control the direction of the vehicle. It is connected to the steering system, which is responsible for transmitting the driver's input to the wheels. The steering wheel evolution is a testament to human ingenuity and a constant drive for innovation.

2.2.1 From the simple tiller to the steering wheel

The steering wheel's inception can be traced to the early development of automobiles. This evolution illustrates how essential this component has become in the development of vehicle design and control emanating from using a lever or tiller. According to Sinha (2020), in 1886, when Karl Benz secured a patent for the first automobile, the prevailing mode of transportation was the horse-drawn carriage. The drivers received training on how to guide their horses by using reins, maneuvering them to the left and right for direction. The tradition of horse-drawn carriages evolved into the automobile, where the front wheels were directed by a basic tiller mechanism. According to Geeks (2023), the tiller was a vertical lever connected to the front axle, which the driver would turn to steer the vehicle. However, this design had limitations in terms of control and maneuverability. However, as cars became faster and more complex, it became clear that a more efficient and effective method of steering was needed. In 1894, Alfred Vacheron, a Frenchman, made a significant change by substituting the tiller on his Panhard & Levassor with a steering wheel, as noted by Van der Velden (2022). This development marked a crucial evolution in vehicle design. This was done to improve the sensitivity and control of steering for the Paris to Rouen race in July of that year. This innovation was supposed to improve the speed of the vehicle over the race. Chaudhury (2020) further elucidate that the French engineer Alfred Vacheron is often credited with creating the steering wheel for the inaugural automobile race, the roughly 200 km event from Paris to Rouen held in July 1894. In his Panhard & Levassor vehicle, which was equipped with a Daimler engine, he replaced the traditional steering lever with a steering wheel. Chaudhury (2020) determined that Alfred Vacheron accomplished his objective of enhanced control. This was made possible by allowing the steering movement of the front wheels to be distributed more evenly and accurately across multiple rotations of the steering column, starting from a neutral central position until it reached a stop or 'locked.' Consequently, this innovation enabled higher driving speeds.

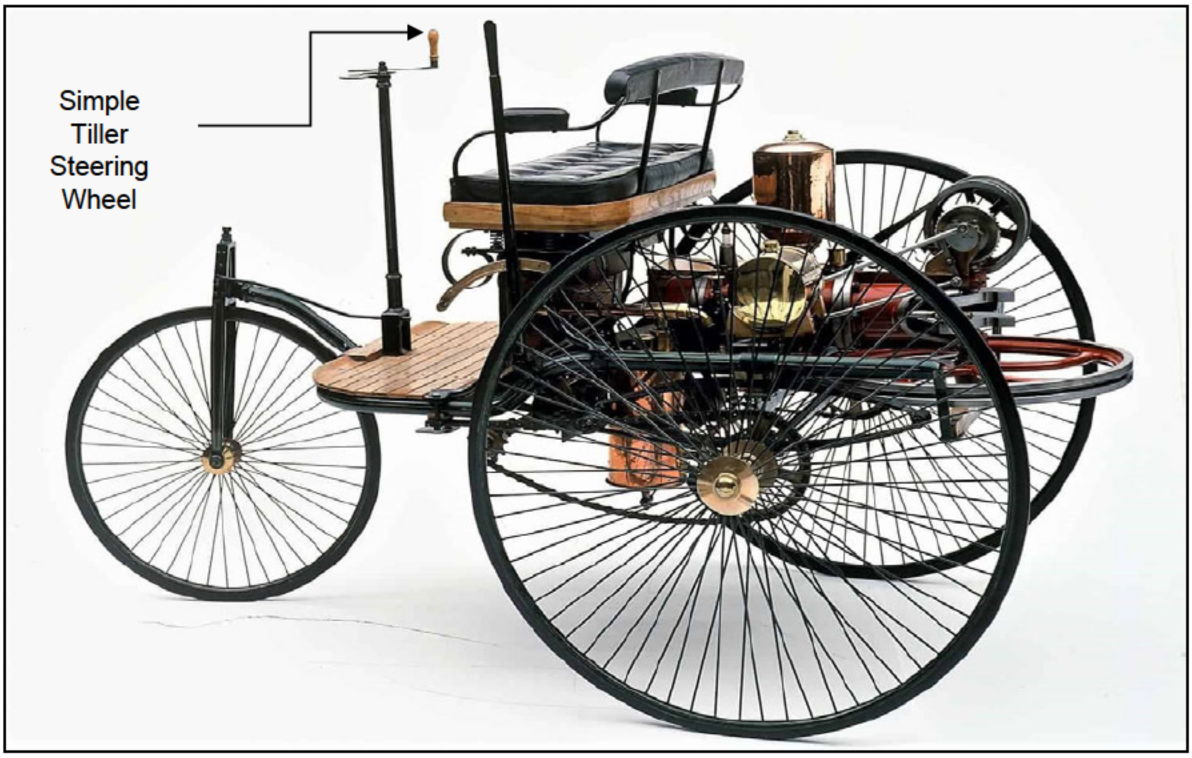


Figure 11:The 1886 Benz patent-motorwagen with its simple tiller steering

Source: *Adapted from Chaudhury (2020)*

2.2.2 Steering wheel evolution

According to Wright (2021), Alfred Vacheron in fitted the first automobile steering wheel to a Panhard 4 HP model in France in 1894. Holm (2022) stated that the steering wheel concept was adopted from the British Navy ships who were said to have adopted the concept as early as 1703. Consequently, Panhard commenced mass production of fitting steering wheels in their models in 1898. According to Donelly (2018), the inventor of the Rambler Model who was a British immigrant to the United States presciently located the steering wheel to the right side of the automobile in 1900.

Wright (2021) elucidated the further progression of the steering wheel by exploring the milestone of incorporating the warning horn control in the centre of the wheel in1915 by the Scripps-Booth Model C that first used this arrangement as an electric switch rather than a pneumatic bulb.

According to Patrascu (2022), the steering wheel was comparatively a wooden circle fitted in front of the driver with the sole purpose of directional movement of the vehicle. The steering procedure was configured mechanically, the driver pulled the tiller to the left or right, while the wheels that touched the ground opposed that on account of the friction with the surface below, hence steering was a difficult task especially on a stationary automobile. Geeks (2023) articulated the evolution of the steering wheel from humble beginnings as a simple wooden wheel, and that the steering wheel has undergone numerous transformations to become the ergonomic and technologically advanced component. According to Geeks (2023), with each iteration of steering wheel advancement, the focus has been on improving driver comfort, control, and safety.

Holm (2022) identified further progressions and additional features to the steering wheel constituting the telescopic steering wheel in 1949, the power steering wheel in 1951, the adjustable, collapsible and tilt steering systems in the 1960s, the antitheft steering locking system in the late 1960s.

Wright (2021) argued that steering wheel audio controls were largely thought to have been established by Mercedes Benz in 1984, however, they seemed to have been adopted earlier by the Japanese Domestic Market (JDM) as early as the 1970s. Wright concluded that the audio controls technology came on mainstream in the automobile industry in 1984.

McCormick (2006) identified an Industrial Engineer named John W. Hetrick to be the inventor of all types of airbags due to a near accident that he and his family were exposed to in 1948. According to Bellis (2019), the airbag to be incorporated into the steering wheel was first assembled in 1975 by General Motors on Oldsmobile's and Buicks in 1976.

Fandakova *et al.* (2023) stated that modern steering wheels are produced as integrated units made up of both metal and plastic components The lightweight metal frame undergoes an injection molding process that incorporates polyurethane and a plastic upper component. Nearly all steering wheels can be customized with leather, silicone, and plastic components that are fitted along the edge of the wheel. Certain steering wheel models allow for the replacement of standard components with customized alternatives. This offers users the opportunity to personalize their setup while maintaining the essential functionality. Fandakova *et al*. (2023) in Figure 12 showcases a variety of steering wheels, ranging from basic models to those with multiple functions. These examples have undoubtedly influenced the design of contemporary steering wheels.

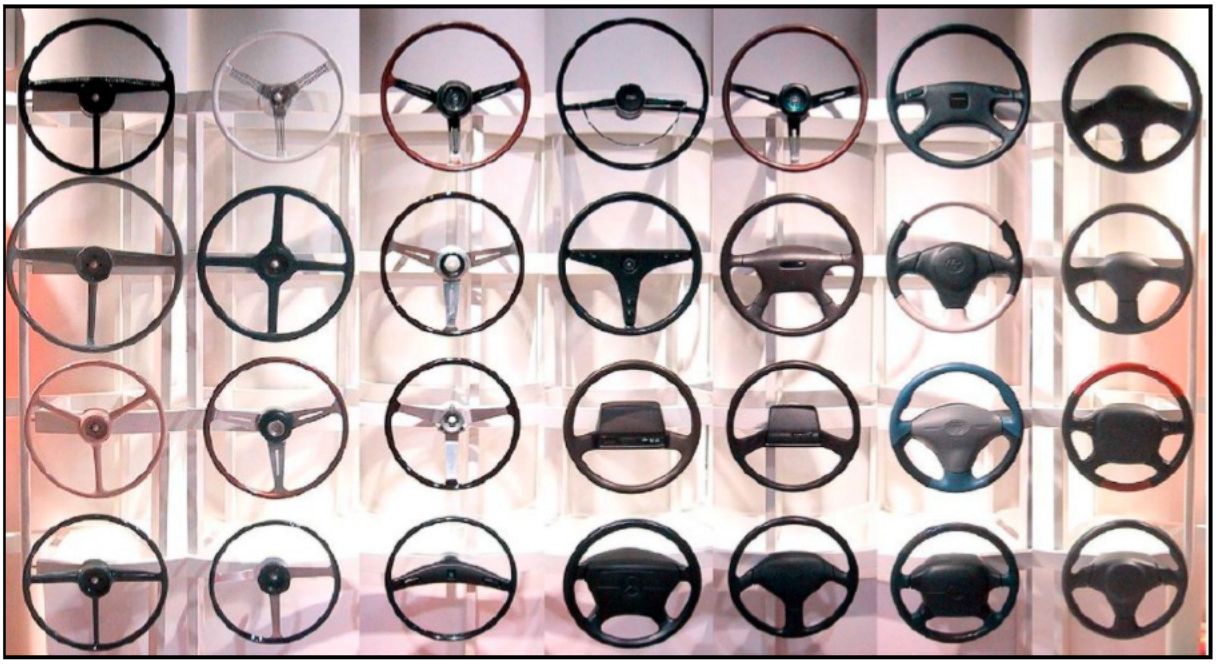


Figure 12:Steering wheels from different time periods, with different complexity of design

Source: *Adapted from Fandakova et al. (2023)*

2.3 Lean manufacturing

Womack and Jones (1996) distinctly outlined the birth of Lean Manufacturing (LM) since 1930 in Toyota's textile loom factory whereby a device for detecting a broken thread was developed and would subsequently immediately stop the line immediately, and this phenomenon enabled one person to supervise several looms. In 1935 Toyota decided to venture into automobile manufacturing and fund the development of its designs in the process rather than licensing foreign designs. After a big strike in 1950, Toyota made a commitment to the unions to reduce employee redundancy. To satisfy this challenge, Toyota created product development and production systems that improved product designs and efficiency using fewer resources to compete with global car makers locally in Japan and in foreign marker (2001) delineated LM as a philosophy that integrates a range of tools and techniques into business operations. Its goal is to enhance efficiency by maximizing the use of time, human resources, and assets, ultimately boosting productivity. Additionally, LM focuses on elevating the quality of products and services delivered to customers. Juran and De Feo (2010) defined LM as the process of optimizing organizational systems by eliminating, or at least reducing the waste within them. According to van Assen (2018), the primary goal of lean is to foster ongoing enhancements in work processes with a focus on the customer. Essentially, LM is designed to drive improvements in processes that prioritize customer satisfaction. According to Abid and Ozkan (2009), meeting customer demands with shorter delivery times and managing fluctuations in demand are crucial aspects of operational success. In today's competitive landscape, achieving a competitive edge requires catering to the unique needs of each customer, leading to an expansion in the variety of products offered. (Christopher, 2000) cited in Abid and Ozkan (2009).

According to Donna *et al.* (2015), the concept of lean was introduced into management terminology by researcher John Krafcik, who highlighted its significance in relation to the Toyota Production System (TPS). According to Lander and Liker (2007), the (TPS) is a manufacturing philosophy that fosters a culture of continuous improvement by establishing standards and involving all employees in the process of waste elimination. Rosinni *et al.* (2019) illustrated a more recent approach of lean 4.0 in conjunction with industry 4.0 as production paradigms with a common objective to manufacture highly customized products efficiently in small batches.

Table 4: Definitions of lean manufacturing

Item	LM Definition	Author
1	LM is utilization of only value-adding activities to produce the product.	Carreira (2004)
2	LM is the systematic elimination of waste.	Santos *et al.* (2006)
3	The core principle of LM is to reduce the expenses associated with managing fluctuations in demand. A production process is considered lean when it delivers goods or services with the least possible costs of managing variations.	Hopp and Spearman (2008)
4	LM is a scientific approach that aims to optimizethe flow of a system, whether it is a physical product or a service.	Suneja and Suneja (2010)
5	LM is a method of producing goods that involves using fewer resources than mass production. This includes reducing waste, minimising human effort, utilising less manufacturing space, requiring less investment in tools, and reducing the amount of time spent on engineering new products.	Wang (2011)
6	LM is a proactive and customer-centric approach in which individuals within a specific organization consistently work to eliminate inefficiencies to generate value.	Oppenheim (2011)
7	LM is a business methodology and ideology focused on minimizing waste, resulting in cost reduction, enhanced quality, and faster delivery to customers.	Ortiz (2012)
8	LM is a methodology aimed at minimizing the time required to complete a process and eliminating any activities or resources that do not directly contribute value.	Taghizadegan (2013)
9	LM is a customer-centric approach aimed at achieving continuous improvement and eliminating waste throughout an entire organization.	Fliedner (2016)
10	LM is the enhancement of value by the elimination of waste.	Ambe (2017)
11	LM focuses on maximizing value while minimizing effort. In the context of manufacturing, this approach emphasizes enhancing efficiency by shortening process times.	Kumar *et al.* (2017)
12	Lean means manufacturing without waste.	Dinesh and Mahadevan (2018)
13	Lean is a critical path for growth and a source of competitive advantage.	Khalil (2018)
14	Lean is a philosophy and a system that strives for perfection	Arnout (2020)
15	A production philosophy focused on reducing the consumption of all resources, including time,across the various operations within the organization.	Logu *et al.* (2021)

Source: *Researcher's own construction*

Researchers agree that the diverse principles and tools associated with LM share a common objective: the eradication of all forms of waste Wang (2011), Ortiz (2012), Fliedner (2016), Ambe (2017), and Dinesh and Mahadevan (2018),and the non-value-added activities at every stage of the production or service process as confirmed by Wang (2011) and Taghizadegan (2013).

Based on empirical analysis, Yichalewal *et al.* (2019) deduced that developing countries are tardy to implement LM in comparison to their affiliates in the Western world and therefore inefficiencies render them uncompetitive.

Salonitis and Tsinopoulos (2016) noted that implementing lean principles in the manufacturing sector is a complex endeavour. Unlike merely applying a collection of tools, lean represents a comprehensive management philosophy that requires careful consideration of various factors during its implementation. The process involves multiple stakeholders with differing interests, all of which must be addressed to successfully adopt lean practices.

Ismyrlis (2021) asserted that Lean and Kaizen methodologies have provided valuable assets in the field of management. According to Shang (2017), kaizen is a term rooted in Japanese culture that emphasizes the concept of ongoing enhancement. It is composed of two elements: 'Kai', which signifies change, and 'Zen', indicating good or improved outcomes. According to Ramezani and Razmeh (2014), Kaizen through collaborative management based on staff suggestions is based on three dimensions:

1. Improving the quality of products and services.
2. Zero waste.
3. Customer satisfaction.

Shang (2017) stated LM as a Kaizen method and added the following to the list of methods used in continuous improvements efforts:

1. PDCA Cycle
2. Lean Six Sigma
3. Poke yoke
4. 5S
5. The seven QC Tools
6. Andon
7. Jidoka

Hargrave (2023: para.21 line 1) listed the five kaizen elements or principles as: know your customer, let it flow, go to Gemba which means the source, empower people, and be transparent.

Lean manufacturing in the South African context

Coetzee *et al.* 2019 highlighted that many industries in South Africa have taken on the LM to promote continuous improvement initiatives. Nevertheless, numerous studies have substantiated that the low success rate of LM adoption and or implementation can be traced back to an excessive focus on lean tools and techniques, frequently disregarding the human factor, as outlined in the respect for people principles . According to Dondofema *et al.* (2017), the predominant focus of publications from South Africa during the years 2014-2015 is on the application of essential lean tools. In comparison, German publications from the same period prioritize the adaptation of lean principles to fit their local industries perfectly. There is a notable inclination among German researchers to adopt and integrate LM as an environmentally conscious production system. In contrast, South African researchers are primarily engaged in applying lean principles within product design and mineral processing, sectors where LM is often perceived as unfamiliar (Dondofema *et al.* 2017).

2.3.1 To explore the key drivers for implementing LM for the selected steering wheel manufacturer.

Meshref *et al.* (2022), a driver refers to an essential factor, resource, process, or decision that plays a pivotal role in a company's ongoing success and development. Consequently, LM drivers are the key variables that compel management to adopt lean practices. Sarwar *et al.* (2019) remarks that the drivers of LM stimulates the efficiency of organizational processes.

Sangwan *et al.* (2014) stated that recognizing the factors that drive Lean Management (LM) offers valuable insights into the key motivational elements to prioritize when making Lean decisions. Additionally, the correlation results among these drivers will allow the researcher to effectively allocate resources, facilitating the successful implementation of Lean strategies. Salonitis and Tsinopoulos (2016) enumerated the most key common drivers for implementing lean manufacturing as summarized by most researchers as follows:

1. Expand the company's presence in the market.
2. Enhance adaptability.
3. Necessity for sustainability due to internal limitations.
4. Creation of essential performance metrics.
5. Aspiration to adopt global best practices.
6. Component of the organization’s ongoing initiative.
7. Emphasis on prioritizing customer needs.
8. Demand or encouragement from clients.
9. Obligation set by the parent company.

Niemann *et al.* (2018) discussed two main drivers in implementing lean as follows:

1. **Enhanced competitiveness.**

   Lean manufacturing focuses on optimizing organizational processes to enhance product quality and increase efficiency. A company’s competitiveness directly influences its longevity in the market.

2. **Maximising resource utilization to achieve savings on cost.**

   LM enables companies to cut costs by minimizing unnecessary expenditures, lowering the frequency of stock replenishment, simplifying processes, and optimizing energy usage. By decreasing resource consumption in the production of goods or services, businesses can achieve significant savings, which in turn can lead to higher profit margins or the ability to provide more competitive pricing for customers.

   Coutinho (2021) outlines 5 major drivers for implementing LM are to achieve:

   1. Fast, flexible, and efficient processes.
   2. Varied, reliable and innovative products.
   3. Stable, uninterrupted operational flow.
   4. Engaged and motivated employees.

5. Constantly stimulated performance indicators.

Yandell (2012) identified four typical lean drivers to be

1. Workplace organization
2. Uninterrupted flow
3. Error free processing
4. Single Minute Exchange of Dye (SMED)

Logu *et al.* (2021) listed the major transformation needs for automotive industry that drive the implementation of LM as:

1. Streamlining operations across companies, facilities, and product lines.
2. Aligning with global benchmarks for product excellence.
3. Implementing lean manufacturing techniques.
4. Significant capital investment in facilities and machinery.
5. Enhancing employee skills and capabilities.
6. Raising recruitment criteria.
7. Promoting cross-training and skill development.
8. Restructuring supply chain processes.
9. Substantial funding directed towards research and development.

Meshref *et al*. (2022) identified eighteen LM drivers and categorized them into five distinct groups: value, reduced variability, flow variability, pull, and continuous improvement.

Table 5: Eighteen lm implementation drivers

Cluster	LM No	LM Driver	Driver Benefits
Value	1	Client focus	Value achievement
	2	Regular client communication	Improve communication between project stakeholders
	3	Clear definition of client's requirements	Customer satisfaction
Reduce variability	4	Standardized works	Rework minimization
	5	Reviewing the design drawings at an early stage	Rework minimization
	6	Daily meetings	Reduction in rework
	7	Schedule look ahead	Improved planning
	8	Workforce Motivation	Employee satisfaction

Flow variability	9	Collaboration with Suppliers	Improve communication between project stakeholders
	10	Using visualization tools on site	Enhancing transparency
	11	Day to day observation	Improving life cycle cost
Pull	12	Just in time	Material storage control
	13	Document management systems	Improve process control
Continuous Improvement	14	(Training) Continuous education programs	Continuous improvements
	15	Quality plans	Improve quality
	16	Considering the customer feedback	Customer satisfaction
	17	Benchmarking	Improve decision making
	18	KPI (Key Performance Indicator)	Increase productivity

Source: *Adapted from Meshref et al. (2022)*

Ambe (2017) suggested seven key lean drivers that impact automotive industry as enumerated below:

1. Production
2. Inventory
3. Location
4. Transportation
5. Information
6. Sourcing
7. Pricing

In line with Ambe (2017) item 2, Demeter and Matyusz (2011) concluded from an empirical analysis that Lean companies keep fewer inventories of any type, hence inventory management is a distinct driver for implementing LM. Inventories constitute an important immobilization of resources which can slow down the development of automobile parts manufacturers (Dongdong and Xingwu, 2018) cited in Saliji (2021). Tarver (2023) highlighted seventeen inventory management techniques listed below:

1. Demand Forecasting
2. ABC Analysis
3. Safety Stock
4. Re-order points
5. PAR levels
6. Just In Time (JIT)
7. Drop shipping

8. Cross-Docking
9. Inventory Management Software
10. FIFO and LIFO
11. Consignment Inventory
12. Economic Order Quantity (EOQ)
13. Perpetual Inventory Management
14. Minimum Order Quantity (MOQ)
15. Six Sigma and Lean Six Sigma
16. Bulk Shipping
17. Bottom Line

Several authors noted above highlighted Inventory Management as one of the drivers for LM. According to (Balram, 2023) cited in Rahman *et al*. (2013) For lean manufacturing, Kanban serves as a tool to control the levels of buffer inventories in the production; in simpler terms to regulate production quantities. When a buffer reaches its preset maximum level, the upstream machine is directed to stop producing that part type. Hence, in the manufacturing environment, Kanban are signals used to replenish the inventory of items used repetitively within a facility. According to Htun *et al.* (2019), Kanban (kahn-bahn) is Japanese word that when translated means visible record or visible part. The kanban system is based on a customer of a part pulling the part from the supplier of that part. The premise of kanbans is that material will not be produced or moved until a customer sends the signal to do so, Htun *et al.* (2019). Adnan (2013) concurred the former discourse in that the kanban system emphasized minimum level of inventory by producing only what is needed and to ensures the supply of the right product, at the right time, in the right quantity and at the right place. Kanban system becomes practical; it synchronizes all manufacturing activities entire manufacturing with customer demand.

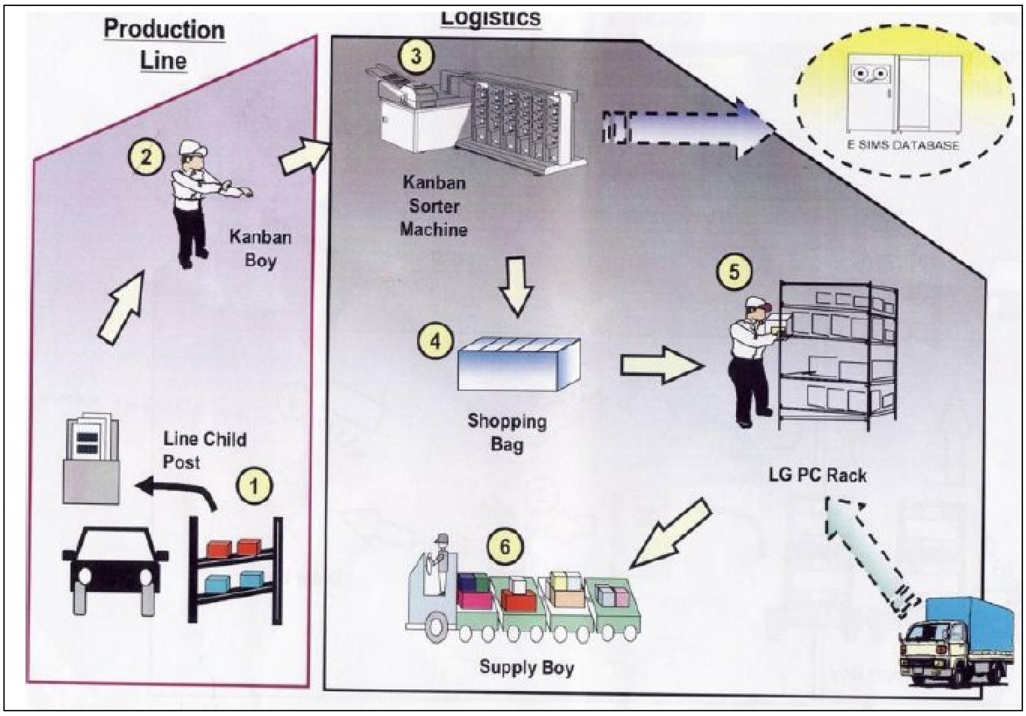


Figure 13: Kanban illustration

Source: *Adapted from Rahman et al. (2013)*

The studies by (Landeghem, 2011), (Houti, 2019) and (Dat MINH, 2018) cited in Zvidyayi (2021) identified the critical LM drivers as:

1. Top management involvement and commitment.
2. Middle management commitment.
3. Employees commitment.
4. Standard for evaluation and KPI.
5. LM training and consulting.
6. Culture change.
7. Effective communication.
8. Rewarding/Recognition.
9. Understand tools & techniques.
10. Linking to suppliers/vendors.
11. Linking to customers.
12. Flexibility and prioritization.

According to Varghese (2020), the three drivers of LM are Cost, Quality and Time, and because they are interdependent, their relationship can be visualized in Figure 14.

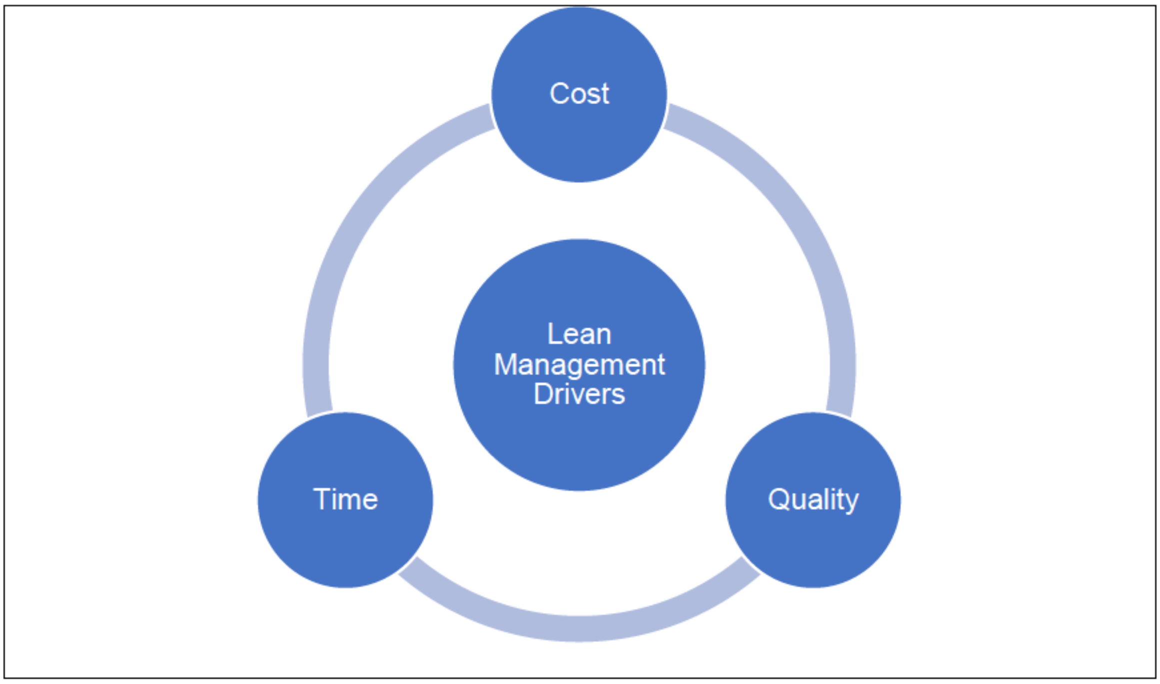


Figure 14: The three interdependent LM drivers

Source: *Adapted from Varghese (2020)*

According to the empirical findings of Shah and Ward (2003), three critical factors were established that influence and affect the implementation of LM as enlisted below:

1. **Unionization**

   It is often assumed that because implementation of most manufacturing practices requires negotiating changes in work organization, unionized facilities will resist adopting lean practices and thus lag behind non-unionized facilities. However, there are also instances in which unions have been cooperative and helpful in the implementation process. Katz, (1985) and Cappelli and Scherer,(1989) cited in Shah and Ward (2003)

2. Plant age

According to (Stinchcombe,1965) cited in Shah and Ward (2003), plant age imply either a tendency towards resistance to change or a liability of newness. The resistance to change view is supported by the organizational sociology literature which suggests that the age of an establishment should inversely influence the rate of adoption of innovations, because organizational forms tend to be frozen at birth. According to Shah and Ward (2003) three lean practices, planning and scheduling strategies, safety improvement programs, and total quality management pro-grams have significant positive association with age of the plant. This implies that old plants are more likely to implement these practices relative to new plants, and hence plant age is a key driver of LM.

3. Size of the plant

Shah and Ward (2003) empirically concluded from the 22 lean practices examined, that plant size significantly impacts all but two practices. No significant relationship was found between size and implementation of two practices: cross-functional work force, quality management programs. As predicted all the effected practices have a significant positive association between plant size and implementation. This suggests that large plants are likely to implement the twenty practices more extensively compared to small plants.

Bhat (2008) identified cellular manufacturing (CM) as a key driver of LM, and defined CM as an approach that helps to build a variety of products with as little waste as possible by arranging the workstations in a sequence that supports a smooth flow of materials and components through the process with, with minimal transport delay. Adding to this discourse Metternich *et al*. (2013) asserted that in recent decades, CM has been discussed with the following aspects:

1. Grouping of part families.
2. Cell formation and layout.
3. Line balancing.
4. Improvements to job shop production.

Coetzee *et al.* (2019) noted that Organizations are pressured to implement and adopt LM approaches to enhance their efficiency, competitiveness, shift in customer demands, an increased variety of products, demand, and the quest for perfect quality. Kumar *et al*. (2013) eighteen drivers for lean implementation in an automobile component manufacturer as listed in Table 3 above and used the Interpretive Structural Modelling (ISM) approach defined by Ahmad and Qahmash (2021) as a technique to establish the interrelationships between elements of interest in a specific domain through experts' knowledge of the context of the element.

The ISM approach using the eighteen LM drivers enumerated in table 3 above is shown in figure 15 below:

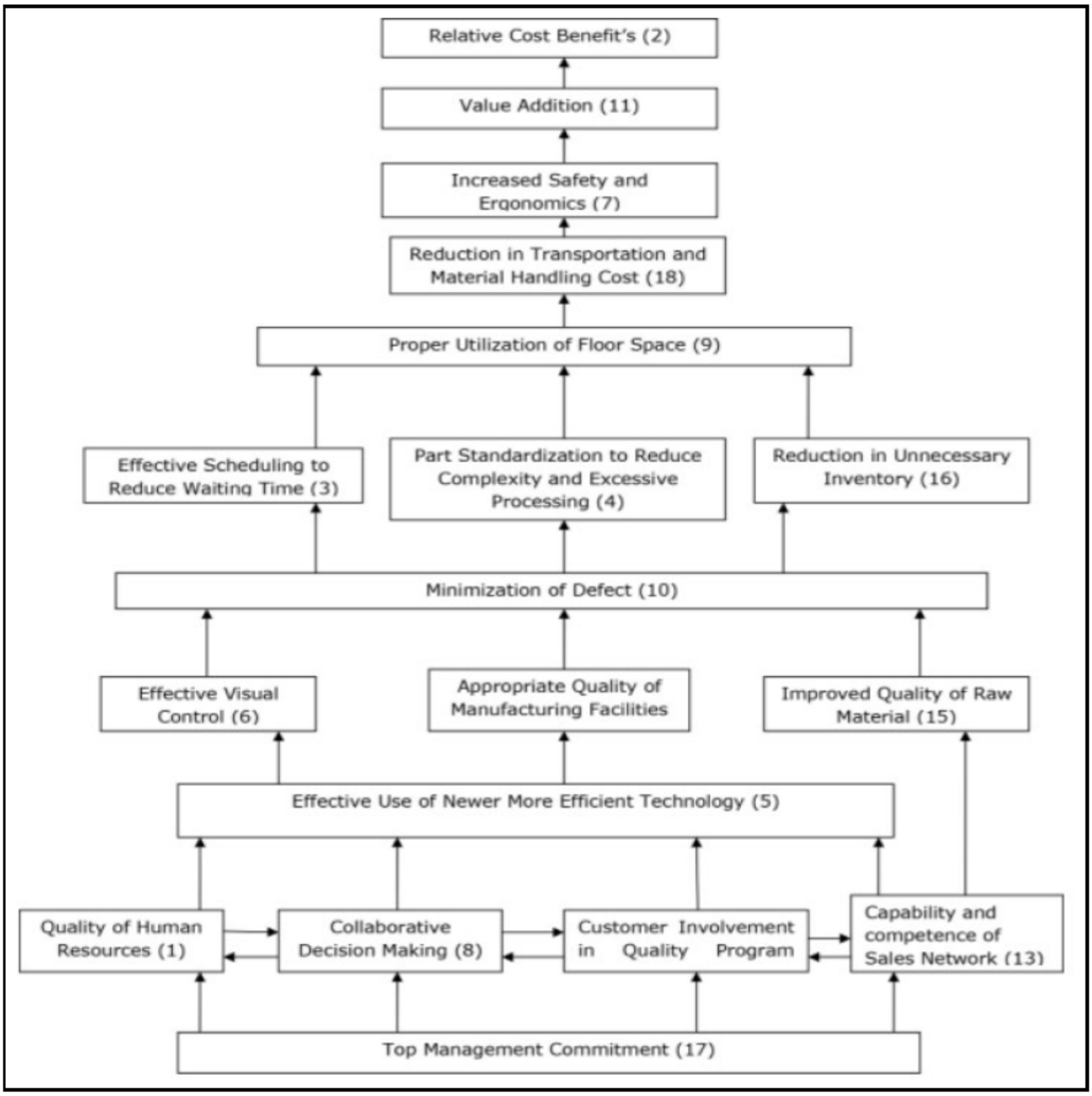


Figure 15: ISM based model of LM drivers

Source: *Adapted from Kumar et al. (2013)*

2.3.1.1 Industry 4.0 and the fourth industrial revolution (4IR).

According to Raji and Rossi (2019), Industry 4.0 also regarded as the fourth industrial revolution represents the current advancement in industrial processes. It signifies the confluence of technologies ranging from several digital technologies to novel materials and processes. According to Wang *et al.* (2016) and Kamble *et al*. (2019) cited in Raji and Rossi (2019), the various technologies of industry 4.0 connect the machines, equipment, devices, products and logistics tools to facilitate "real time" communication among them in a way that the system inherently generate and feed information thereby adding value to the manufacturing process. Tripathi and Gupta (2021) defined 4IR or Industry 4.0 (I4.0) as the transformation to novel systems, that bring together the physical and digital technologies to an increasingly interconnected population. According to Nyagaza *et al.* (2021), the advent of 4IR can transform emerging economies into another developmental echelon by increasing productivity and improving the future fluidity of innovation across various industries. Predictively, 4IR in emerging economies will come with the newest disruptive technologies. According to Jegede (2021: para. 2 line 5), one of the major concerns about 4IR is the perceived disruptive force in people's mindsets and fears of robots displacing workers. Calls in South Africa intensified for government to create more employment and protect jobs in labour-intensive industries from automation. According to Knott-Graig (2018), the first Industrial Revolution was powered by steam, while the second Industrial Revolution was ignited by the power of electricity. Both led to economic growth and massive gains for mostly European and American societies, and the countries that took advantage of them created more jobs than they lost. The Third Industrial Revolution ushered in the Information Age and introduced us to computing, mobile communications, and the first wave of the internet. It is virtual and people-orientated, and its products, Google, Facebook, Twitter, and eBay exist almost entirely online, ubiquitously, without touching the physical world. It tore down communication barriers, made neighbours out of enemies, and again, Africa was left behind.

According to Ruane (2023: para. 22 line 1), today's smart machines also have predictive maintenance capabilities that allow them to send alerts when they sense an inconsistency, an ability that falls under the jidoka philosophy of lean manufacturing. Time-consuming administrative tasks can also be automated. For example, onboarding new workers is a long and laborious process that takes up valuable time. By digitizing employee paperwork, new hires can fill out and save documents to the company server on their own, allowing HR to focus on value-adding tasks like talent acquisition.

Section 2.3.1 highlights the Kanban system as an important LM driver. Abbadi (2018) proposed that the kanban system must follow the 4IR revolution and be transformed to Kanban 4.0. Figure 16 shows the evolution of the Kanban system into Kanban 4.0 as proposed by Abbadi (2018).

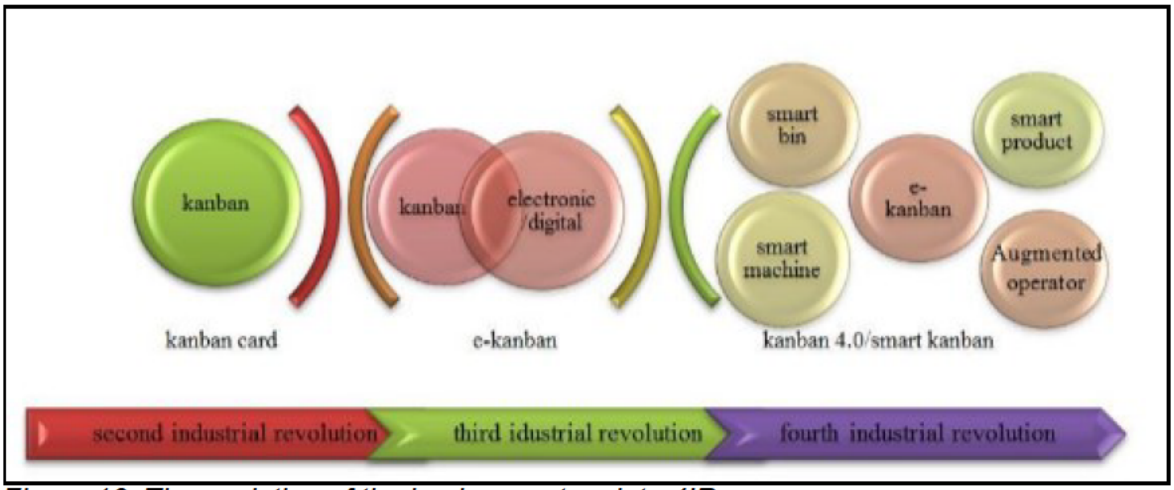


Figure 16: The evolution of the kanban system into 4IR

Source: *Adapted from Abbadi (2018)*

Corfe (2018) identified four areas where 4IR technologies can optimize productivity through data revolution:

1. Cost Saving

   Data use to identify sources of wastage within supply chains, such as underutilized labour, investments that are not yielding significant benefits and energy & water leakages.
2. Time Saving

   Ability to analyze real time data, rather than waiting for the process to finish to collect the data.
3. New Product development

   Use of data for product design and development.
4. Understanding market conditions

   These include predicting potential upturns and downturns in product demand and adjusting business behaviours accordingly.

2.3.2 To explore the possible barriers to implementing LM in this case study with reference to a systematic literature review

According to Chong and Perumal (2020), misunderstanding is the main barrier of lean manufacturing implementation. Roos and Kiohling (2021) discussed that the absence of knowledge about LM implementation barriers is one of the main reasons for organizations to fail to implement the philosophy and stated the most common barriers as understanding and training of employees, top management commitment, and resistance to change. Abu *et al*. (2021) through an empirical research analysis summarized the main LM barriers as knowledge, resources, culture, and human attitude. Furthermore, the analyses also highlighted four dominant challenges which are related to culture and human attitude issues – lack of employee commitment, lack of senior management's interest and support, and difficulty in implementation. Overall, the ability to deal with the challenges involving factors of knowledge, culture, and human attitude, determine the success of LM implementation, especially in companies that have limited resources. Lodgaarda *et al.* (2016) illustrated a case study result of the barriers that were obtained in a case study conducted with results of how each Management level views the contribution to failure due to each barrier as encountered in their organization. The results are illustrated in Table 6 below:

Table 6: Barriers to LM implementation

Category	**Perceptions of barriers**	**Top Managers 4**	**Middle Managers 14**	**Workers 10**
Management	Limited management commitment	75%	50%	50%
	Limited leadership	75%	50%	60%
	LM is not a daily focus	75%	43%	50%
Organizing for lean	Roles and responsibilities defined	75%	79%	0%
	Lack of involvement	50%	43%	30%
	Lack of teamwork	0%	36%	0%
	Lack of motivation	75%	43%	30%
	Failure to prioritize lean tools and practices	25%	21%	50%

Lean Tools and practices	Chosen lean tools and practices not according to best practices	100%	86%	40%
	Chosen lean tools and practices not adding sufficient value	100%	43%	20%
Knowledge	Lack of knowledge about lean (Philosophy, principles, tools)	100%	57%	40%
	Lack of capturing and sharing of knowledge	25%	29%	30%

Source: *Adapted from Lodgaarda et al. (2016)*

Tiwari and Tiwari (2018) categorized the key lean manufacturing barriers for the automotive industry as shown in Figure 17 below.

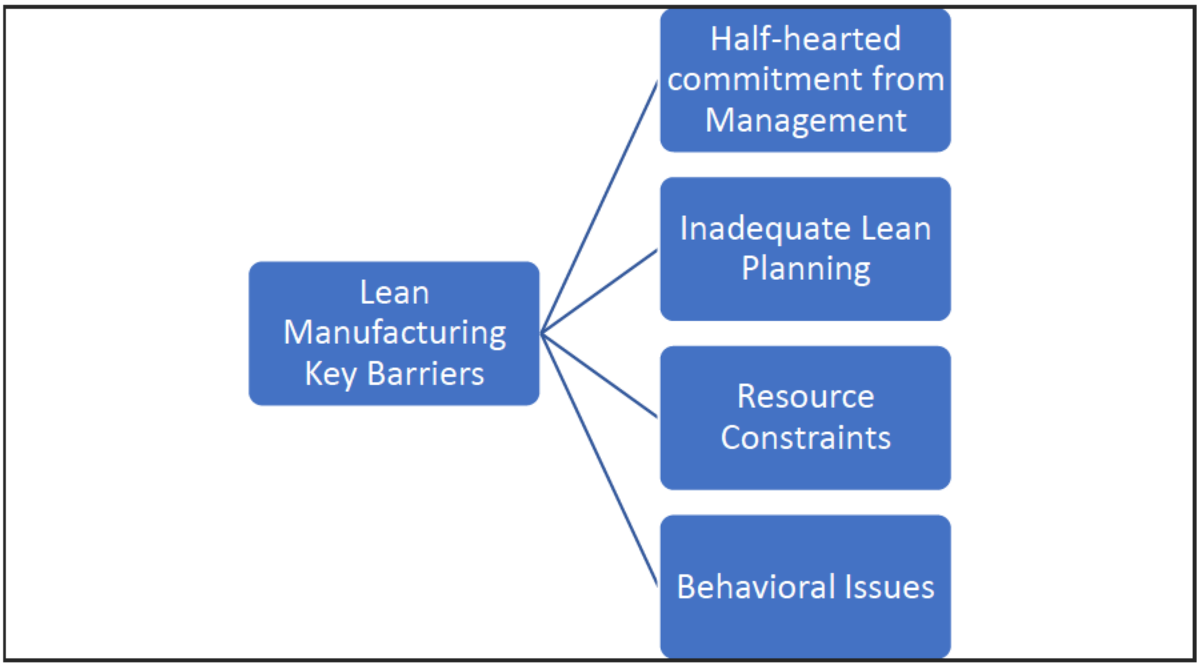


Figure 17: Lean manufacturing barriers conceptual model

Source: *Adapted from Tiwari and Tiwari (2018)*

Moradlou and Perera (2017) investigated LM barriers in nine different industries and summarized the findings in Figure 18.

Figure 18: Main barriers in implementation of LM

Source: *Adapted from Moradlou and Perera (2017)*

In a single case study survey in Norway, Lodgaard *et al.* (2016) cited in Nwaki *et al.* (2021) found that the barriers to lean implementation based on the relative percentage weighting are limited management commitment, limited leadership, lean not a daily focus, roles and responsibilities not defined, lack of motivation, chosen tools, and practices not according to best practices, chosen lean tools and practices not adding sufficient value, and lack of knowledge about lean (philosophy, principles, tools).

Bashir *et al.* (2010) cited in Nwaki *et al.* (2021) carried out an in-depth analysis of barriers to LC implementation and categorized the barriers into financial, educational, governmental, attitudinal, managerial, and technical barriers.

Chan *et al.* (2019) identified ten barriers for LM implementation enlisted below:

1. Worker attitude or resistance, which means workers' unwillingness, was at the first rank. The main reason for low-level implementation of LM was anxiety in changing the workers' mindset.
2. Lack of resources to invest or necessity of high investments or financial constraints.
3. Lack of formal training for workers.
4. Lack of support or commitment from managerial level including inconsistent and unclear communication between management and workers implementation.
5. Lack of formal training for managers was placed at the fifth place.

6. Lack of consultants in the field.
7. Lack of information sharing between managerial level and production workers.
8. According to Hines *et al*. cited in Chan *et al.* (2019) poor consultation sharing between managerial level and production workers was one of the top ten barriers for poor sustainability of LM.
9. Incompatibility of lean or JIT with the company bonus, rewards, or incentives systems.
10. Lack of cooperation and mutual trust between management and employees.

Maware and Parsley (2022) illustrated the hierarchical structure of the LM barriers as follows:

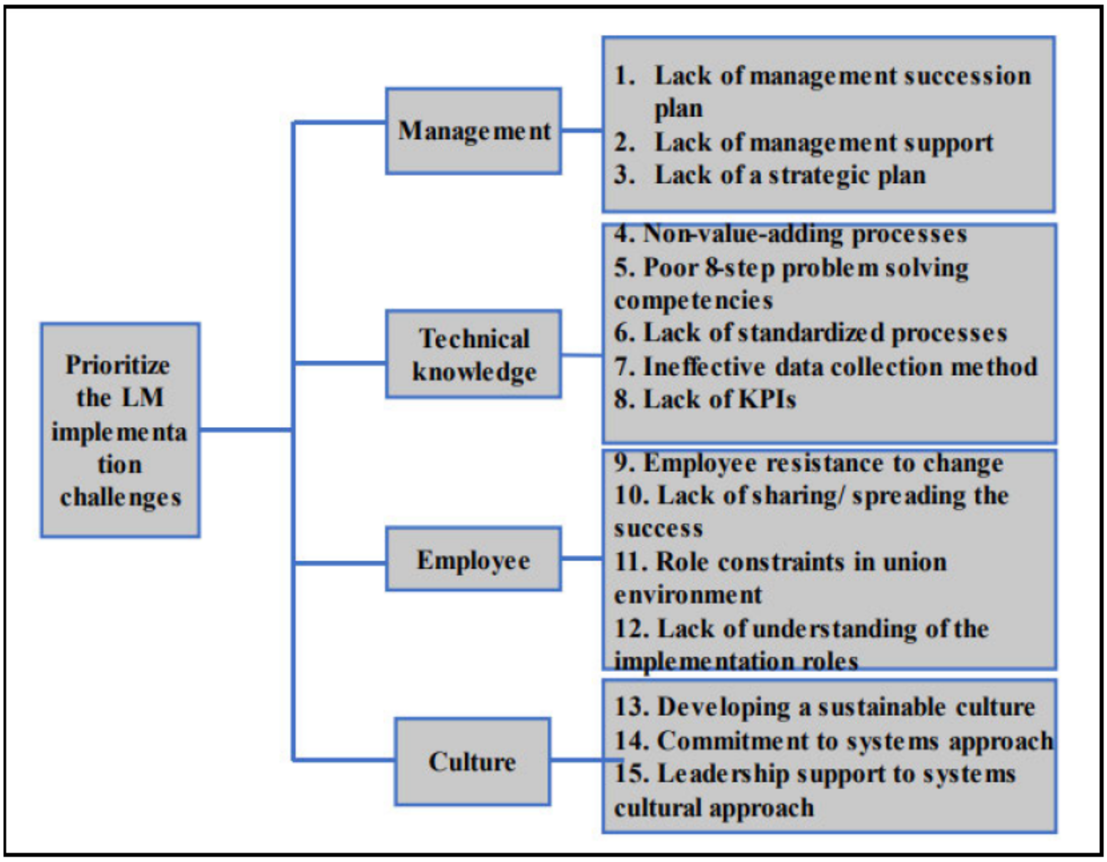


Figure 19: Hierarchy of LM barriers adapted from)

***Source**: Adapted from Maware and Parsley (2022)*

Jadhav *et al.* (2014) used the ISM approach to exhibit the relationship of the identified and ranked LM barriers in a production set up. The adapted model is shown below:

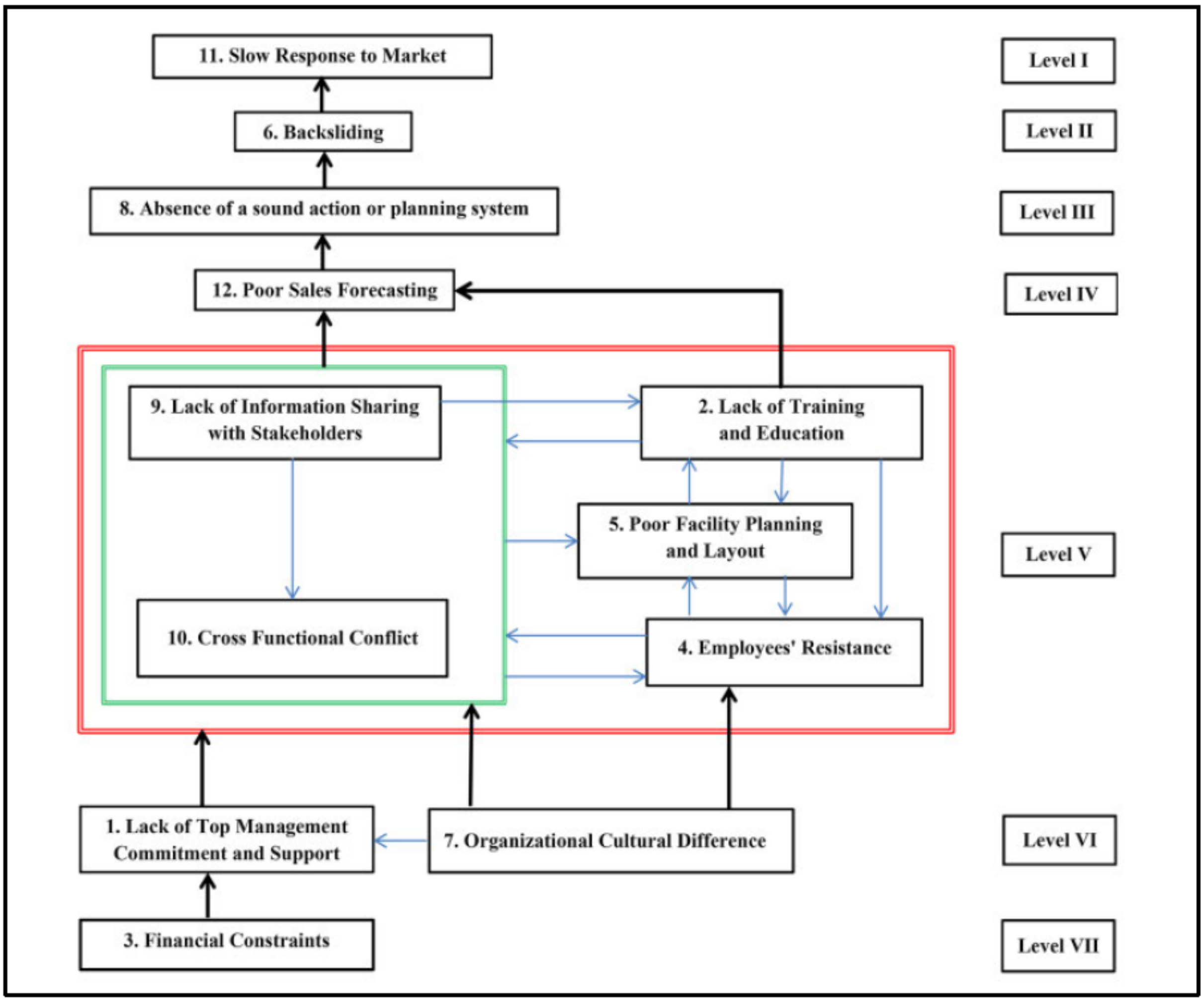


Figure 20: ISM Model of LM barriers

***Source**: Adapted from Jadhav et al. (2014)*

2.3.3 To investigate the manufacturing performance of the current steering wheel manufacturing process with regards to LM drivers and barriers by using focus groups, one on one interviews, and participant observation

Khan and Shan (2011) affirm that performance measurement has been defined from different perspectives by different authors, and the following literature cited in Khan and Shan (2011) summarize the definitions:

Neely *et al*. (1995) defined it as “the process of quantifying the efficiency and effectiveness of an action. Otley (1999) defined it as an information system that helps managers performing their job and managing the behaviour of the organization. Gates (1999) defined it as the procedure to implement strategy in an organization by translating business strategy into deliverable results. Bititci *et al.* (1997) defined it as an information system and a reporting process through which the employees are given feedback on the outcome of their actions. Bourne *et al.* (2003) defined it as a set of multi-dimensional performance measures used for planning and managing the business. Maisel (2001) defined it as a system that enables an organization to manage its performance and ensures that all the functions and activities are in line with the strategy to achieve the business results and create shareholder value. Therefore, based on the above definitions, there is a lack of agreement on a single definition of performance measurement (Franco Santos *et al.* 2007)

According to Ghalayini and Noble (1996) cited in Gomes *et al* (2004), the literature concerning performance measurement evolved through two phases. The first phase started in the late 1880s, while the second phase started in the late 1980s. The first phase was characterized by its cost accounting orientation. This orientation aimed at aiding managers in evaluating the relevant costs of operating their firms.

Gomes *et al*. (2006) listed the criticisms exposed by various scholars based on the weaknesses of traditional measurements used by manufacturing firms and therefore augmented the latter with the following:

1. SMART system as visualized in figure 8.
2. The performance measurement matrix.
3. The balanced score cards.
4. Integrated Dynamic PSM.

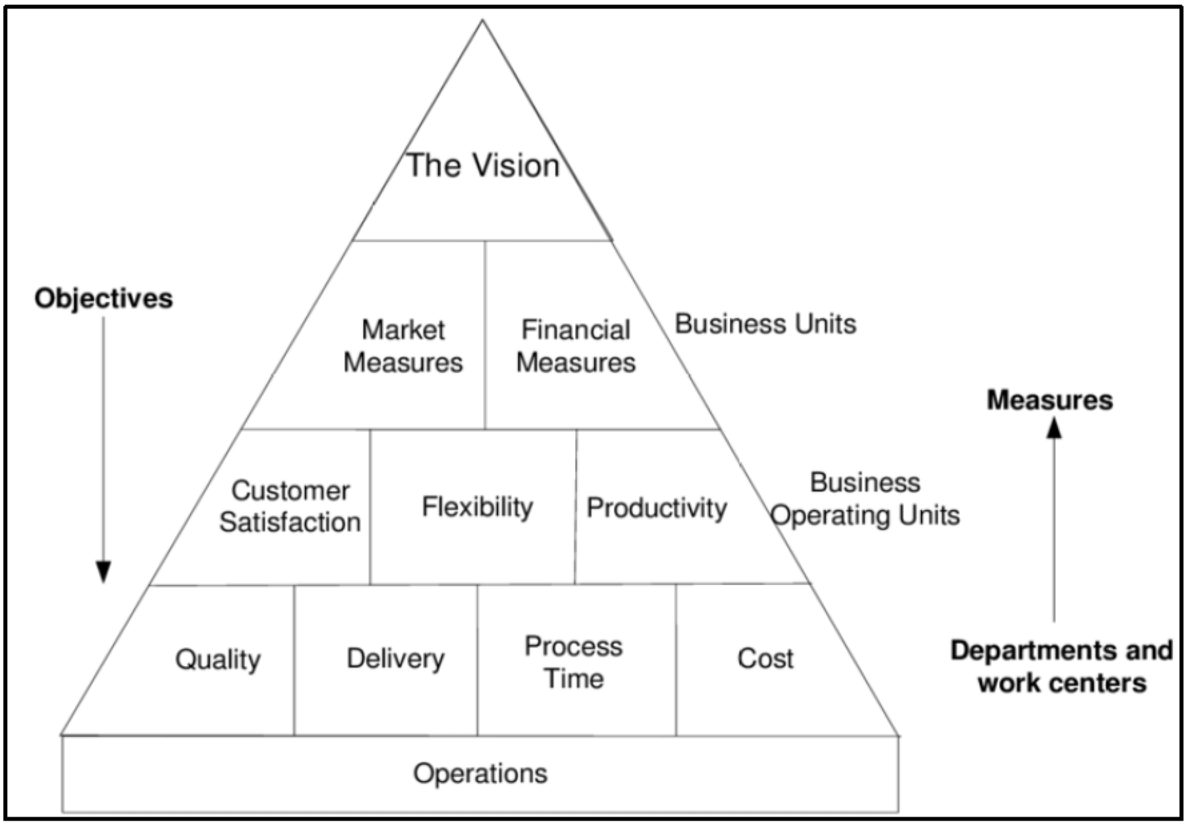


Figure 21: SMART PSM

***Source**: Adapted from (Lynch and Cross, 1991 cited in Gomes et al. (2006)*

Favi *et al.* (2017) concluded that all manufacturing performance measurement methods seek to analyze the 4Ms listed and explained below:

1. Material – relates to the assembly issues related to the product and components design, including the number of components, the geometrical entities, and the assembly systems
2. Method – relates to assembly issues related to the assembly procedure, including unclear instructions, and errors
3. Machine – these are assembly issues related to the workstation layout, including tools arrangement, available equipment, and consumables
4. Man – include assembly issues related to the workers, including task errors, not adequate training, and ergonomics aspects.

Kaplan and Norton (1992) discussed the Balanced Score Card (BSC) as a performance measurement system that has four perspectives as follows:

1. How customers see the organization? (customer perspective).
2. How the organization excels at how they are seen? (internal perspective).
3. Can the organization continue to improve and create value? (innovation and learning perspective).
4. How does the organization view shareholders? (financial perspective).

Neely *et al*. (2012) described the performance prism as a performance measurement system that has five interrelated facets listed below:

1. Stakeholder satisfaction – who the stakeholders are and what they require?
2. Stakeholder contribution – what the organization requires from the stakeholders?
3. Strategies – what strategies need to be in place to satisfy the wants and needs of the stakeholders while satisfying the company's requirements too?
4. Processes – what processes are required put in place to enable the company to execute the strategies?
5. Capabilities – what capabilities are required to allow the company to operate?

Manufacturing performance is described by Wickramasinghe and Wickramasinghe (2017) in terms of various dimensions such as manufacturing plant's labour efficiency, machine efficiency, conformance quality, manufacturing plant productivity, schedule attainment, on-time delivery, inventory management, production volume flexibility, and manufacturing cost efficiency.

Kumar *et a*l. (2017) listed the manufacturing performance metrics with respect to LM by measuring the following before and after implementation of LM.

Table 7: Manufacturing performance metrics

Strategic	Tactical	Operational
An assessment of returns on capital investments, inventory levels, revenue streams, cash flow metrics, and competitive market standing	Productivity, financial turn over, supply chain, quality cost, regularity	Safety, quality, delivery, time to market, manufacturing efficiency

***Source**: Adapted from Kumar et al. (2017)*

Hwang *et al*. (2020) emphasised that the six components used for evaluating manufacturing process performance should assess the metrics that measure production, quality, flexibility, overall waste, human resources, and continuous improvement.

2.3.4 To explore the prevalence of overcoming the LM barriers and challenges

The Oxford dictionary defined prevalence as the condition of being widespread in a particular area or at a particular time; general occurrence, existence, practice, or acceptance; predominance.

Leeson (2023: para 4 line 1) highlighted that throughout all disciplines, resistance to change as the most common barrier in implementing LM and that it often arises when organizations attempt to implement LM without including the workforce. Five strategies to overcome this barrier were suggested as listed below:

1. Communication and Education
2. Involvement and collaboration
3. Setting realistic expectations
4. Leadership commitment
5. Change management

Armstrong (2017) discussed a diagnostic approach to implementation of LM that identified existing opportunities and constructed a roadmap for achieving results. The approach consisted of four phases summarised below:

1. Data capture and preparation

2. Assessment of the current state
3. Strategic options evaluation and selection
4. Benefits, hypothesis, and report.

To tackle lean implementation barriers, Sakataven *et al*. (2021) discussed the deployment of the ISM Technique depicted in 4.1.1. Sakataven *et al*. (2021) thus classified fifteen lean barriers into 10 levels, analysed their interdependency, and then developed a framework to address each of the barriers.

Alyousef (2019) identified the most used lean practices in the Manufacturing Industry as Setup Time Reduction, Standard Work and TQM among most of the organizations evaluating. These were identified as the most effective tools for improving the organization implementing LM.

Gaikwad *et al*. (2020) summarised twelve strategies to overcome LM barriers based on a systematic literature review as shown below:

Table 8: List of LM strategies

Item	Name of strategy	Description of strategy
1	Effective management	The strategy 'effective management' can smooth the implementation process as well as can faster the process. Effective management means the management process, which is more effective for organisations.
2	Effective cross function management	Cross-function management can help to improve the efficiency of supply chain activities. In this system, different functional experts work together to attain the desired goal. Therefore, for successful implementation, this strategy can integrate the overall activities in the LM implementation program.
3	Appropriate selection of staff for effective LM training	For arranging training for LM implementation, an appropriate selection of staff can enhance the productivity of the team as well as the process.
4	Precise selection of LM tools and techniques	Precise selection of LM tools and techniques for LM implementation can be an imperative strategy for the organization. Proper selection of that tool can enhance the overall efficiency of the system
5	Establishing strategic planning committee	Establishing a strategic planning committee is one of the strategic approaches for LM implementation. The committee can direct the implementation process and guide the employees who will be engaged with the system
6	Bringing in additional financial resources	Bringing in additional financial resources can be a strategy for an organization as additional financial resources will help to implement LM.
7	Effective employee empowerment and encouragement sessions.	This strategy will assist organizations to faster the process as well as bring good quality at work.
8	Linking LM to business strategy	It is imperative to link LM with the existing business strategy for bringing success in the implementation process. Therefore, this strategy would help to smooth the system.
9	Holding review meetings for LM project tracking	Holding review meetings for LM project tracking also can be a strategy for the LM implementation as the quality of the project largely depends on review meetings.
10	Improving supplier relationships	Suppliers are an integral part of a business. Therefore, improving supplier relationships can bring the success of the business. It can be a good strategy for LM implementation.
11	Improving the reward and recognition system	Improving the reward and recognition system will motivate the employee to produces quality products as well as minimize waste. Therefore, this could be a good strategy for an organization to implement LM.
12	Extending LM to supply chains	Extending LM to supply chains would help improve supply chain activities. Thus, it would be a strategy for an organisation

***Source**: Adapted from Gaikwad et al. (2020)*

According to Bakke and Johansen (2019), successful implementation of Lean requires customizing and tailoring of methods so that they fit the culture and the specific need in the groups. Lean methods must also be applied correctly in a structured way and with support from a professional facilitator to be utilized.

2.3.5 To develop a conceptual lm implementation framework based on the drivers and barriers

According to Crawford (2020), a conceptual framework is an argument for the study which can be represented in two parts namely:

1. The argument should establish the importance of the intended audience in the study.
2. The argument should demonstrate the alignment among the research questions, data collection, and data analysis, as well as the use of rigorous procedures to conduct the study.

Crawford (2020) tabulated a list of definitions of conceptual framework definition as enlisted in Table 9.

Table 9: Definitions of conceptual framework

Definition	Author
An argument about why the topic one wishes to study matters, and why the proposed means of study are the most appropriate.	Ravitch and Riggan (2017)
Either a graphical or narrative explanation of the main subjects of study, the key factors, variables, or constructs, and the presumed relationships among them.	Miles et al (2014)
The actual ideas and beliefs the researcher holds about the studied phenomena, either written down or not. This may also be called a Theoretical framework or idea context of the study.	Maxwell (2013)
This is the first major section of a research proposal and demands a solid rationale. By linking the specific research questions to larger theoretical constructs, to existing puzzles or contested positions in a field, or to important policy issues, the researcher shows that the particulars of the study serve to illuminate larger issues and therefore hold a potential significance for that field.	Marshall and Rossman (2016)

Source*: Adapted from Crawford (2020)*

According to Chong and Perumal (2020), a framework is a set of simplified guidance for an organization to follow systematically, which is easy to understand and could assist the organization in following efficiently in an implementable way.

Since misunderstanding is a major barrier of lean implementation, therefore the development of the conceptual lean manufacturing framework, it is essential to integrate the required suitable lean practices in different phases of implementation process steps to allow the practitioners to understand clearly the requirements for implementing lean manufacturing effectively. Imenda (2017) defined a conceptual framework as the result of bringing together several related concepts to explain and give a broader understanding of the phenomenon under research. According to Mostafa *et al.* (2013), lean implementation initiatives can be categorized as a roadmap, conceptual implementation framework, descriptive and assessment checklist initiatives.

Jasti and Kodali (2014) concluded after literature reviews that thirty-five LM frameworks exist and that very few frameworks have been developed by using case study research methodology. TickFei *et al.* (2015) argued that most of the lean manufacturing frameworks were categorized as design/conceptual frameworks which considered only what (elements) constitute lean but very few emphasized how to implement lean, and that:

1. Most of the frameworks failed to give a clear description of the sequences and steps to implement lean; and
2. Most of the frameworks did not link the lean elements to the internal stakeholders or functional departments of an organization.

Anand and Kodali (2010) provided a taxonomy of existing LM frameworks as listed below:

Table 10: Taxonomy of existing LM frameworks

No	Framework for LM	Author(s)	Classification based on	
			Type	Proposer
1	Concepts of lean manufacturing	Karlsson and Ahlstrom	D	A
2	Conceptualization of lean manufacturing	Karlsson and Ahlstrom	D	A
3	The components necessary for applying lean manufacturing	Jina *et a*l.	D	A
4	The lean automotive vision model	James-Moore and Gibbons	D	A
5	The theoretical concept of the lean Enterprise	Karlsson and Ahlstrom	D	A
6	Small and medium-sized firms as lean Enterprises	Karlsson and Ahlstrom	D	A
7	The 20 keys to workplace improvement	Kobayashi	D	C
8	Lean manufacturing tools	Adams *et a*l.	D	A
9	Lean enterprise	Czarnecki and Lloyd	D	A
10	The lean manufacturing model	Olivier *et a*l.	D	A
11	The central theme, principles and characteristics of lean thinking	Bicheno	D	C
12	Lean shipbuilding	Liker and Lamb	D	C
13	The Toyota production system	Liker and Lamb	D	O
14	A lean reference framework	Davies and Greenough	D	C
15	A lean manufacturing model	Sanchez and Perez	D	A
16	House of lean	Dennis	D	C
17	Lean manufacturing in an enterprise approach — linked functions	Cook and Graser	D	C
18	Lean — A framework	Hines *et a*l.	D	A
19	A generic framework for the management of change towards a lean enterprise	Smeds	I	A
20	A conceptual framework for successful JIT implementation	Wafa and Yasin	I	A
21	Framework for LM with a process view of implementation	Ahlstrom and Karlsson	I	A
22	Chrysler operating system	Flinchbaugh	I	O
23	Six steps to implementing lean	Airbus	I	O
24	Organizational learning framework	Flinchbaugh	I	C
25	The lean manufacturing house	Flinchbaugh	I	C
26	Just in time thinking principles	Kobayashi	D+I	C
27	The essential elements of lean Manufacturing	Katayama and Bennett	G	A
28	Lean manufacturing as outcome and Process	Lewis	G	A
29	A theoretical framework for LM Implementation	Motwani	G	A
30	Lean engineering	Morgan and Liker	G	C

***Source**: Adapted from Anand and Kodali (2010)*

Legend

D - Design/conceptual framework

I - Implementation framework

D + I - Combination of Design/conceptual framework and implementation framework

G - General framework

A - Academic/researchers-based framework

C - Consultant/expert-based framework

O - Organisation based framework

Deros *et al.* (2012) developed the implementation of a LM framework to reduce manufacturing costs after the analysed list of thirty frameworks above. However, the framework only emphasized 5S and assumed that the cost competitiveness challenge can be solved fully by addressing 5S. This Framework is shown below:

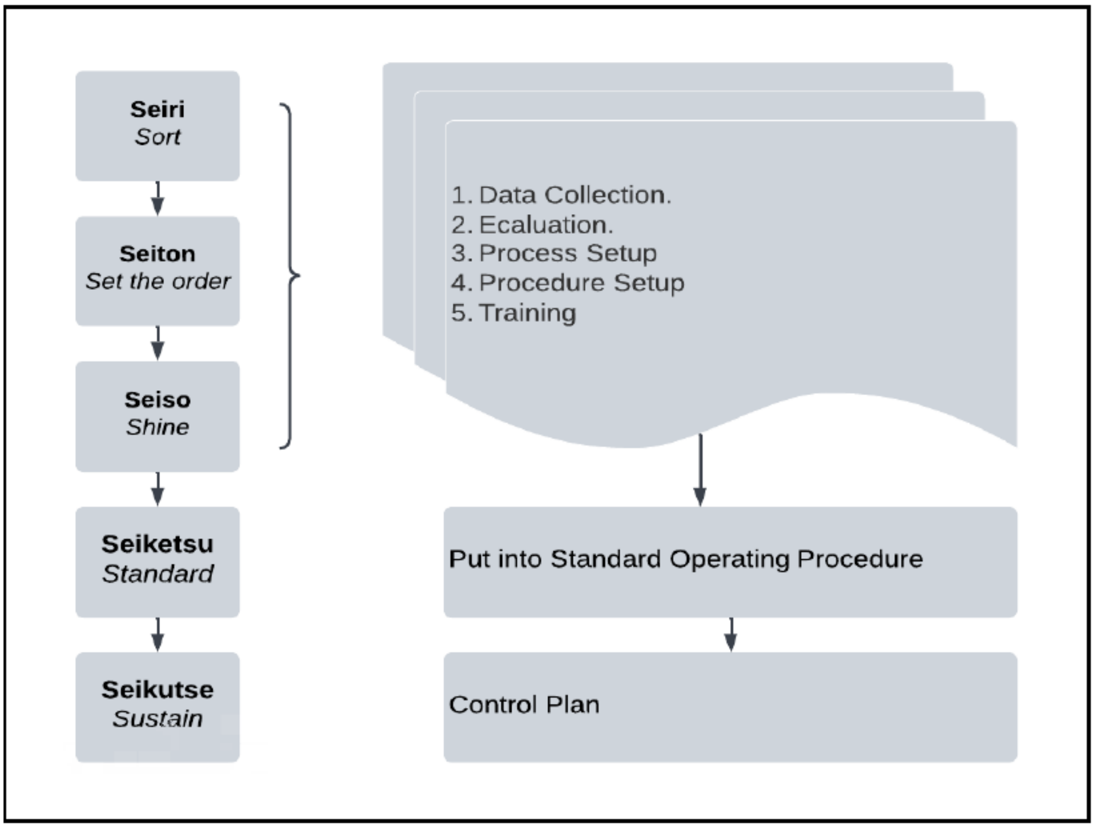


Figure 22: LM framework adapted from Deros et al. (2012)

***Source**: Adapted from Deros et al. (2012)*

Mostafa *et al.* (2013) identified the complications of lean to be driven by executive management, cultural, managerial, implementation and technical barriers, and then proposed four phases of conceptual framework development as conceptual, implementation design, implementation and evaluation. These are shown in Figure 23.

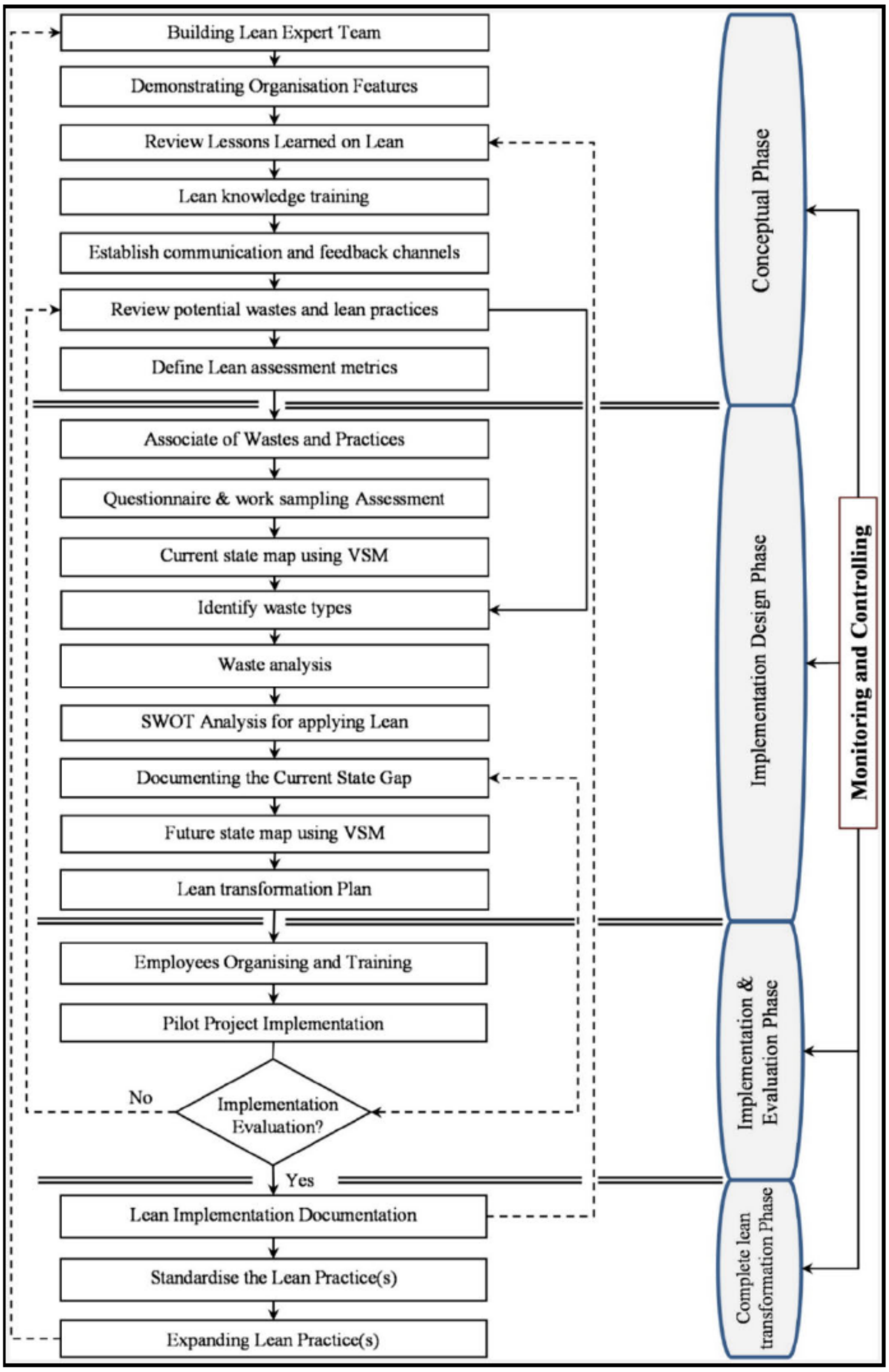


Figure 23: The four phases of conceptual framework

***Source**: Adapted from Mostafa et al. (2013)*

Figure 23 is further broken down to show the input, toolbox and output shown in figure 24.

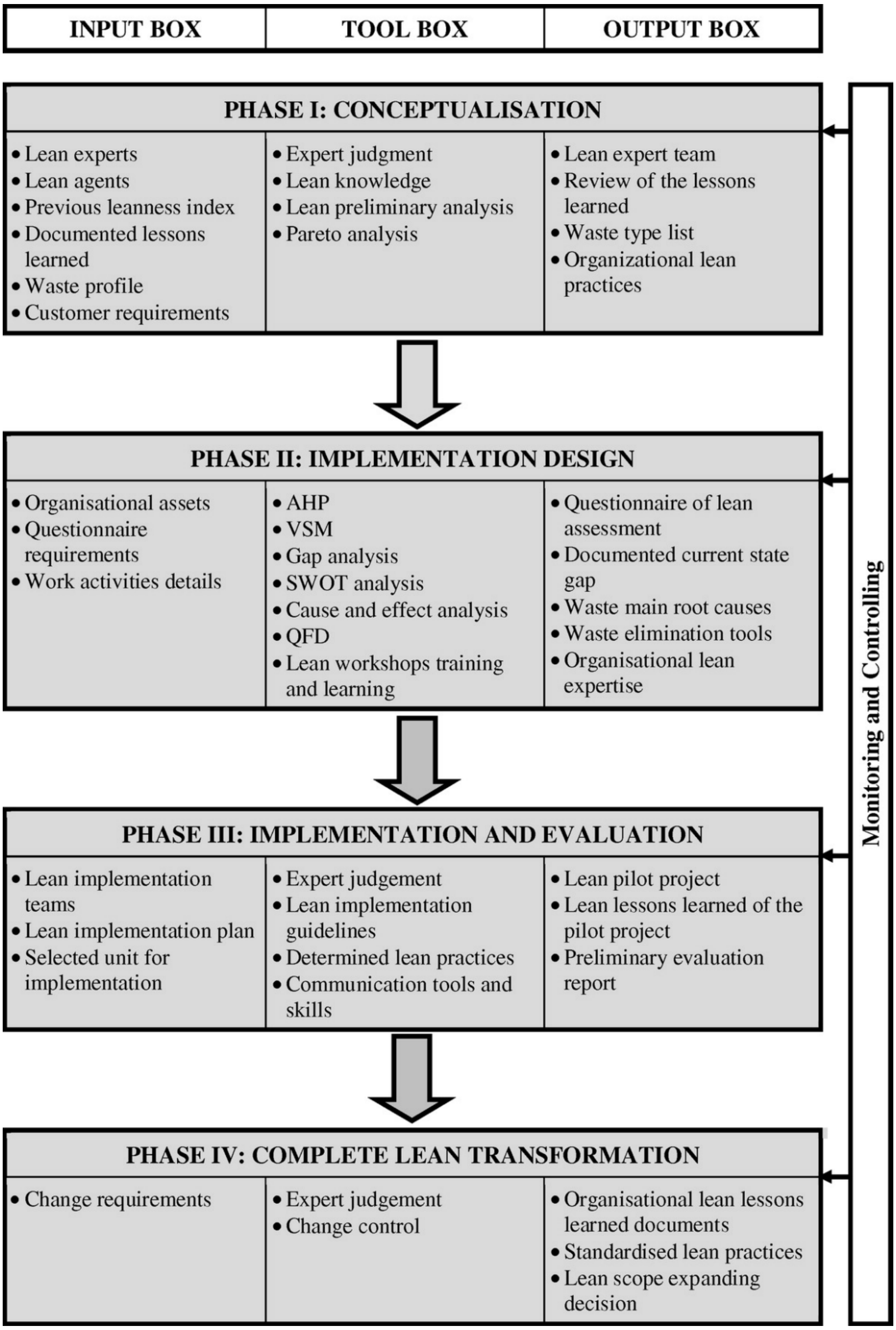


Figure 24:Tooling the conceptual framework

***Source**: Adapted from Mostafa et al. (2013)*

Almanei *et al*. (2018) asserted change management as a critical factor in LM implementation and that change is not a once-off project, but rather a continuous process with impact both on processes and people.

Before the development of the conceptual framework, the lean drivers and barriers were accessed and are shown in Figure 25.

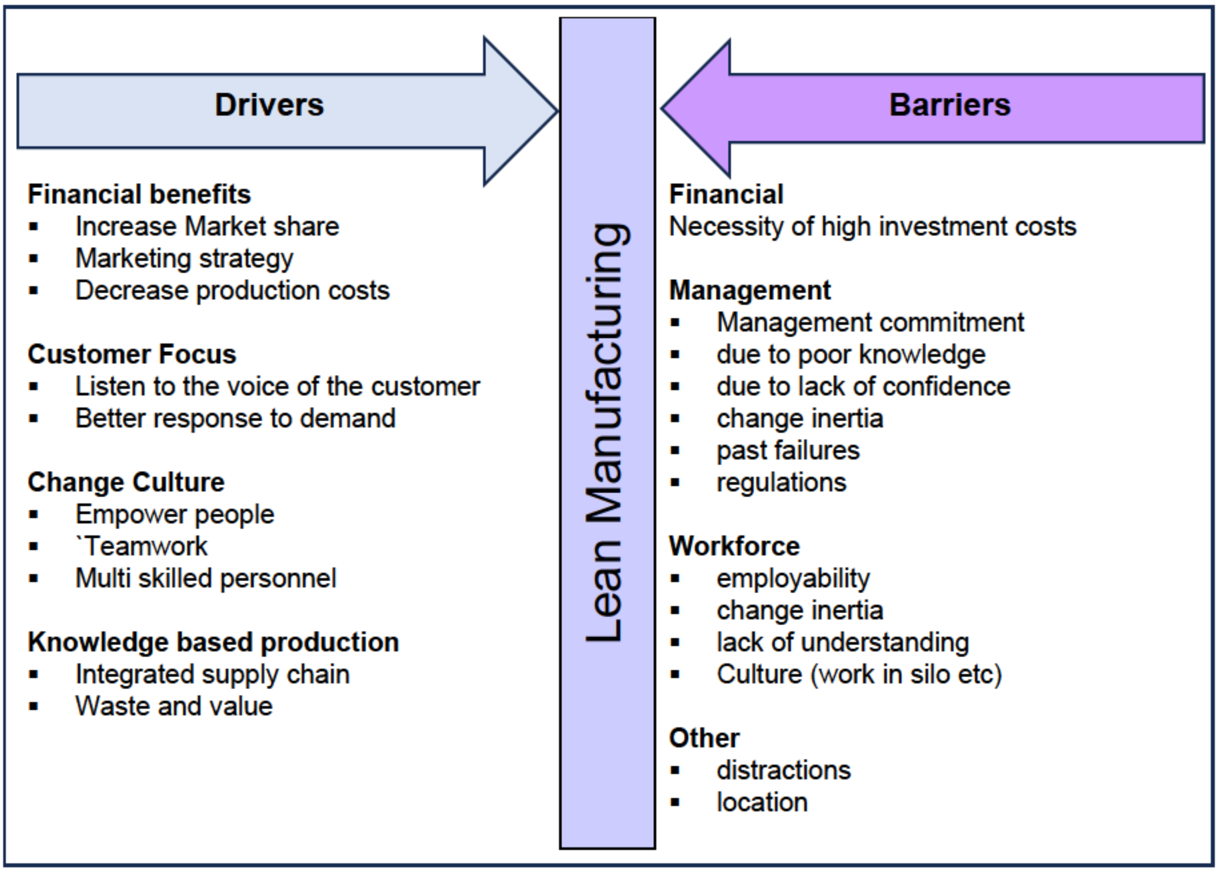


Figure 25: Lean drivers and barriers

***Source**: Adapted from Almanei et al. (2018)*

The design of the conceptual framework in Figure 26 is rooted in the principles of change management.

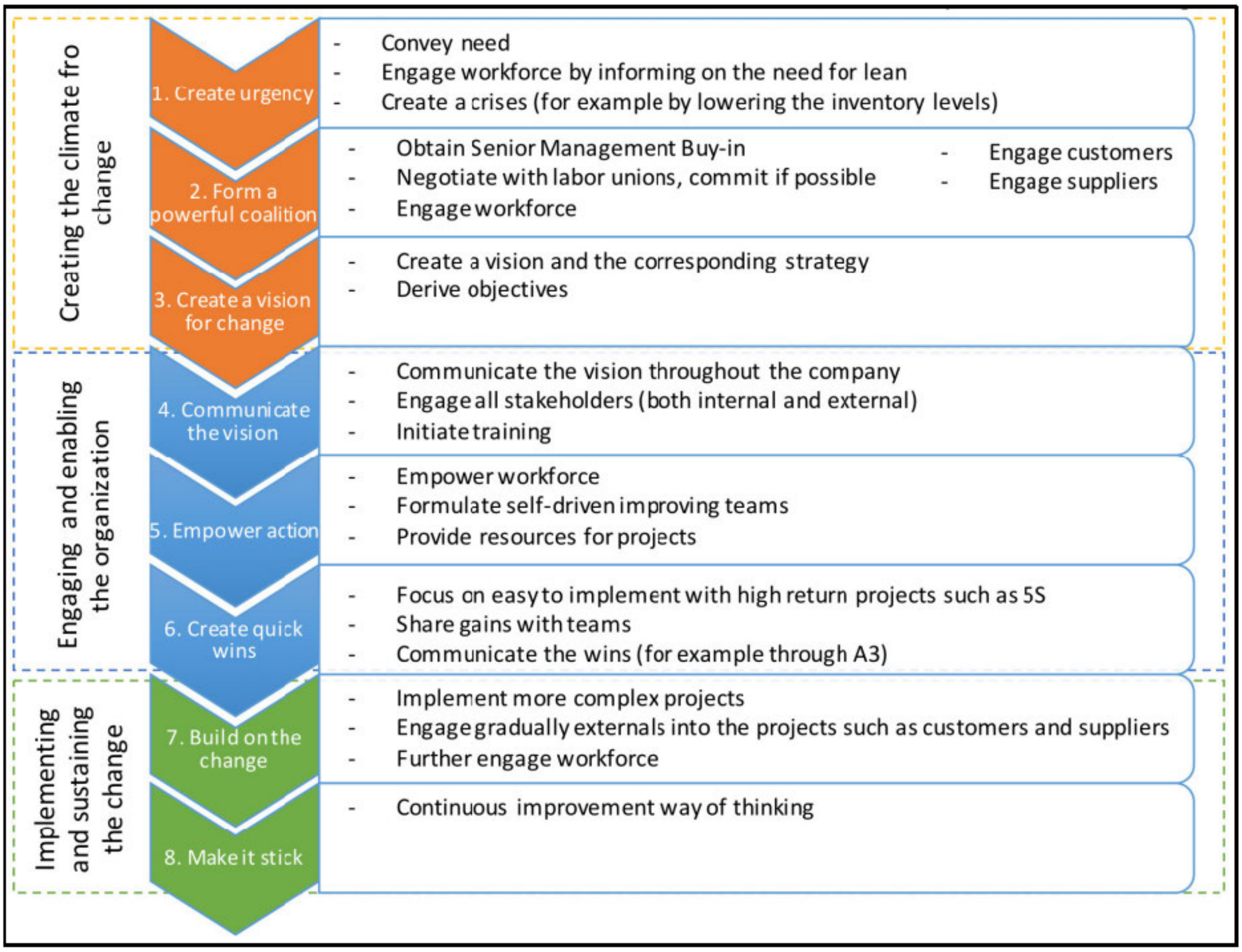


Figure 26: Conceptual framework based on change management

***Source**: Adapted from from Almanei et al. (2018)*

McMackin and Flood (2019) formulated a framework that shows five categories of variables that relate to each other. The five categories of variables are:

1. Human Resources Strategy.
2. Lean Culture.
3. Relational coordination.
4. Lean change process.
5. Employee relations.

Table 11: Sample of key studies on which the SPL framework

Topic	Reference	Literature/method	Notes/significance
Lean (General Review)	Danese *et al*. (2018	A comprehensive review analyzed 240 studies published in 25 different journals between 2003 and 2015.	Suggests anchoring lean research within established management theories through the application of both theory development and empirical validation.
	Hadid abd Mansouri (2014)	A thorough analysis conducted on 221 articles published until 2013 has been completed.	Utilizes the socio-technical systems theory to differentiate between lean technical practices and lean supportive practices.
	Sha and Ward (2007)	A thorough examination of existing literature and an accompanying survey.	Acknowledges that successful lean implementation necessitates the concurrent handling of both social and technical systems.
Organizational culture and leadership	Erthal and Marques (2018)	A systematic review identified a total of 65 articles published up to the year 2016.	The analytical framework employed by Hofstede *et al*. (1991) serves as a basis for examining both national and organizational culture.
	Bartolotti *et al*. (2015)	The study explores the interplay between organizational culture and performance literature, utilizing quantitative analysis derived from high-performance manufacturing project data collected through surveys of healthcare professionals from 221 hospitals across the United States.	Successful lean plants tend to exhibit greater institutional collectivism, a forward-looking perspective, and a focus on humane practices, while demonstrating lower levels of assertiveness.
	Dobrzykowski *et al.* (2016)	A comprehensive empirical investigation that amalgamates survey results and performance metrics from 221 hospitals across the United States, focusing on insights gathered from healthcare professionals.	When leadership adopts a thorough lean philosophy, it fosters a harmonious balance between strong financial outcomes and safety performance.
	Lam *et al.* (2015)	An assessment conducted among healthcare practitioners.	There are five key tactics of influence—collaboration, consultation, ingratiation, inspirational appeals, and rational persuasion—that significantly impact levels of commitment.
	Van Dun and Wilderom (2016)	Utilizing a combination of approaches, including a structured review of existing literature.	Identified values for leaders encompass honesty, openness, collaboration, and a commitment to ongoing improvement. Among the essential behaviors of middle managers are attentive listening and a willingness to concur.
	Bhasin and Burcher (2006)	The literature review concentrated on lean philosophy, human resource practices, lean accounting, and the engagement of suppliers.	Emphasizing the significance of organizational culture in the successful execution of lean strategies.
Culture (teams)	Van Dun and Wilderom (2012)	A thorough examination identified 13 high-quality studies focused on lean team behavior published between 1996 and 2010.	Recognized two primary categories influencing lean teams: human dynamics and facilitators.
	Angelis *et al.* (2011)	Empirical research study	The impact of lean methodologies on employee commitment is largely influenced by

			the effectiveness of management in applying both technical and social practices.
Culture (continuous learning/ improvement	Liker and Hoseus (2010)	An examination of the Toyota manufacturing facility in Kentucky from a human resources standpoint.	The impact of lean practices on employee commitment largely hinges on the effectiveness of management in implementing both technical and social approaches.
	Brunet and New (2003)	The concept of Kaizen, as implemented by various Japanese firms, emphasizes continuous improvement and refinement in processes and practices.	The pivotal importance of senior leaders in embracing Kaizen practices.
	Suarez-Barraza and Ramis -Pujol (2010)	A case study from Mexico examining the application of lean principles within the human resources functions of public service.	The Lean Kaizen methodology underscores the significance of having a team that feels empowered.
HR Strategy	Lasonci *et al.* (2017)	Conducted an employee survey within a solitary company case study. This encompasses a thorough examination of lean strategies that integrate HR practices, alongside an empirical analysis..	The influence of shop floor culture and subcultures on lean implementation revealed that lean production practices and operational performance act as intermediaries in the relationship between human resource management practices and overall firm performance.
	Gollan *et al.* (2013)	Analysis of a medical devices Firm	Integrating lean methodologies with human resource practices resulted in the establishment of a highly efficient work system.
	MacDuffe (1995)	Data from a survey conducted across 62 automotive manufacturing facilities were analyzed in an empirical study.	A groundbreaking research study explored the links between production strategies, collections of HR practices, and performance levels within automotive manufacturing facilities in the United States.
	Langoni *et al.* (2013)	Ten research examples.	Top-performing organizations adopted a lean approach, integrating both lean technical strategies and human resource practices. This included implementing job rotation, providing training opportunities, fostering participation, offering incentives, and promoting teamwork.
	De Menezez *et al.* (2010)	A comprehensive dataset encompassing 24 years of practices in Operations Management and Human Resources within British manufacturing companies.	Research reveals that companies that actively integrate Operations Management with HRM practices tend to achieve superior performance consistently.
Relational coordination	Gittel (2011)	Analysis and summary of randomized controlled trial research conducted thus far.	Highlights the theoretical underpinnings of RCT, tracing its roots back to the contributions of Mary Parker Follett.
	Gitell and Douglas (2012)	Conceptual advancement.	Emphasizes three forms of coordination: interpersonal connections between workers, collaborative efforts between workers and customers, and leadership dynamics characterized by reciprocal exchanges rooted in specific roles.
	Pless et al. (2017)	Systematic literature review	Evaluates four models for organizational redesign with a focus on how they define problems and execute solutions, particularly within the context of care pathways. These models include lean thinking, relational coordination, and contemporary socio-technical design.

	Heaphy *et al.* (2016)	An overview article presenting a specialized topic forum focused on relationships.	Emphasizes the crucial role of a relational viewpoint in grasping the dynamics of work and organizations.
Lean change implementation process	Stouten *et al.* (2018)	An analysis of scholarly and practical writings.	A comprehensive overview of the existing knowledge surrounding change management, highlighting what is established, debated, unexplored, and well-understood.

***Source**: Adapted from Mcmackin and Flood (2019)*

According to the analysis presented in Table 11, McMackin and Flood (2019) developed an additional conceptual framework, which is illustrated in Figure 27 below:

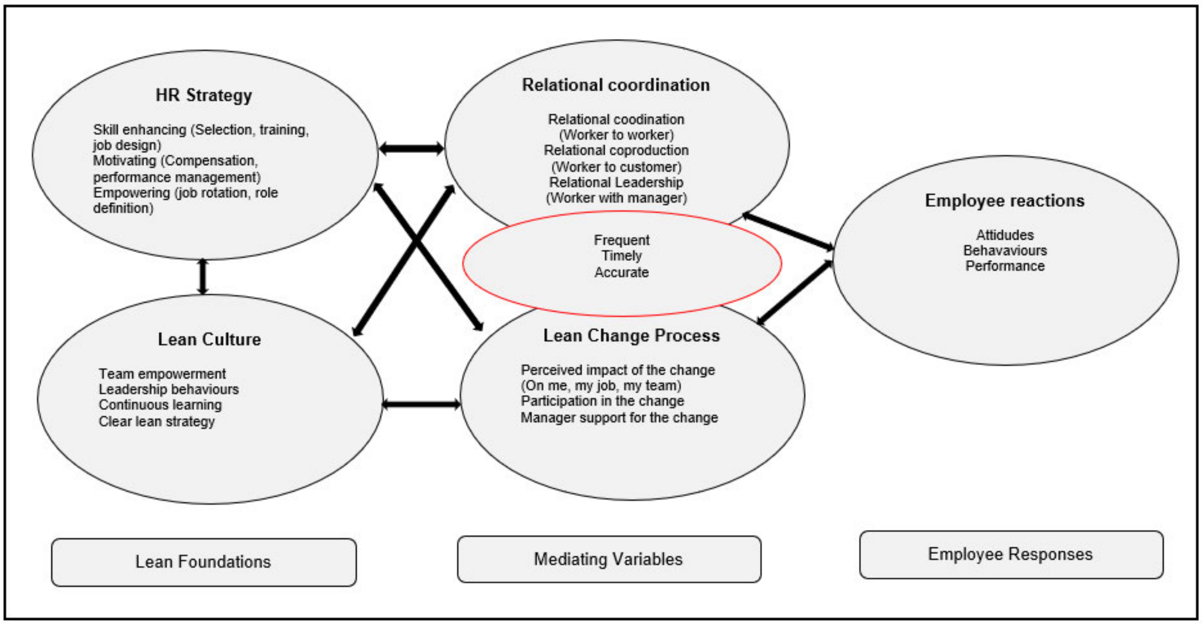


Figure 27: Theoretical framework for the lean social pillar

***Source**: Adapted from Mcmackin and Flood (2019)*

Zvidyayi and Chikuruwo (2023) encapsulated the barriers of LM implementation in automotive industry into fourteen categories and proceeded to build a framework based on the LM implementation barriers as shown in Figure 28.

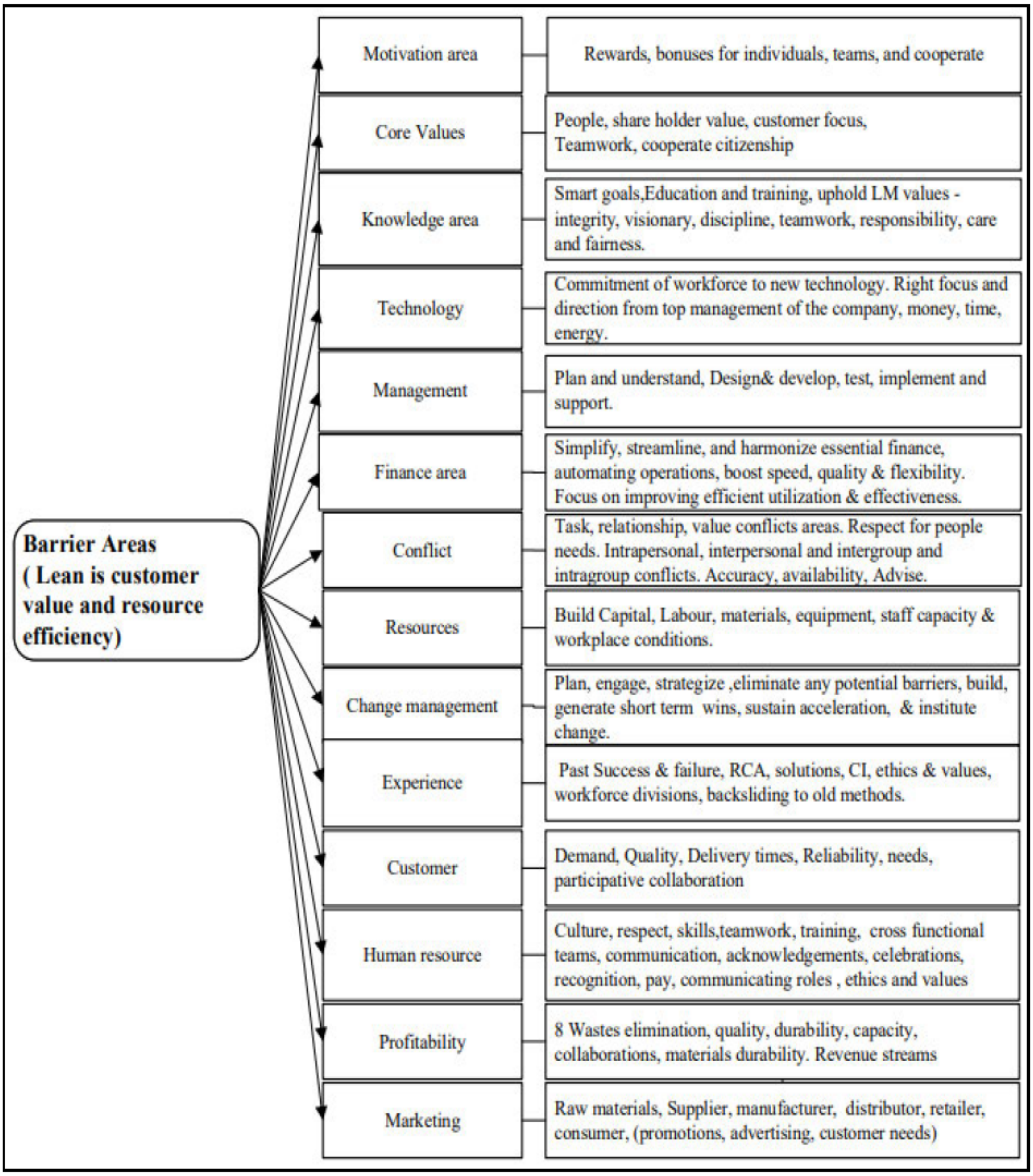


Figure 28: LM framework based on lean barriers

***Source**: Adapted from Zvidyayi and Chikuruwo (2023: 6)*

Murman (2002) as cited in Van der Merwe *et al*. (2014) discussed cultural monuments that exist within an organization and are based on three or four different mindsets. These mindsets often conflict with lean thinking. These monuments embody outdated practices and regulations that were previously effective; however, they now obstruct the majority of organizational members from questioning the status quo, even in light of evident signs that current strategies are failing. It is crucial to dismantle these intangible monuments in order to achieve a streamlined culture. Dismantling these non-physical monuments is imperative to attaining a lean culture. Mann (2005) cited in Van der Merwe *et al*. (2014) argues that visual controls are important contributors to LM, as they not only connect people to the process, but also reflect the extent to which the process is being adhered to. The ultimate purpose of visual controls, however, is to create an environment where everybody is aware of the current operational status. Therefore, based on a pillar of coordination and communication, an LM Framework of culture change adapted from Van der Merwe *et al*. (2014) is shown in Figure 29.

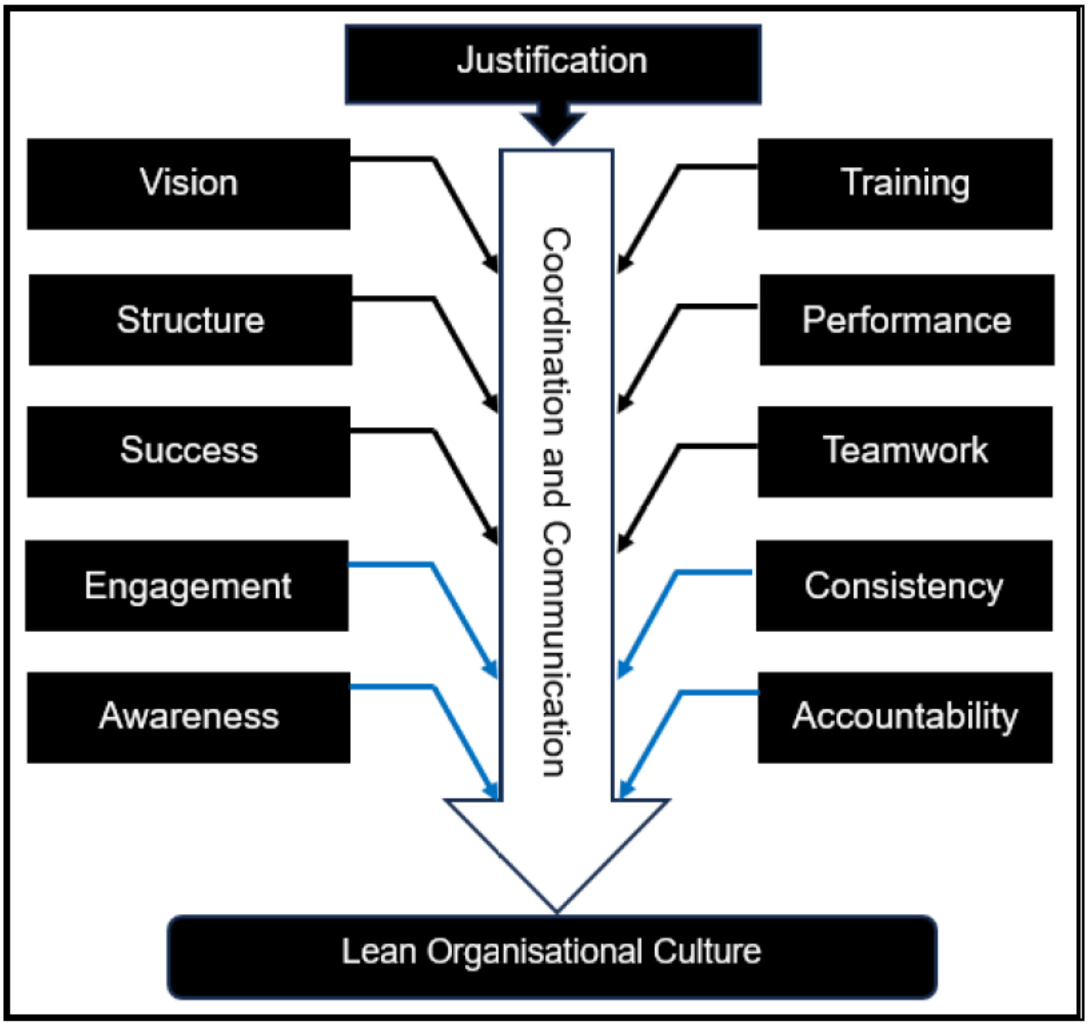


Figure 29: LM framework of culture change

Source: *Adapted from Van der Merwe et al. (2014)*

Rathilall and Singh (2018) suggested a lean six sigma framework to improve the competitiveness of specific ACM organizations in KwaZulu Natal. However, for an organization like XYZ that has a headquarters that is on the verge of withdrawal, a standalone effective LM framework will be better suited due to the reasons listed by Sangode and Hedaoo (2018) below:

1. Insufficient resources in terms of finances, personnel, and time.
2. Resistance to adopting Six Sigma within the organization stems from inadequate communication, personal agendas, a skills gap, and negative employee attitudes.
3. A shortage of guidance from senior executives and a lack of understanding of Six Sigma principles.
4. Inconsistent organizational alignment with Six Sigma practitioners at various levels.
5. Cultural challenges impeding progress.
6. High costs and time commitments associated with training and coaching.
7. Perceived complexity makes the implementation of Six Sigma seem daunting.
8. Inadequate selection of Six Sigma projects: This issue involves choosing suboptimal projects for enhancement.

According to Chong and Perumal (2020), the characteristics criteria that must be fulfilled when developing a conceptual LM framework are:

1. Organized and easy to comprehend.
2. Straightforward in format.
3. Featuring obvious connections between the components or stages described.
4. Broad enough to be applicable across various situations.
5. Serves as both a guide and a framework for actualization.
6. Focuses on how to, rather than and what is, in an initiative-oriented manner.
7. Must be feasible for implementation.

2.3.6 To empirically validate the LM implementation framework

Nordin *et al.* (2012) defined validation as a process by which a judgement is made as to whether a tool is fit to purpose. Inglis (2008) delineated six distinct strategies for validating a framework as enumerated below:

1. Reviewing scholarly literature concerning the subject of discussion.

2. Gathering insights from an expert panel.
3. Conducting empirical investigations.
4. Engaging in survey research.
5. Launching pilot projects.
6. Analyzing case studies.

According to Yussiff *et al*. (2015), validation pertains to the evaluation of whether a particular design meets its designated purpose and performs in accordance with expectations. Nordin *et al*. (2012) further discussed the validation of a conceptual model by seeking input from an expert panel using the Delphi Technique approach. Aigbavboa (2015) defined the Delphi method as a technique of reaching consensus. The Delphi approach is characterized by its reliance on expert judgments to secure a robust consensus through iterative questionnaires consensus by experts on issues that cannot be resolved in a once-off discussion. The Delphi approach is characterized by its reliance on expert judgments to secure a robust consensus through iterative questionnaires Gallota *et al.* (2018). According to Skulmoski *et al.* (2007), the Delphi process consists of the selection of expert panel, questionnaire design and scoring methods, number of iteration rounds, and data analysis. Figure 30 illustrates the framework validation using Delphi technique as adapted from Nordin *et. al* (2012).

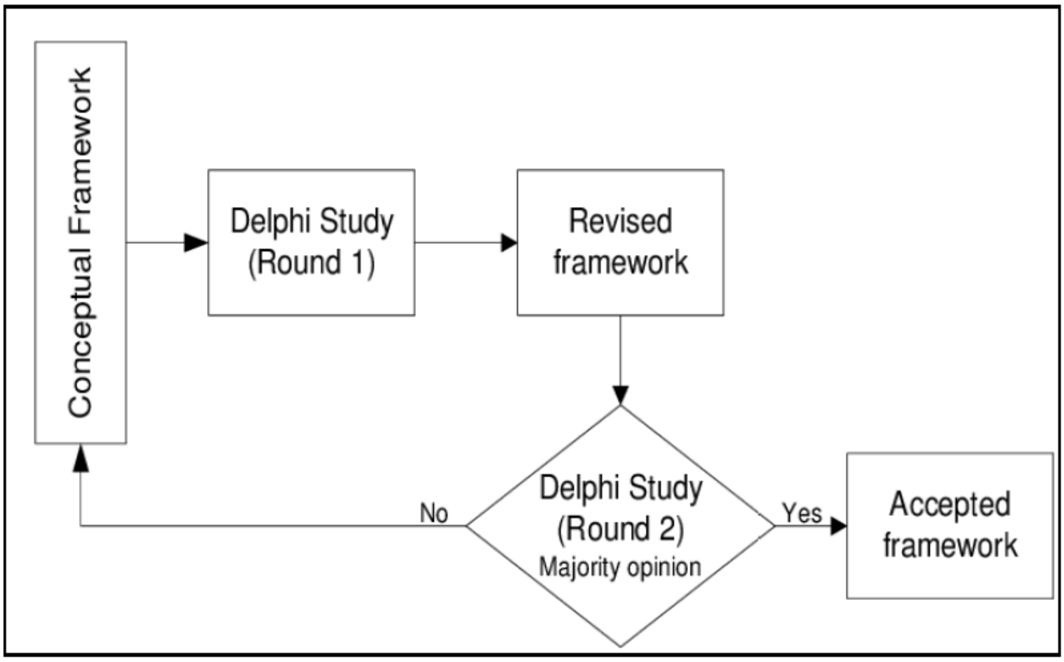


Figure 30: Delphi technique

Source*: Adapted from Nordin et. al (2012)*

Since Delphi technique focuses on eliciting expert opinions, the selection of expert panel is generally dependent upon the disciplinary areas of expertise required by the specific issue. According to Skulmoski *et al.* (2007), the Delphi participants should meet four requirements:

1. Knowledge and experience with the issues under investigation.
2. Capacity and willingness to participate.
3. Sufficient time to participate in the Delphi technique; and

Effective communication skills. Skulmoski *et al.* (2007) also concluded that with regards to the panel size, the representation is assessed by the qualities of the expert panel rather than its number because the Delphi technique does not call the expert panels to be representative samples for statistical purposes.

According to Brady (2015) The Delphi method underscores the importance of structured and confidential communication among individuals with expertise in a specific subject, aiming to reach a collective agreement in the realms of policy, practice, or organizational decision-making and the methodological discourse surrounding the Delphi method consistently suggests that qualitative studies should implement thematic analysis as part of their analytical framework. Regional challenges and opportunities in adopting LM.

2.4 Regional challenges and opportunities in adopting LM

According to (Anon, 2022), South Africa continues to be a dominant player in the Sub-Saharan automotive manufacturing and market. The industry enjoys the advantages of a well-established manufacturing infrastructure, largely owing to the presence of major vehicle manufacturers from Europe, America, and Japan. While Rathilall and Singh (2018) noted that LM has been investigated within the South African automotive sector, Mund (2011) indicated that the rate of LM implementation in South Africa is tardy and preferred by organizations with a global footprint that are already engaged in efforts to enhance their operations.

Coetzee *et al.* 2019 empirically highlighted the challenges that African automotive manufacturers face in the adoption of lean manufacturing, specifically focusing on the development of people, whether individually, in groups, or across the entire organization. Coetzee *et al.* (2019) futher posited that various studies undertaken in South Africa have validated that the inadequate success rate of lean adoption can be linked to an excessive concentration on lean tools and techniques, often at the cost of the human aspect.

According to Khuluse (2015), LM in African manufacturing companies confronts several challenges, such as cultural concerns, technological difficulties, employee development issues, and supply chain complications.

Conversly, Akinradewo *et al.* (2018) enumerated the opportunities of adopting LM, as boosting productivity, minimizing time and accidents, enhancing reliability, improving quality, and ensuring customer satisfaction. In the context of African manufacturing, even slight Lean adjustments can lead to considerable enhancements in productivity and cost reductions. The dedication of leadership and the empowerment of employees to effect change is what sets an organisation apart (Brown, 2025).

2.5 Challenges, barriers, and drivers for implementing lean manufacturing in South Africa's manufacturing sector

As asserted by Monyane *et al.* 2018, there exists a significant gap in research concerning the drivers and barriers of lean manufacturing from the perspective of the South African manufacturing sector.

According to Theisen *et al.* 2019, the difference between implementation and adoption of a system is as explained below:

Implementation encompasses the installation and configuration of a new system or tool, as well as the training of staff on its operation. A system is deemed implemented once it has been developed, funded, and is fully operational and ready for use. In contrast, adoption can be likened to a system that is implemented and is also actively engaged, successfully fulfilling its intended objectives

As noted by Karimulla *et al*. 2024, South African organizations struggle with the effective implementation of LM due to their focus solely on the tangible aspects of LM, such as its methods and principles. To successfully implement LM, a constructive mindset and vision are essential. Furthermore, it is crucial for top management teams to motivate employees to maintain a culture centered around continuous improvement and lean principles. Mbewe (2020) added to this discourse by noting that several frequently cited barriers to LM implementation in the South African manufacturing sector include insufficient comprehension of LM principles, inadequate commitment and backing from management, employee resistance to change, and a deficiency in necessary skills and resources. Furthermore, Van Dyk *et al.* (2019) indicated that the low success rate of LM implementation can be ascribed to an imbalanced emphasis on lean tools and techniques, neglecting the human element, as articulated in the Respect for People (RFP) principles.

Coetzee (2019) explored LM implementation in South Africa and concluded that successful outcomes were largely a result of management's active involvement in the process. A significant obstacle is the tendency to focus on lean tools and techniques while overlooking the human dimension of lean.

2.6 Conclusion

The literature review concluded that from the frameworks that have been deployed none has been applied to a steering wheel manufacturing process globally. Most of them are generic and not industry-specific. The researcher commends the valuable work of previous scholars in creating principles and frameworks that facilitate the improvement of processes and systems through LM. The researcher agrees with Hart (1998) in that a literature review does not merely consist of annotations and citations nor does it aim to have a summative report, however, it should invoke the use of ideas in the literature to justify the approach that the researcher decides to take for their study, the selection of methods and demonstration that this research contributes to something new and therefore should not be underestimated.

2.7 Chapter summary

The researcher examines a systematic literature review on the investigated topic and subsequently delves into the historical background of the steering wheel to gain a deeper understanding of its development and the rationale behind it. The literature review is conducted per the research objectives to ensure comprehensive coverage of all relevant literature. The chapter delves into the drivers and barriers related to LM, while also addressing the frameworks that have been created and utilized to lay the groundwork for this study.

CHAPTER 3

RESEARCH METHODOLOGY

This Chapter presents a description of the research process and provides information concerning the method that was utilized and the justification for selecting the method. This chapter also describes the progression of the data collection method from participant selection, data collection, and data analysis processes. Consequently, the chapter concludes with a discussion of the validity and reliability of qualitative research and how these fundamental aspects were addressed in the study.

3.1 Introduction

Phair and Warren (2021) suggested the Saunders Research onion for developing a Research Methodology and explained that working from the outside of the onion inwards, the researcher faces a range of choices that progress from high-level and philosophical to tactical and practical.

Saunders *et al*. (2019) divided the research onion into three levels of decisions:

1. The first two outer rings are the Research philosophy and Research approach.
2. Next is the Research design which constitutes.

a) methodological choices,

b) research strategy

c) time horizon; and

3. Tactics, i.e., the inner core of the research onion, which includes data collection and analysis aspects.

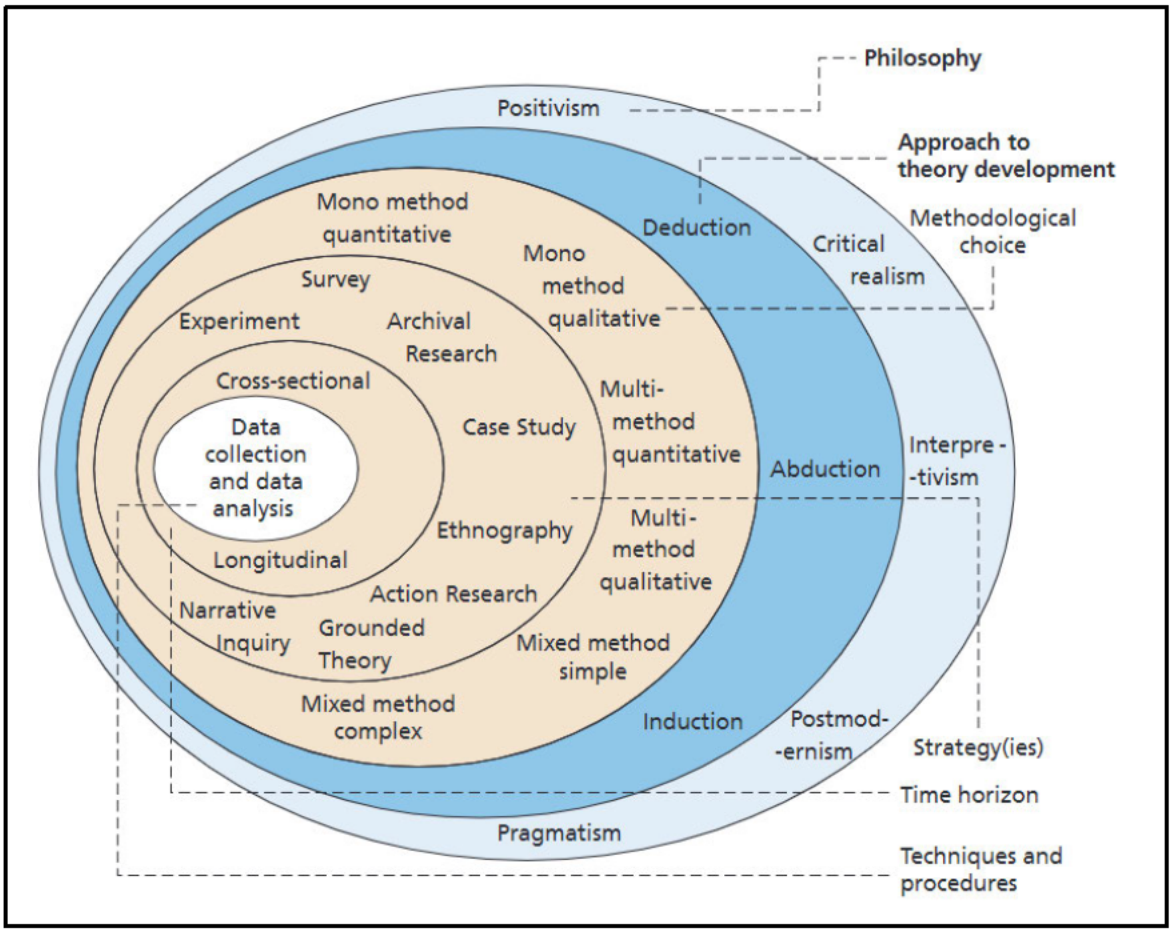


Figure 31: Research onion

***Source**: Adapted from Saunders et al. (2019)*

Phair and Warren (2021) enumerated six layers of the Saunders Research Onion as below.

3.1.1 Onion layer 1: Research philosophy

The Research philosophy is the foundation of any study as it describes the set of beliefs that the research is built on and can be described from either an ontological or epistemological point of view (Phair and Warren 2021). Ibezimako (2019) stated that there are three main philosophies that are critical in any research:

1. Ontology

Ontology is defined by (Crotty, 2003) cited in Ahmed (2008) as the study of being. Ontology is concerned with 'what is', that is, the nature of existence and the structure of reality as such (Crotty, 1988) cited in Al-Saadi (2014) or what is possible to know about the world (Snape and Spencer, 2003) cited in Al-Saadi (2014). According to Dudovskiy (2020), ontology is the study of being and deals with the nature of reality. According to Moon and Blackman (2017), Ontology helps researchers recognize how certain they can be about the nature and existence of objects they are researching. For instance, what 'truth claims' can a researcher make about reality?

2. Epistemology

According to Moon and Blackman (2017) epistemology is the study of knowledge. Epistemology is concerned with all aspects of the validity, scope and methods of acquiring knowledge, such as a) what constitutes a knowledge claim; b) how can knowledge be acquired or produced; and c) how the extent of its transferability can be assessed. According to Dudovskiy (2020), epistemology refers to what can be accepted as knowledge. Epistemology is important because it influences how researchers frame their research in their attempts to discover knowledge.

3. Axiology

Axiology is a branch of philosophy that studies judgements about the value or worth of the research (Dudovskiy, 2022).

3.1.2 Onion layer 2: Research approach

Phair and Warren (2021) stated that the research approach is the broader method used for Research, and the two methods are Inductive or deductive approaches. Malhotra (2017) asserted that Inductive strategy assumes that all science starts with observations which provide a secure basis from which knowledge can be derived and claims that reality impinges directly on the senses, hence there is a correspondence between sensory experiences, albeit extended by instrumentation, and the objects of those experiences. The conclusion of an inductive argument makes claims that exceed what is contained in the premises and so promises to extend knowledge by going beyond experience. The Deductive (hypotheticodeductive or falsificationist) approach is the reverse of an Inductive one. It begins explicitly with a tentative hypothesis or set of hypotheses that form a theory that could provide a possible answer or explanation for a particular problem, then proceeds to use observations to test the hypotheses rigorously. (Malhotra, 2017). Phair and Warren (2021) differentiated the two approaches: Inductive approaches entail generating theories from research, rather than starting a project with a theory as a foundation. Deductive approaches, on the other hand, begin with a theory and aim to build on it (or test it) through research.

To satiate the ontological and epistemological foundation, the definition by Dudovskiy (2022) of the former and the latter is very paramount to build on. On the ontological level, the researcher considered globally accepted empirical inferences to the present South African steering wheel manufacturing process case that has never been explored before and defined by Stutchbury (2021) as critical realism that is operationalized on a small-scale study. This research substantiates empirically how the new framework is derived based on globally accepted inferences that are already available from literature research.

The epistemological aspect as explained by Higginbottom and Lauridsen (2014) is a blend of the positivism and constructivism stances, the former being a philosophical stance where knowledge is gained through empiricism, and the latter views reality as being socially constructed. Koskela *et al.* (2019) deduced that proper scientific reasoning occurs only via deduction from forms or specifically, axioms to something that can be compared to observations. Therefore, the most fundamental essence of reality does not belong to the material world, but to the realm of abstract concepts, the world of ideas. Therefore, the epistemological aspect of this study is substantiated by the empirical validation of the newly adopted framework in the South African steering wheel manufacturing case study.

3.1.3 Onion layer 3: Research strategy

Research strategy can be referred to as a general way that helps the researcher choose the main data collection methods or sets of methods to answer the research question and meet the research objectives (Melnikovas, 2018). Saunders *et al.* (2016) cited in Melnikovas (2018) suggest the main research strategies to be experimental, survey, archival research, case study, ethnography, action research, grounded theory and narrative inquiry.

3.1.4 Onion layer 4: Choices

Saunders *et al.* (2016) cited in Melnikovas (2018) define research choices regarding the use of quantitative and qualitative research methods, as well as the simple or complex mix of both or the use of mono methods. Quantitative research methods use numbers and mathematical operations, while qualitative methods imply the collection of vast descriptive data. Mono method is used when the research is focused either on quantitative or qualitative data gathering; mixed methods – quantitative and qualitative methods used within the same research to achieve different aims and offset the constraints of the use of a single method; multi-method choice undermines the use of both, qualitative and quantitative methods.

3.1.5 Onion layer 5: Time horizon

Phair and Warren (2021) described the time horizon as how many points in time a researcher plans to collect their data at, and that there are two options that exist, that is, the cross - sectional, and the longitudinal time horizons. According to (Bryman, 2012) the time horizon describes the required time for the completion of the project work. According to Melnikovas (2018), depending on the objectives of the research, long-term, mid-term, and short-term future as well as point of retrospective may be selected as the research time horizon.

3.1.6 Onion layer 6: Techniques and procedures

According to Melnikovas (2018), previous choices determine the type of basic data collection and analysis procedures, whilst the onion layer of Techniques and procedures moves the research design towards data collection and analysis and is depicted in the centre of the onion. Phair and Warren (2021) outlined the activities of the Techniques and procedures layer as listed below:

1. Decide on what data to collect and what data collection methods to use.
2. Decide the sampling of the population.
3. Determine the type of data analysis to use to answer the research questions.
4. Set up the materials to use for the study (such as writing up questions for a survey or interview).

3.2 Research design

According to Yin (2009), the most important condition for differentiating among various research methods is to classify the type of the research question; in which ‘what’ questions can be exploratory and any of the research methods can be employed. ‘How’ and ‘why’ questions favour the use of case studies, experiments, or histories. According to Merriam (1998) case studies are useful for studying a process, program, or individual in an in-depth holistic way that allows for deep understanding and that the interest is in the process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation. Creswell (2002) recommends a case study methodology if the problem to be studied relates to developing an in-depth understanding of a case or bounded system and if the purpose is to understand an event, activity, or process and further define a bounded case as one that is separated for research in terms of time, place, or some physical boundaries. Further contrasting foundational considerations to validate a case study were also adapted from Creswell (2002) and are depicted in Table 7 below. With consideration of the literature review referenced, this study was aligned to a bounded case study.

Yin (2018) cited in Schoch (2020) concluded that once the decision to conduct a case study has been reached, the subsequent action is to define the case and then bounding the case. Mills *et al*. (2010) explain that binding a case implies the possibility of demarcating, hence drawing boundaries around, the specific case to be studied.

Baxter and Jack (2008) propose the following categories to bind a case and the corresponding applications based on the research theme have been identified:

- By time and place - (2022-2024), Durban South Africa.
- Time and activity - (2022-2024) Implementation of lean principles framework.
- By definition and context - Implementation of lean principles framework.

According to Flyvbjerg (2006), a case study is a context-dependent, in-depth investigation of a single example of a phenomenon and therefore focuses intensively on a single case and the case in focus is supposed to be representative of a larger group of cases. This research, therefore, fits a context-dependent in-depth investigation.

Stake (1995) cited in Ebneyamini and Moghadam (2018) identified three types of case studies as intrinsic, instrumental, and collective. Zainal (2007) cited in Ebneyamini and Moghadam (2018) discussed that other case study categories include interpretive and evaluative case studies. Cohen *et al*. (2007) describe an intrinsic case study as studies that are undertaken to understand the case in question, an instrumental case study as examining a particular case to gain insight into an issue or a theory, and a collective case study as groups of individual studies that are undertaken to gain a fuller picture. Hence this research is further classified as an intrinsic case study.

Table 12: Contrasting foundational considerations of five qualitative approaches

Foundational Considerations	Five approaches to qualitative research				
	1 Narrative research	2 Phenomenology	3 Grounded theory	4 Ethnography	5 Case study
Research focus of approach	Exploring the life of an individual	Understanding the essence of the experience	Developing a theory grounded in data from the field	Describing and interpreting a culture sharing group	Developing an in depth description and analysis of a case or multiple cases.
Unit of analysis	Studying one or more individuals	Studying several individuals who have shared the experience	Studying a process, an action, or an interaction involving many individuals.	Studying a group that shares the same culture	Studying an event, a program, an activity, or more than one individual.
Type of research problem best suited for approach	Needing to tell stories of individual experiences	Needing to describe the essence of a lived phenomenon	Grounding a theory in the views of participants	Describing and interpreting the shared patterns of culture of a group	Providing an in-depth understanding of a case or cases
Nature of disciplinary origins	Drawing from the humanities including anthropology, literature, history, psychology and sociology	Drawing from the philosophy, psychology, and education	Drawing from sociology	Drawing from anthropology and sociology	Drawing from psychology, law, political science, and medicine

Source: *Adapted from Creswell (2002)*

Akhtar (2016) defined research design as the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with clarity and precision. According to Asenahabi (2019), research designs can be categorized into three as follows:

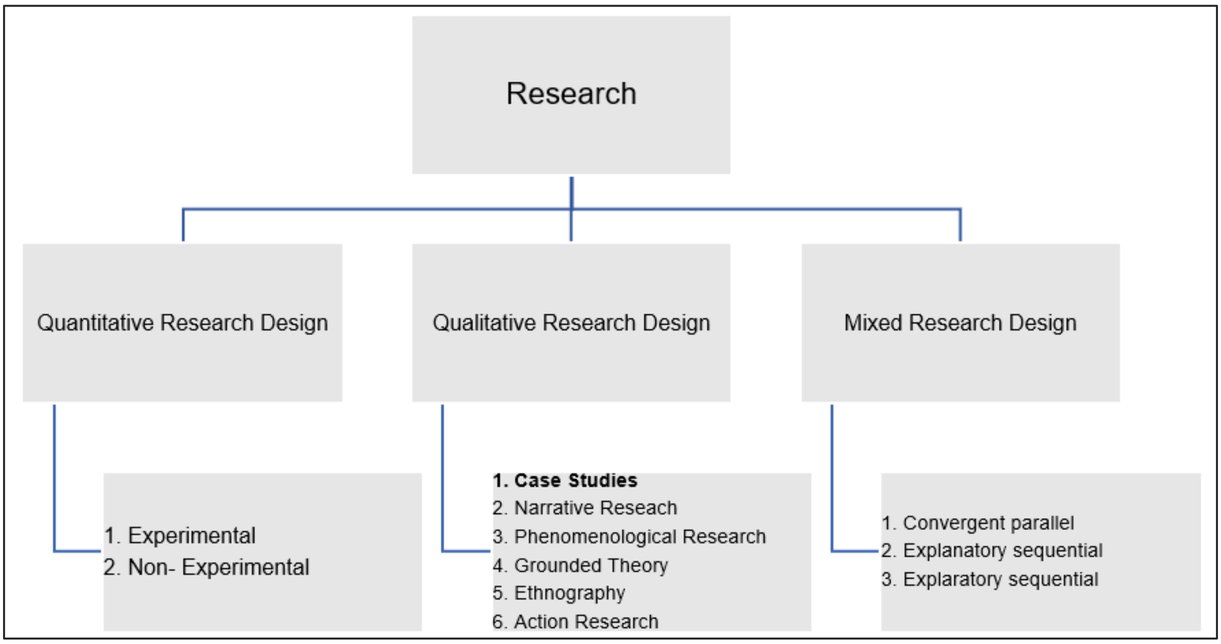


Figure 32: Research design

***Source**: Adapted from Akhtar (2016)*

Therefore, based on Asenahabi (2019) since this is a case study, qualitative research was the adopted methodology. According to Busetto *et al.* (2020), qualitative research can be defined as the study of the nature of phenomena and is especially appropriate for answering questions of why something is not observed, assessing complex multi-component interventions, and focusing on intervention improvement. The most common methods of data collection are document study, participant observations, semi-structured interviews, and focus groups. Aspers and Corte (2019) define qualitative research as an iterative process in which improved understanding of the scientific community is achieved by making new significant distinctions resulting from getting closer to the phenomenon studied. Creswell and Creswell (2018) further elucidated that qualitative researchers may collect data through examining documents, observing behaviour, or interviewing participants. The researchers gather the information and interpret it. They do not tend to rely on questionnaires or instruments developed by other researchers.

3.3 Target population

According to Casteel and Bridier (2021), the target population is the specific, conceptually bounded group of potential participants to whom the researcher may have access that represents the nature of the population of interest. The target population corresponds to the entire set of subjects whose characteristics are of interest to the researcher. For this study, the target population consisted of all the 105 employees from the case study company. Andrade (2020) asserts that sampling is done when it is usually impossible to study the entire population. (Sandelowski 1995 cited in Casteel and Bridier 2021) affirm that small sample sizes are often too small to support the development of claims, provide informational redundancy, or acquire theoretical saturation. (Marshall *et al*. 2013 cited in Casteel and Bridier 2021: 355) states that saturation often occurs at a minimum of 30 samples and the better saturation as the sample gets larger. Therefore, for this case study, the sample size consisted of all the staff who were working in steering wheel-related roles, and they are depicted in Table 13 with a total staff complement of 42.

3.4 Sampling methods

Taherdoost (2020) supported by Etikan and Bala (2017) delineated two types of sampling methods:

1. Probability or random sampling where every item in the population has an equal chance of selection.
2. Non-Probability or non-random sampling is often associated with case study research design and qualitative research.

Being a case study based on one organization with a relatively small sample size, this research adopted a non-probability sampling method. Taherdoost (2020) delineated four types of non-probability sampling methods as quota sampling, snowball sampling, purposive sampling, and convenience sampling. The purposive sampling method is best for this case study based on an explanation by (Maxwell 1996 cited in Taherdoost 2020) that it is a strategy in which settings, persons, or events are selected deliberately to provide important information that cannot be obtained from other choices. It is where the researcher includes cases or participants in the sample because they believe that they warrant inclusion. Therefore, for this study, the focus groups were predominantly the production shop floor supervision staff with a mix of production support departments. According to company XYZ management team (2021) restructuring exercise minutes, the new company structure is as shown in Table 13 below:

Table 13: Supplier XYZ new company structure

Department	Full Staff Compliment	Steering Wheel Staff	Other Commodities
Managing Director	**1**	-	-
Human Resources	1	-	-
Marketing	5	-	-
Purchasing	3	-	-
Finance	2	-	-
Logistics	4	-	-
Production	68	35	33
Quality	9	4	5
Maintenance	8	2	6
R&D	4	1	3
TOTAL	**105**	**42**	63

Source: *Company XYZ management team (2021) restructuring exercise minutes*

3.5 Measuring instrument and data collection

This research satisfied the grounded theory criteria as defined by Merriam *et al.* (2019: 185), that grounded theory is the study of experience from the standpoint of those who live it, and like all types of qualitative research studies, data in grounded theory studies can come from interviews, observations, and or documents and artifacts. (Behling and Law 2000) defined a research Instrument as a tool used to collect primary research data directly from the sources. Yin (2009) delineated the six sources as questionnaires, interviews, documentation, archival records, visualization, and participant observation. Austin and Sutton (2015) recommended focus group interviews, one on one interviews, and participant observations as data collection methods for small target population case studies. Ahmad *et. al* (201) concurred with the recommendation of using one on one interviews, focus groups, field research, case studies, and conversation or content analysis, hence for this research, data collection was through focus group interviews, one on one interviews with Management and participant observations. Gundumogula

(2020) advised that participant's consent to record the focus group interviews, one on one interviews, and participant observations should be sought before the planned sessions hence for this case study, the consent was requested by using the letter of information in Appendix B. Gundumogula (2020) delineated the advantages of conducting the focus group interviews online as follows:

1. Convenience to the participants by joining in from their homes.
2. Reduction of carbon footprint, by avoiding the transportation of the participants.
3. Sessions can be recorded with participants' consent and company policy guidelines.

3.5.1 Participant observation

Merriam (1998) suggested that the most important factor in determining what a researcher should observe is the researcher's purpose for conducting the study in the first place and that where to begin looking depends on the research question, but where to focus or stop action cannot be determined ahead of time. Werner and Schoeple (1987) cited in Kawulich (2005) delineated three types of participant observation as follows:

1. Descriptive observation, in which one observes anything and everything, assumes that the researcher knows nothing; the disadvantage of this type is that it can lead to the collection of minutiae that may or may not be relevant to the study.
2. Focused observation emphasizes observation supported by interviews, in which the participants' insights guide the researcher's decisions about what to observe.
3. Selective observation, in which the researcher focuses on different types of activities to help delineate the differences in those activities.

Participant observation is learning through exposure to or involvement in the day-to-day or routine activities of participants in the setting (LeCompte & Schensul, 1999) cited in Ozkaynak *et al.* (2020). The researcher conducted this by shadowing the participating team members and accompanying the participating team members through the events in a day as proposed by Ozkaynak *et al.* (2020). The researcher adopted the checklist elements as proposed by Merriam (1998) and obtained field notes using the guide from Schensul and LeCompte (2013).

Checklist elements proposed by Merriam (1998) and corresponding notes and questions that the researcher used included:

1. The physical setting:
   What is the physical environment like?
   What is the context?
   What kinds of behaviour is the setting designed for?
   How is space allocated?
   What objects, resources, and technologies are in the setting?
2. The participants:
   Describe who is in the scene, how many people, and their roles.
   What brings these people together?
   What are the relevant characteristics of the participants?
3. Activities and interactions:
   What is going on?
   Is there a definable sequence of activities?
   How do the people interact with the activity and with one another?
4. Conversation: What is the content of the conversation in this setting?
   Who speaks to whom?
   Who listens?
   Is it possible to record the meeting?

Points that were used for obtaining field notes were adopted from Schensul and LeCompte (2013)

1. Use of exact quotes when possible.
2. Use of pseudonyms to protect confidentiality.
3. Description of activities in the order in which they occur.
4. Provision of descriptions without inferring meaning.
5. Inclusion of relevant background information to situate the event.
6. Separation of researcher's own thoughts and assumptions from what one observes.
7. Recording the date, time, place, and name of the researcher on each set of notes.

3.5.2 Recruitment

Since this research depicted the purposive sampling phenomenon, the participants were therefore only obtained from within the organization as stated in section 3.4 that the members should have good knowledge about the steering wheel manufacturing process. The focus groups were predominantly the production shop floor supervision staff with a mix of production support departments, and then one-on-one interviews were carried out with Management as depicted in 3.4.

3.5.2.1 Recruitment of focus groups and one on one interviews

Recruitment followed principles adopted from Latimer (2020) and Gigs (2021) listed below. Items 1-3 detailed the preparation considered by the Researcher before approaching the proposed focus group and one-on-one interview participants.

1. **Research brief**

   The letter of information in the appendix was shared with the proposed members of the focus groups. The letter of information informed the candidates about the title of the research, the aim, objectives, risks, and benefits of the research.

2. **Focus interview questions**

   The interview questions were formulated as per Appendix B: Section A.

3. **Reaching the participants**

   In this instance, all the participants were already employees of company XYZ, hence the mode of communication with them was through their company e-mails that were provided by their Management.

4. **Informing the participants about the venue, date, and time of the meeting**

   Gigs (2021) implored that the venue and mode of the meeting can influence the decision of the potential participants to either participate or not, hence the venue will be advised by XYZ Management and communicated accordingly during the meeting invitations that will be sent on e-mails. This invitation will comprise the letter of information identified in item 1 above and the interview's date, time, and venue as authorized by XYZ Management. For the participants that are not on email, the researcher will avail hard copies of the letter of information to them. According to Dilshad and Latif (2013), the recommended duration of a focus group session is one and a half hours and at most an hour for one-on-one interviews, hence the focus group meetings will be held for one and a half hours, and a maximum duration of an hour will be reserved for the one-on-one interviews.

3.5.3 Data collection

A systematic literature review to identify the LM drivers and barriers was conducted to cater to objectives 1 and 2. Consequently, objectives 3 and 4 were collected using focus group interviews, one-on-one interviews, and participant observations.

3.5.3.1 Focus group interviews

The recruitment adopted the summary in section 3.5.2.1. Considering the COVID-19 restrictions, the case study company is thus amenable to conducting certain focus group interviews via MS Teams whenever feasible, otherwise, the case study company has also availed meeting boardrooms for this project on the premises in line with covid 19 protocols.

Guest, Namey, and McKenna (2017) investigation of the number of focus groups required for saturation revealed that more than 80% of all themes were discoverable within two to three focus groups, and 90% were discoverable within three to six focus groups with optimum members of 6-10 per group. Five focus groups will be planned for this research with a minimum of 5 people per group selected from the steering wheel staff in Table 9 and further clarified in Table 14 below:

Table 14: Focus groups

Focus Group	**Number of Members**
Group 1	9
Group 2	9
Group 3	8
Group 4	8
Group 5	8
Total	**42**

***Source**: Researcher's own construction*

The researcher scheduled the focus group meetings as depicted on the Interview schedule listed in the appendix. The researcher facilitated the interviews, and a comprehensive list of the interview questions is provided in Appendix Section A. The researcher made annotations and reconfirmed the highlighted points with the interviewees to uphold accuracy.

3.5.3.2 One-on-one interviews

One-on-one interviews were held with Management as per the portfolios that they are responsible for as depicted in supplier XYZ Management Team (2021) restructuring exercise minutes as follows:

1. Managing Director
2. Production Manager
3. Maintenance
4. Quality Manager
5. R&D Manager

3.6 The basis of questionnaire design

The interviews were facilitated, with the specific questions utilized being enumerated in Appendix Section B. If there are any ambiguous responses that the researcher requires with Management based on the focus group interviews, Appendix Section A will be utilized. The interviewer will ensure to take notes and reconfirm the points noted to ensure accuracy from the interviewees.The basis of the two questionaires utilized in the study depicted in Appendix 2 and 3 is depicted in the subsections below:

3.6.1 Focus group questionaire

The organization of the focus group questionnaire is systematically designed to assess the manufacturing performance of steering wheel production in relation to LM manufacturing principles. It utilizes a layered framework that categorizes questions into thematic groups connected to a hierarchy of levels, specific outcomes, and evaluation metrics.

These focus group questions correspond with the investigation of objective 3, which is to analyze the manufacturing performance of the existing steering wheel manufacturing process. Therefore, the investigation of manufacturing performance and the evaluation of current efficiency are the primary focuses of the questionnaire. Each outcome is divided into metrics or appropriate dimensions. The questions are open-ended, addressing both perception-based and factual inquiries. The formulation of the questions is therefore intended to investigate the two essential components outlined below:

1. A balanced scorecard aimed at examining the operational perspective.
2. A lean manufacturing approach regarding efficiency perspectives.

3.6.2 One-on-one interviews questionnaire

The one-on-one interview questionnaire serves to investigate the strategic level of the organization.

Furthermore, the one-on-one questionnaire also refines and repositions the focus group questionnaire.

This questionnaire is structured around the major cost drivers identified in the steering wheel manufacturing process, based on the systematic literature review, and features targeted open-ended questions within each segment.

3.7 Pilot study

(Janghorban *et al*. 2014) refer to a pilot study as a pre-test for a research instrument such as a questionnaire or interview guide. According to Morris (n.d), a population size of less than 5000 is considered small. Breen (2006) does not recommend a pilot study for a relatively small case study target population, however, delineates three essential modifications to the focus group interviews below:

1. Extension of the time with the focus groups so that questions are checked for their meaning and to allow participants to request clarity where there is ambiguity.
2. Send the questions to the group in advance of the session to check that participants do not anticipate having any problems responding to them.
3. Setting up a second session with the same group of participants after an initial analysis has been conducted if there are further questions arising that were not initially included in the previous schedule.

Hence for this study, the above modifications were employed for the focus group and one-on-one interviews, and no pilot study was conducted.

3.8 Validity

According to Freitas *et al.* (1998), the results obtained from a focus group or one-on-one interview are valid if the interview questions are used for a problem that is adopted for investigation. A focus group one-on-one interview has high face validity; that is, they measure what it intends to measure, and there is confidence in the data collected. The people tell their perceptions on the topic, which cannot be so easily achieved in an individual interview or other forms of data collection. Therefore, the survey questions for this research were created. According to Guba (1982), there are four essential criteria for adoption by qualitative researchers in pursuit of trustworthiness listed below:

3.8.1 Credibility

The researcher followed the steps suggested by Shenton (2004) to promote confidence:

1. Adoption of well-established data collection and capturing methods.
2. The development of an early familiarity with the culture of participating organizations.
3. Random sampling.
4. Triangulation is the use of different observation methods that are being employed in this study, and for this study focus group interviews, one-on-one interviews, and participant observations will be utilized.
5. Tactics to help ensure honesty in informants when contributing data – The researcher will allow all approached participants to refuse to participate so that the data collection sessions involve only the genuinely interested members. The researcher will encourage the participants to be frank from the onset.
6. Iterative questioning – The researcher will return to matters previously raised by an informant and extract related data through rephrased questions. If falsehood is detected, the researcher will discard the data.

7. Frequent debriefing sessions – The researcher will schedule frequent briefing sessions involving the Managing Director and the Team leaders to report on the progress and flaws of the course.
8. In alignment with ISO 9001 clause 9.2, for which company XYZ holds certification, the researcher will arrange meetings that include the Managing Director and the leaders of focus groups as outlined below. Short opening meetings will be conducted with the Managing Director or an appointed member of Senior Management, along with the relevant Team Leader of the focus group on the day of the focus group meeting. The debriefing session will act as the final meeting at the conclusion of each focus group session. This means that there will be a total of five closing meetings, summarizing the five focus groups, five one on one meetings with Management, and the participant observation sessions.Peer scrutiny – The researcher will allow for the opportunity of scrutiny by colleagues' peers and academics.

   The researcher intends to use the Delphi process explored in section 2.4 of the literature review. The colleagues, peers, and academics involved will be individuals who have a solid understanding of LM, ideally those who are acquainted with the steering wheel manufacturing process.
9. Researcher's reflective commentary – The researcher will summarize the progress of the study as it develops.
10. Member checks – The researcher will re-read the participants' responses to them for them to confirm that they communicated what was intended.
11. Examination of previous research findings – The researcher will review published literature on similar findings.

3.8.2 Transferability

Lincoln and Guba (1981) refer to transferability as the degree to which the results of the qualitative results can be transferred to other settings or contexts. William (2022) suggests that qualitative researchers can bolster transferability by thoroughly articulating the research context and the essential assumptions that were integral to their investigation. The responsibility for judging the appropriateness of transferring the results to a different context rests with the individual seeking to do so. Therefore, the researcher as per suggestion by William (2022) enhanced transferability by thoroughly explaining the research content and the assumptions made so that whoever wished to transfer makes an informed judgment.

3.8.3 Dependability

Guba (1981) refers to dependability as the ability of the findings of an inquiry to be consistently repeated if the inquiry was replicated with the same or similar subjects or respondents in the same or similar context. To achieve dependability, the researcher adopted the recommendation by Moon *et al*. (2016) of documenting the research design and implementation including the methodology and methods of data collection.

3.8.4 Confirmability

Guba (1981) refers to confirmability as the degree to which the findings of an inquiry are a function solely of the subjects or respondents and the conditions of the inquiry and not of the biases, motivations, interests, and perspectives of the researcher. The researcher adopted the two suggestions of ensuring confirmability as stated by William (2022) of documenting the procedure for checking and rechecking the data throughout the study and then using then requesting another researcher to be an external auditor and confirm the data.

3.9 Reliability

According to Matheson (2019), one estimate of reliability is test-retest reliability. This involves administering the survey with a group of respondents and repeating the survey with the same group at a later point in time and then comparing the responses at the two-time points. Cohen's Kappa coefficient, which is commonly used to estimate interrater reliability, can be employed in this context of test-retest. The Kappa coefficient indicates the extent of agreement between frequencies of two sets of data collected on two different occasions, and if there is complete agreement, k=1, and if there is no agreement, k=0. For this research, a minimum Kappa coefficient of k=0,8 will be acceptable. The research instruments applied in this study include focus group interviews, individual interviews, and participant observations. Through an empirical investigation involving diverse measuring instruments, Rauf *et al.* (2014) confirmed the reliability of the data by juxtaposing responses from three parallel instruments, employing thematic analysis and triangulation as foundational methodologies.

Accordingly, the reliability of the research will be aligned with the framework presented in section 3.9.1 on thematic analysis and Chapter 5, which focuses on the triangulation of results.

3.10 Data analysis

A central aim of data analysis according to Robson (1993) cited in Rabiee (2004) is to reduce data. Yin (1989) cited in Rabiee (2004) alluded to the fact that data analysis consists of several stages, namely, examining, categorizing and tabulating the results or otherwise recombining the evidence to address the initial goal of the study.
Gundumogula (2020) states that focus groups and one-on-one interview data analysis should follow qualitative methods of data analysis. For this case study, data analysis will be done using NVivo, a qualitative data analysis (QDA) computer software that will execute at least five tasks delineated by (Hilal and Alabri 2013) as managing the data, managing ideas, querying data, visual modeling, and reporting.
According to Vaismoradi *et al*. (2013), the two commonly used approaches for qualitative data analysis are qualitative content analysis and thematic analysis. Baxter (2009) describes content analysis as a research tool that is used to determine the presence of certain words, themes, or concepts with some given qualitative data or text. Braun and Clarke (2006) cited in Kiger and Vapior (2020) describe thematic analysis as a method of analyzing qualitative data that entails searching across a data set to identify, analyze and report repeated patterns. According to Kiger and Vapior (2020), the major distinguishing feature of thematic analysis is its flexibility to be used within a wide range of theoretical and epistemological frameworks and to be applied to a wide range of study questions, designs, and sample sizes. The researcher will adopt a thematic analysis approach as recommended by Braun and Clarke (2012) to use when the researcher is seeking to understand a set of experiences, thoughts, or behaviours across a data set in addition to the advantages noted by Kiger and Vapior (2020)

3.10.1 Thematic analysis

Ho and Limpaecher (2020) described thematic analysis as a qualitative data analysis method that involves reading through a data set such as transcripts, in-depth interviews or focus groups, and identifying patterns in meaning across the data to derive themes. Namey *et al*. 2008 cited in Ibrahim (2012) provided a more concise summary in that thematic analysis moves beyond counting explicit words or phrases and focuses on identifying and describing both implicit and explicit ideas. Codes developed for ideas or themes are then applied or linked to raw data as summary markers for later analysis, which may include comparing the relative frequencies of themes or topics within a data set, looking for code cooccurrence, or graphically displaying code relationships.

A common pitfall is to use the main interview questions as the themes (Clarke and Braun, 2013) cited in Maigure and Delahunt (2017). Braun and Clarke (2006) cited in Maigure and Delahunt (2017) formulated a thematic analysis framework that breaks down the analysis into six different phases illustrated in Figure below.

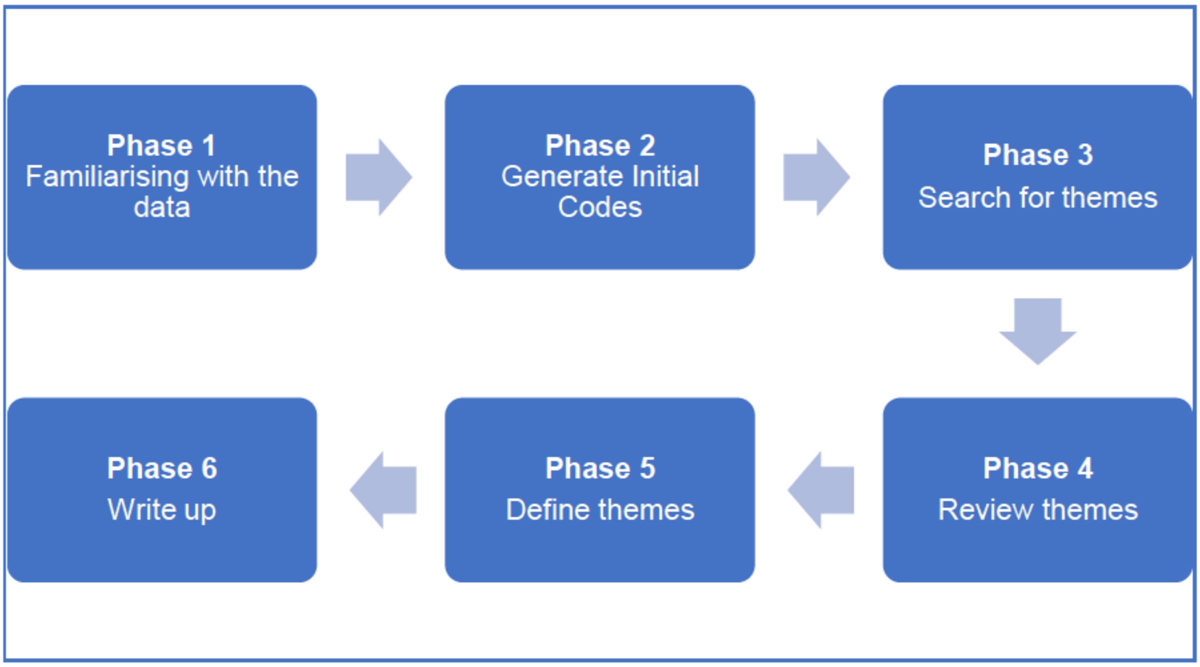


Figure 33: Phases of thematic analysis

***Source**: Adapted from Maigure and Delahunt (2017)*

3.10.1.1 Phase 1: Familiarizing with the data

According to Maigure and Delahunt (2017), familiarizing with the data phase involves reading, and re-reading the transcripts. Willig and Stainton-Rogers (2017) concur with Maigure and Delahunt (2017)'s phase 1 description but further affixes that this stage also involves listening and relistening or watching and re-watching any recordings where applicable, and then involves generating very early analytic ideas, which requires the researcher to be very curious and have an attitude of interrogating the data.

3.10.1.2 Phase 2: Generate the initial codes

Willig and Stainton (2017) articulated distinctly the difference between Phase 1 and 2 as the former being a casual observation and the latter being a systematic and thorough creation of meaningful labels attached to specific segments of the data set. The segments described are the ones that are relevant to the research questions. Maigure and Delahunt (2017) insinuate that there are different ways to code data and the method that is selected by the researcher should be determined primarily to answer the research questions. Medelyan (2023) stated that deductive and inductive coding are the two main methods used to generate codes. Sobecki (2021) annexed two more coding methods to the latter as semantic and latent coding methods. The four coding methods are further encapsulated as follows:

3.10.1.2.1 Deductive coding

According to Medelyan (2023), deductive coding commences with a predefined set of codes and then assigns the codes to the new qualitative data.

3.10.1.2.2 Inductive coding

Medelyan (2023) also named inductive coding as open coding, implying that the researcher starts with no pre-set codes but obtains the codes from the data set. According to Thomas (2003), inductive coding begins with close readings of the text and consideration of the multiple meanings that are inherent in the text.

3.10.1.2.3 Semantic coding

According to Sobecki (2021), semantic coding focuses on the explicit and surface meaning of the words that are being analysed. Byrne (2021) concur that semantic codes are identified through the explicit or surface meanings of the data and that the researcher does not examine beyond what a respondent has said or written.

3.10.1.2.4 Latent coding

According to Sobecki (2021), latent coding focuses beyond the semantics of the data and concentrates more on the underlying meanings and concepts. Byrne (2021) described that latent coding goes beyond the descriptive level of the data and attempts to identify hidden meanings or underlying assumptions, ideas, or ideologies that may shape or inform the descriptive or semantic content of the data. When coding is latent, the analysis becomes much more interpretive, requiring a more creative and active role on the part of the researcher.

3.10.1.3 Phase 3: Search for themes

Maigure and Delahunt (2017) defined a theme as a pattern that captures something significant or interesting about the data and or research questions. According to Braun and Clarke (2006), a theme captures something important about the data about the research question and represents some level of patterned response or meaning within the data set. Braun and Clarke (2012) concluded that though the phase is called searching for themes, it is not like archaeologists digging around, searching for the themes that lie hidden within the data, pre-existing the process of analysis. Rather, analysts are like sculptors, making choices about how to shape and craft their piece of stone analogized as the raw data, into a work of art which is analogized as the analysis. Therefore, searching for themes is a very active process in which the qualitative researchers actively construct themes rather than discover them (Braun and Clarke, 2012). According to Caulfield (2022), themes are broader than codes, and Table is an exhibit of how codes can be transformed into themes.

Table 15: Turning codes into themes

Codes	Theme
Uncertainty	Uncertainty
Leave it to the experts	
Alternative explanations	
Changing terminology	Distrust of experts
Distrust of scientists	
Resentment towards experts	
Fear of government control	
Incorrect facts	Misinformation
Misunderstanding of science	
Biased media information	

***Source**: Adapted from Caulfield (2022)*

3.10.1.4 Phase 4: Review themes

According to Sobecki (2021), this phase is where the themes are compared with the original data and the researcher endeavours to look for missing points or irrelevant results. Maigure and Delahunt (2017) concur that this phase is for reviewing, modifying and developing the preliminary themes that were identified in Phase 3. Nowell *et al*. (2017) affirm that this phase is for the researcher's triangulation of themes and subthemes and test for referential adequacy by returning to raw data. Braun and Clarke (2006) cited in Nowell *et al.* (2017) concluded that at the end of this phase, researchers have a good idea of the different themes, how they fit together, and the overall story they tell about the data.

3.10.1.5 Phase 5: Define themes

King (2004) cited in Nowell *et al*. (2017) advised that it is possible to go on modifying and refining definitions of themes forever, and one of the most difficult decisions to make is where to stop the process of development hence if there remain any sections of text which are clearly relevant to the research question, but are not included, the themes cannot be finalized.

During the fifth phase, researchers determine what aspect of the data each theme captures and identify what is of interest about them and why (Braun & Clarke, 2006) cited in Nowell *et al*. (2017). Dawadi (2020) exhibited this phase by reading through all the main themes and sub-themes, codes and extracts, and then the final name along with its definition was assigned to each theme to tell a story about the data. Braun and Clarke (2006) emphasized that a theme cannot be too diverse and complex.

3.10.1.6 Phase 6: Report writing

The write-up of a thematic analysis should provide a concise, coherent, logical, nonrepetitive, and interesting account of the data within and across themes (Braun and Clarke, 2006). Thorne (2000) cited in Nowell *et al.* (2017) encouraged researchers to communicate the logical processes by which findings were developed in a way that is accessible to a critical reader, so the claims made to the data set are rendered credible and believable. Halpren (1983) cited in Nowell *et al.* (2017) recommended that researchers keep methodological notes, trustworthiness notes, and audit trail notes to ease the reporting process. King (2004) cited in Nowell *et al*. (2017) suggested that direct quotes from participants are an essential component of the final report. Short quotes may be included to aid in the understanding of specific points of interpretation and demonstrate the prevalence of the themes.

3.11 Delimitations

The research will be limited to the case study company's steering wheel manufacturing process and will use LM principles. Due to the limited usage of LM locally as implied by (Dondofema, Matope, and Akdogan 2017), the South African industry faces immense global competition from developed countries such as Germany probably because of the adoption of LM techniques by the latter, therefore references, and benchmarking thereof will be executed with global ACMs that manufacture the steering wheels for OEMs.

3.12 Anonymity and confidentiality

The case study company requested anonymity of their name and information throughout the rest of the study, hence the company will be identified as company XYZ, and all company-provided information and or participants' Hard copies of information obtained from the research will be stored in lockable cupboards for a minimum retention period of five years and will be securely shredded after the retention period. Electronic data will be encrypted and stored safely on the researcher’s laptop and electronic backup external drives for a minimum retention period of five years. Kridel (2014) explains that the best way to destroy data after the retention period is by a process called degaussing, followed by the physical destruction of the device where the data is stored and then disposing of in line with municipal laws. Kridel (2014) describes degaussing as the process of data destruction on a storage device by disrupting the magnetic fields on the storage media. Hence after the retention period, all the research electronic data will be degaussed and perforated by the company’s Information Technology (IT) department in line with the company’s electronic data retention and disposal policy and then subsequently disposed of in line with the company’s IT waste disposal policy.

3.13 Ethical considerations

The researcher has undergone an Introduction to Research Ethics training, see Appendix 3.

The research does not aim to harm or advertise any individual, company, or organization that has participated. All participants will be notified that their information will be strictly confidential. Participation in the study will be free will and participants may withdraw from the study at any time.

3.14 Inclusion and diversity

Qureshi (2017) described inclusion as an organizational effort and practice in which different groups or individuals having different backgrounds are culturally and socially accepted and welcomed. These differences could be self-evident, such as national origin, age, race and ethnicity, religion/belief, gender, marital status and socioeconomic status or they could be more inherent, such as educational background, training, sector experience, organizational tenure, and even personality, such as introverts and extroverts. Ruzycki and Ahmed (2022) warned that Researchers should not assume participant sex or gender, and instead should familiarize themselves with best practices for asking about sex assigned at birth, sexual orientation and gender identity during data collection. Transgender and gender-diverse people are frequently overlooked during the design of data collection forms, which may lead them to withdraw from a study, leading to missed associations during analysis.

3.14 Gate keeper

The researcher utilized the Gate Keeper template attached in Appendix 1 to send to the Managing Director of the case study company, and the company has already responded and granted the researcher permission to conduct the research.

3.15 Chapter summary

The flow diagram of the Research Methodology is shown in figure 34 below:

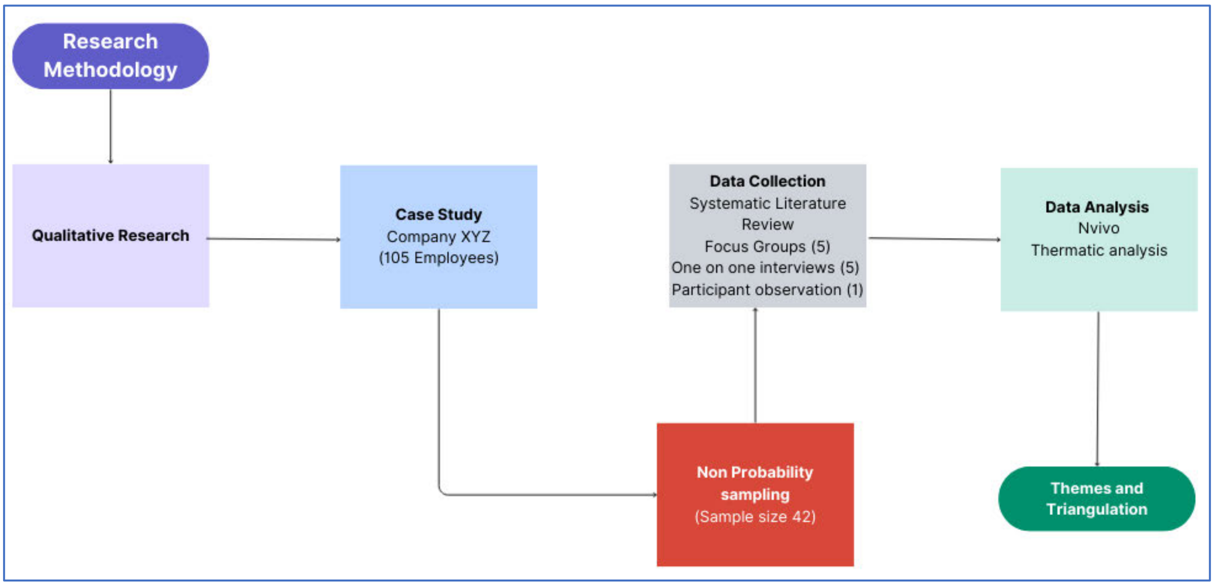


Figure 34: Research methodology flow diagram

***Source**: Researcher's own creation*

This chapter explored the various research methodologies that were applied throughout this study. The research paradigm and philosophies were discussed. A qualitative framework was adopted in the study to explore the nuances of the subject matter. The research utilized focus groups, one-on-one interviews, and participant observation as its primary data collection instruments. The research participants were also purposively chosen, targeting those who had experience and knowledge of the subject matter. NVivo and thematic analysis were utilized for the examination of the data, which was subsequently triangulated to corroborate the results. The actions taken were in strict compliance with the outlined ethical considerations. The subsequent chapter will detail the findings.

CHAPTER 4

STATEMENT OF RESULTS AND ANALYSIS

This Chapter objectively and neutrally presents the findings of the focus group and one-on-one interviews without interpreting them.

4.1 Introduction

This chapter presents the outcome of the data gathering process, reports the results and discusses the findings obtained from the focus group interviews, face-to-face interviews and participant observations with steering wheel department staff purposively selected at company XYZ in KwaZulu-Natal province, South Africa. The data that emerged from the focus group and face-to-face interviews was deductively coded with the aid of software (NVIVO version 12).

4.2 Survey results

The subsequent sections elaborate on the findings derived from the methodology outlined in Chapter 3.

4.2.1 Focus group interviews

Recording of the focus group interviews was not feasible, however, a transcription partner was allocated to the researcher by the Management of company XYZ. The purpose of the transcription partner was to take notes simultaneously with the researcher for purposes of comparison. A total of five focus group sessions were carried out, and each preceding session was an iterative improvement of the previous one.

4.2.1.1 Planned vs actual participants

The number of participants per focus group ranged from 5 to 10 with a median of 7 participants. As depicted in Figure 34, there is a comparison between the projected number of participants for the focus group interviews and the actual number of staff members who engaged, classified by group.

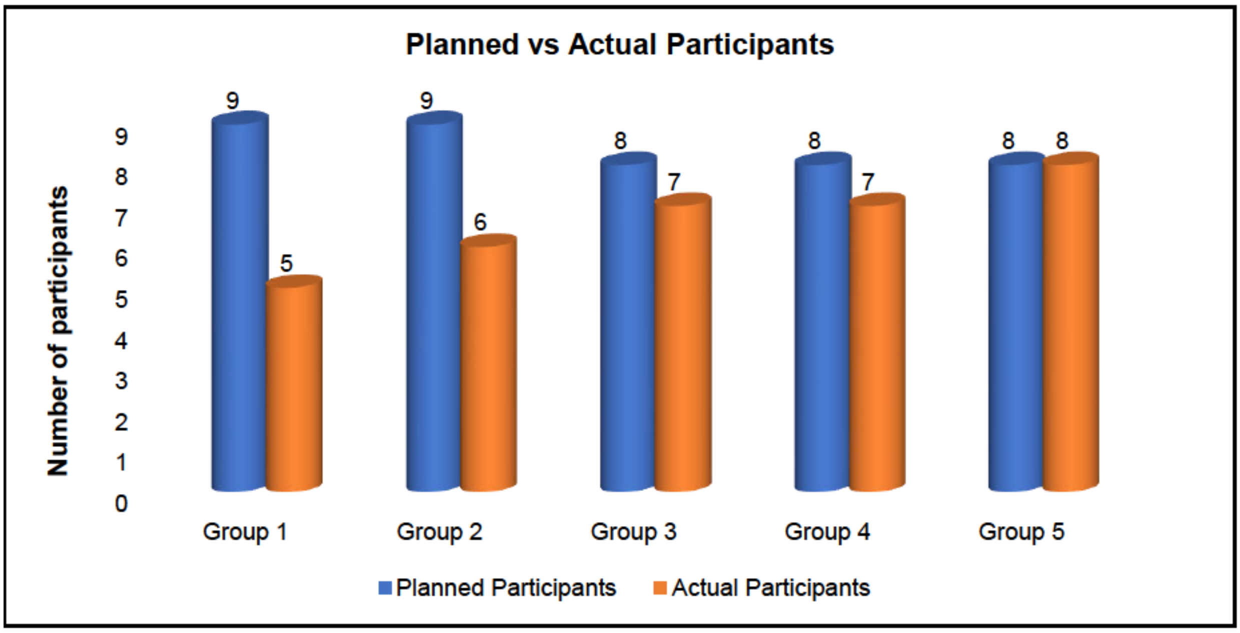


Figure 35: Planned vs actual focus group participants

4.2.1.2 Participants' educational attainment levels

Table 16 indicates that of the total of 33 staff members who participated in the focus group interviews, the highest levels of education attained were as follows:

a. Matric – 8 staff members - (24%)
b. Diploma – 18 staff members – 55%
c. Degree – 6 staff members – 18%
d. Postgraduate/Masters – 1 staff member – 3%

Table 16: Educational attainment levels of participants

Focus Group	Matric	Diploma	Degree	Post Grad/Masters	Total
Group 1	1	3	1	0	5
Group 2	0	2	3	1	6
Group 3	2	4	1	0	7
Group 4	2	5	0	0	7
Group 5	3	4	1	0	8
Total	8	18	6	1	33
Percentage	24%	55%	18%	3%	100%

Figure 35 below shows the graphical presentation of Table 16

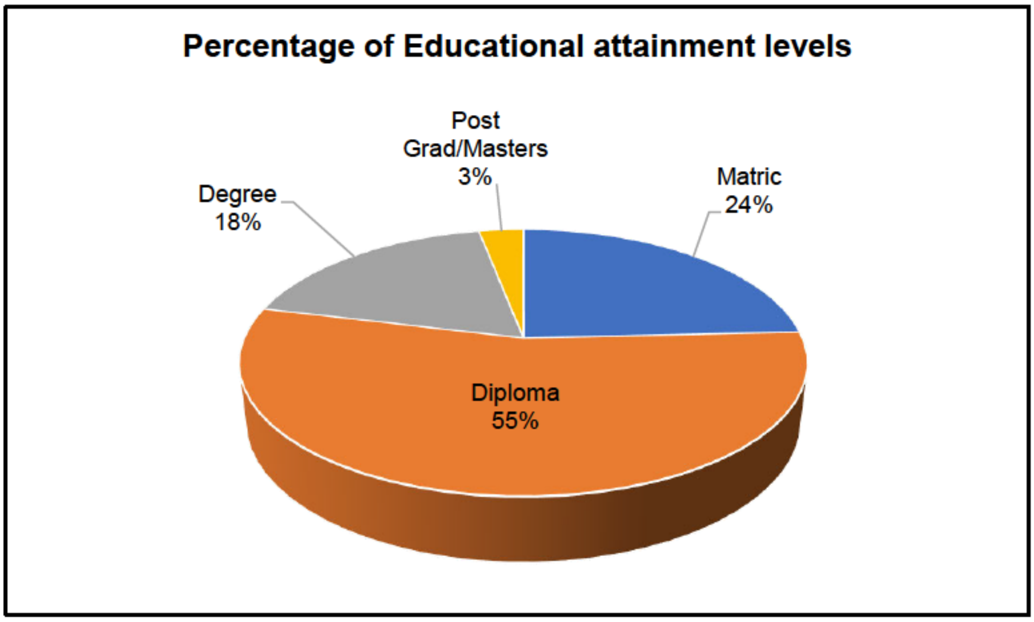


Figure 36: Percentage of educational attainment levels

At least all the participants held a Matric qualification or higher, hence there was no difficulty in explaining most of the concepts in the interview as they were very much aware of them.

4.2.1.3 Participants by company grade

The focus group participants were grouped by the Grades of the positions they hold in company XYZ as follows:

Operator: Grade A – 15%

Operator: Grade B – 21%

Operator: Grade C – 18%

Supervisor Grade: D – 15%

Specialist: Grade E – 15%

Manager: Grade F – 12%

Executive: Grade G – 3%

The median of the Grade participants falls within Grade D of 15%.

The grades explained above are illustrated are illustrated in Table 17 below:

Table 17: Participants by company grade

Focus Group	Operator Grade A	Operator Grade B	Group Leader Grade C	Supervisor Grade D	Specialist Grade E	Manager Grade F	Executive Grade G
Group 1	1	0	2	1	0	1	0
Group 2	0	1	0	1	2	1	1
Group 3	2	2	2	0	0	1	0
Group 4	2	2	1	1	1	0	0
Group 5	0	2	1	2	2	1	0
Total	5	7	6	5	5	4	1
Percentage	**15%**	**21%**	**18%**	**15%**	**15%**	**12%**	**3%**

The grades are predominantly influenced by the number of years of experience and the educational qualification that the operator holds. The percentage of the focus group participants by Grade is exhibited graphically in Figure 36.

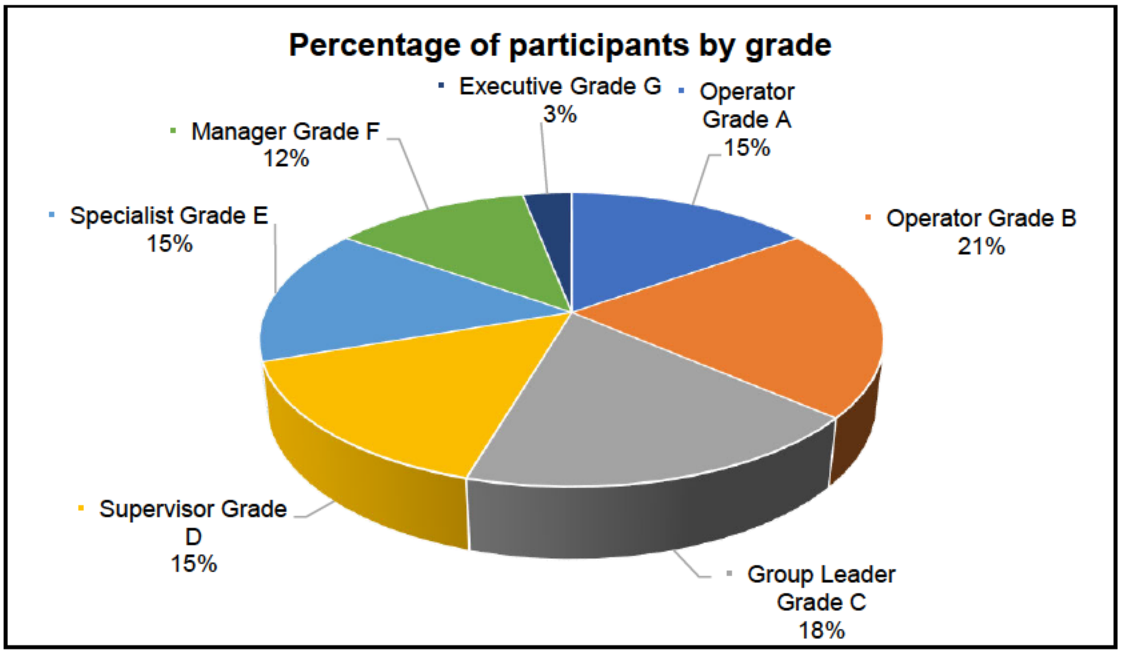


Figure 37: Percentage of participants by grade

4.2.1.4 Participants by years of experience

The number of years of experience of the participants ranged from less than a year to more than 20 years in the same process. Table 18 shows the distribution of the years of experience of the participants.

Table 18: Years of experience of the participants

Focus Group	**Age Group**					**Total**
	20-30	**31-40**	**41-50**	**51-60**	**>60**	
Group 1	1	2	1	1	0	5
Group 2	2	3	1	0	0	6
Group 3	1	4	1	0	1	7
Group 4	1	2	2	2	0	7
Group 5	2	2	2	1	1	8
Total	7	13	7	4	2	33
Percentage	21%	39%	21%	12%	6%	**100%**

The group with the greatest number of years of experience fell within the 5–7-year segment, with a frequency of 7 participants and a percentage contribution of 21%. Consequently, the group that had the least number of years fell within the less than 1 year and between 1-2 years segments, both having frequencies of 4 participants and percentage contributions of 12% each. Figure 37 is a graphical representation of Table 18.

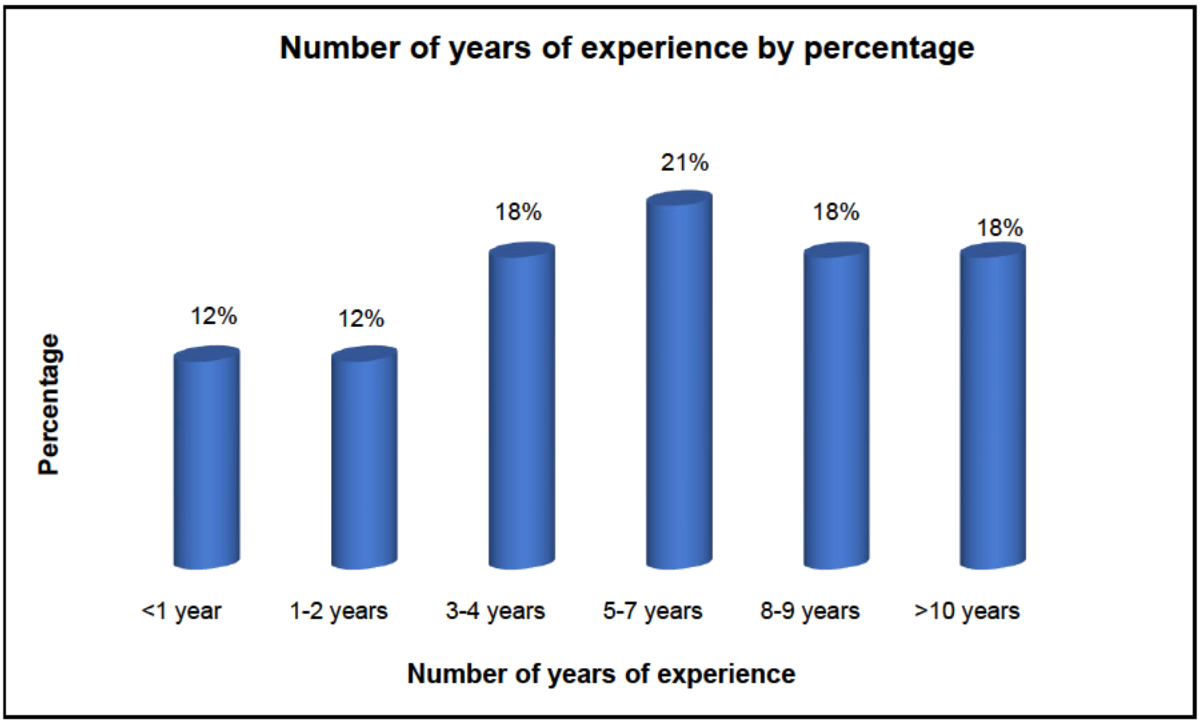


Figure 38: Number of years of experience by percentage

4.2.1.5 Participants by age

The age groups of the participants were collected and visualized in Table 19. The range, frequencies and the corresponding percentage distributions across all the focus groups are listed below:

Table 19: Age groups of participants

Focus Group	20-30	31-40	41-50	51-60	>60	Total
Group 1	1	2	1	1	0	5
Group 2	2	3	1	0	0	6
Group 3	1	4	1	0	1	7
Group 4	1	2	2	2	0	7
Group 5	2	2	2	1	1	8
Total	7	13	7	4	2	33
Percentage	21%	39%	21%	12%	6%	100%

4.2.1.6 Inclusion and diversity

Identification of the focus group genders was not done by the researcher, but the participants were given an opportunity at the beginning of each session to sign up for a register which had three gender identifiers, male, female and other to cater for the groups that do not identify as Male or Female. Table 15 shows the results of the participant's gender distribution by Focus Group. 52% identified themselves as male, 39% identified themselves as female, and 3% identified as other. Predominantly, Company XYZ's Steering Manufacturing process is male-dominated as evidenced by the statistics shown.

Table 20: Gender distribution by focus group

Focus group	**Male**	**Female**	**Other**	**Total**
Group 1	2	3	0	5
Group 2	3	2	1	6
Group 3	4	3	0	7
Group 4	5	2	0	7
Group 5	5	3	0	8
Total	19	13	1	33
Percentage	58%	39%	3%	100%

Figure 38 is the graphical representation of the focus groups gender distribution.

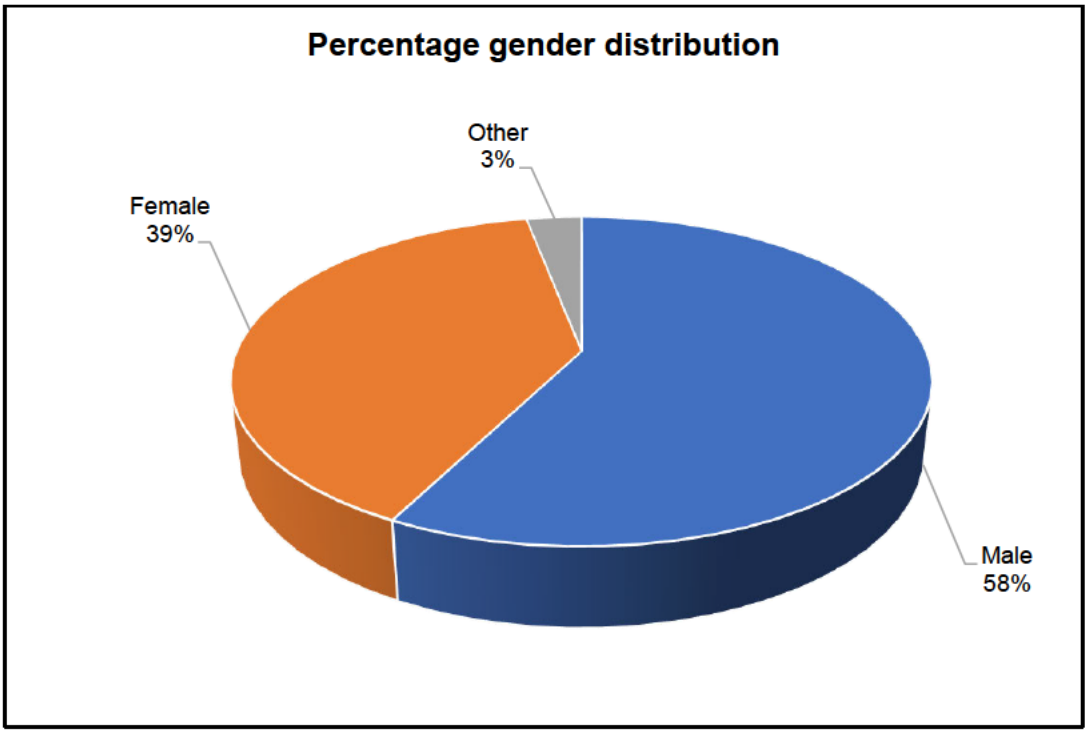


Figure 39: Percentage gender distribution

4.2.1.7 Ethnicity

The participants of the focus groups were also analyzed by their ethnicity. Table 21 below shows the composition of the results.

Table 21: Breakdown of participants by ethnicity

Focus group	African	White	Coloured	Indian	Asian	Total
Group 1	3	1	0	1	0	5
Group 2	2	0	1	2	1	6
Group 3	4	0	1	2	0	7
Group 4	3	1	1	2	0	7
Group 5	5	0	0	2	1	8
Total	17	2	3	9	2	33
Percentage	52%	6%	9%	27%	6%	100%

Table 21 indicates that from all the focus groups combined, 17 (52%) were African, 2 (6%) were white, 3 (9%) were coloured, 9 (27%) were Indian, and 2 (6%) were Asian.

The predominant race at company XYZ Steering Department is Black, and this generally shows the race status of the company. Figure 39 further illustrates the graphical presentation of Table 21.

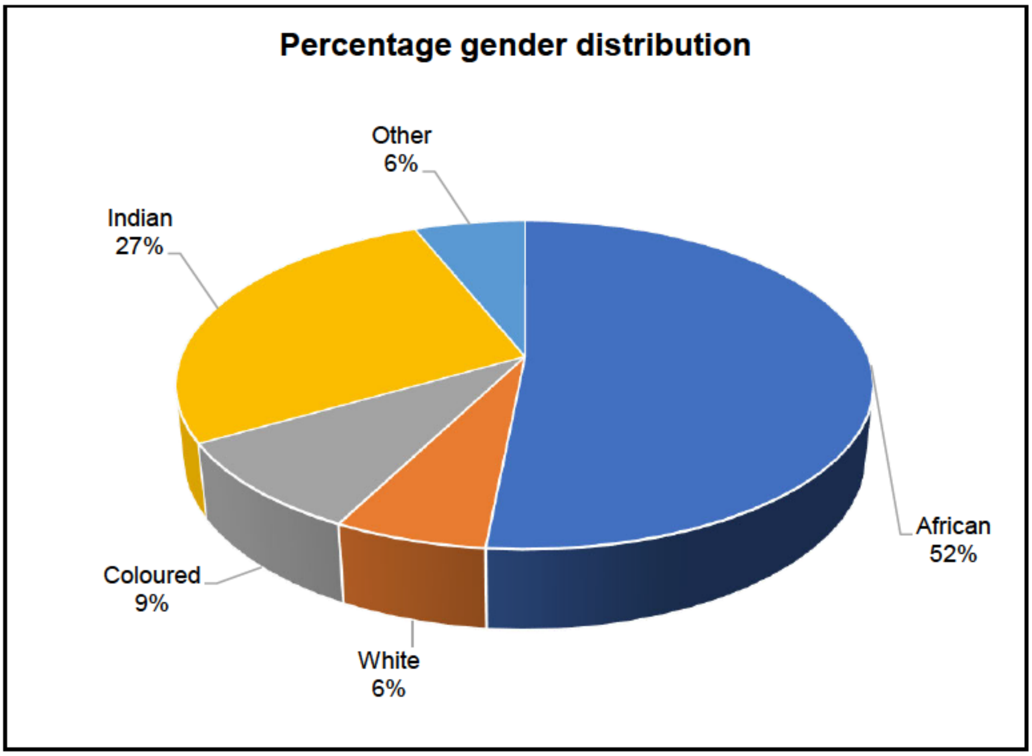


Figure 40: Percentage gender distribution

4.3 Word cloud

An NVivo analysis of the one hundred most frequent words that were used by the participants in the one-on-one interviews and the focus group interviews was conducted and is illustrated side by side in Figures 40 and 41. In Figure 40, suppliers had the highest count of 42 and in Figure 41 process had the highest count of 150. Figure 40 is in line with section 1.1 that OEMs are putting immense pressure on their tiered suppliers to reduce costs. This is further supported by the word cost which had the second-highest count. Figure 41 is in line with objective 3 in section 1.9, and literature review section 2.3.3 which illustrates the gravity of processes in LM.

Figure 41: One-on-one interview word cloud

Figure 42: Focus group interview word cloud

4.4 Emerging themes and subthemes from the one-on-one interviews

The analysis of the data gathered from the one-on-one interviews resulted in the identification of the themes and subthemes highlighted in Table 22. The names of interviewees where applicable have, however, been changed to Respondent 1, 2, 3, 4 and 5 to ensure anonymity.

Table 22: LM drivers themes and sub themes generated from one-on-one interviews

Theme	Subtheme
Factors affecting Supplier selection	Supplier margins
	Supplier selection methods
	Material costs
	Purchasing policies
	Supplier location
Assessing the technological capability of the local company	Plant age
	Affiliate technology
	Affiliate comparison
	Production volumes
	Improving production volumes
Indirect costs cutting measures	Costs cutting measures for energy andwater expenses
	Overhead costs cutting measures
	Implementing water consumption costs Cutting measures
	Energy costs cutting measures
Types of energy	Types of Energy
	Alternative energy sources
Localization in comparison to shipping expenses	Localization
	Mode of transport
	Packaging
	Shipping agencies
	Shipping frequency
	Stock levels

Source: *Researcher's own construction*

The themes were identified in line with objective 3 (O3), and aligned with the research question 3 (RQ3):

O3: To investigate the manufacturing performance of the current steering wheel manufacturing process concerning LM drivers and barriers by using focus groups, one-on-one interviews, and participant observation.

RQ3: How do the identified LM drivers and barriers affect the current manufacturing performance?

In addition, and in supporting the discussion on themes, relevant quotes from the data generated from the one-on-one interviews were used. Data from the one-on-one interviews was transcribed verbatim and used as such during the discussion.

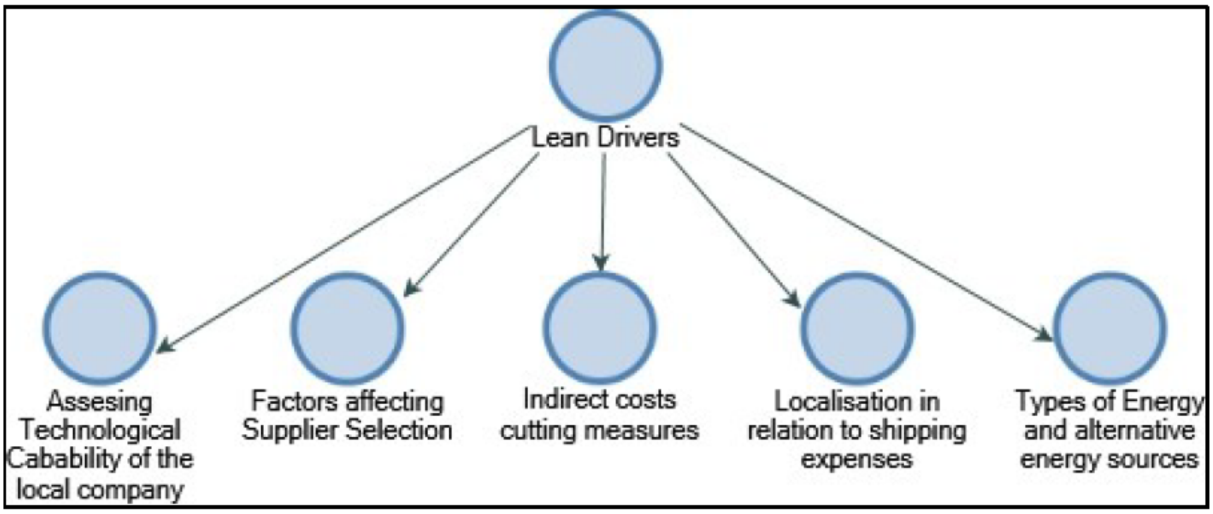


Figure 43: Map virtualization showing the themes of LM drivers

***Source**: Researcher's own construction*

4.4.1 Theme 1: Factors affecting supplier selection

According to Cheraghi et al. (2004) based on the results of an empirical study, the study identified quality, price and delivery as the most critical factors in the supplier selection process. Mwikali and Kavali (2012) concurred with most of the findings and concluded that the major criteria that influence supplier selection are cost (material cost, the cost of purchase, transportation, distribution costs and taxes), technical capability, quality, delivery, lead times, financial status and margins offered, supplier location, risk factor and political stability. This theme aimed to add further dimension to the above discourse by exploring further the factors affecting supplier selection of company XYZ. The thematic data generated from the one-on-one interviews resulted in the identification of five subthemes shown in figure 43.

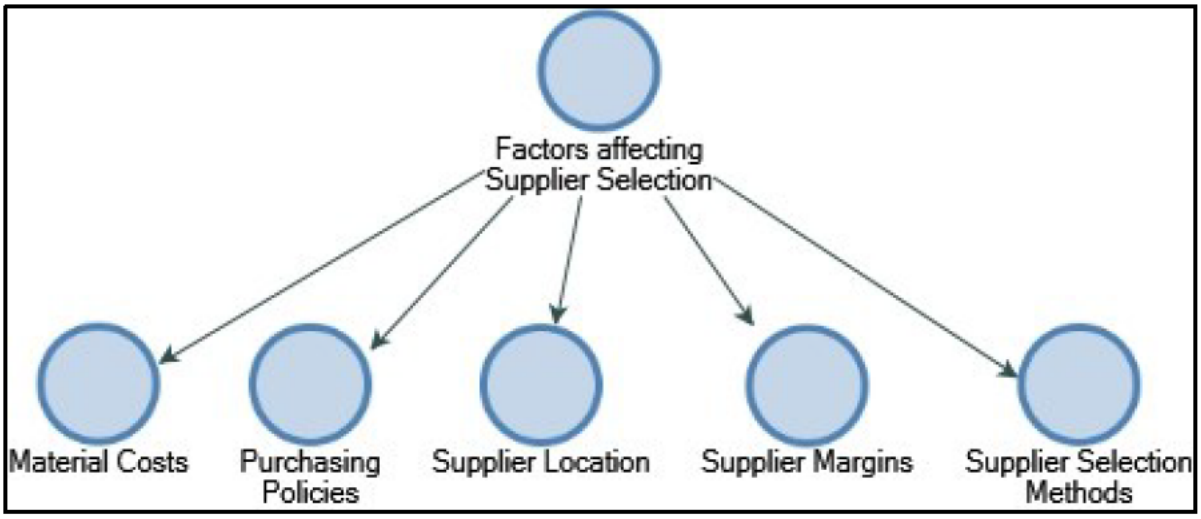


Figure 44: Map virtualization showing the first sub-theme of LM drivers

***Source**: Researcher's own construction*

4.4.1.1 Sub-Theme 1: Material costs

(Stanley and Gregory, 2001) cited in Mwikali and Kavali (2012) cited material cost as the most inevitable cost in the manufacturing industry. Supplier selection is determining from whom and how much the required raw materials, semi-products, and other materials will be bought (Ecer and Kucuk, 2008) cited in Ozturk (2017).

4.4.1.2 Sub-theme 2: Purchasing policies

Wei and Chen (2008) used empirical analysis to show that the explanatory capabilities of variables are very significant in monopoly power organizations inclusive of the manufacturers of steering systems, electro mechanism, and other intricate parts systems, hence original equipment manufacturers have little control. According to Tsao and Tai (2013), for the automotive industry, the material purchasing policy is one of the most important management decisions.

A respondent expressed that the responsibility for crafting the purchasing policy at company XYZ is assigned to the Purchasing department, as detailed in the following excerpt:

Respondent 1

We buy most of our spares through the Purchasing Department. They would prioritize the prices and availability of what we require.

Echoing the sentiments of Respondent 1, Respondents 3 and 4 concurred that the responsibility for the formulation of the Purchasing policy at company XYZ rests with the purchasing department.

Respondent 3

The Purchasing Department will better answer this question.

Respondent 4

Please consult this question with our Purchasing Department. I understand that the cost of the parts being bought, and quality are one of the two major drivers. Purchasing always requests us to evaluate all new Suppliers that they would like to source with. We would carry out a Full Quality Audit. Usually, we would get some findings, and then ask them to fix them within some reasonable time, only then can we approve them as our Supplier who can meet our Quality standards.

Dickson (1996) cited in Cheraghi *et al.* (2004) emphasized that price was not a consistently important factor in the vendor selection process. Similarly, technical capability, production capacity, and warranties while considered by the respondents to be very important for some of the purchases were also deemed unworthy of much consideration in other instances. He finally concluded that three factors were crucial in the choice of vendors: the ability to meet quality standards, the ability to deliver the product on time, and performance history. Respondents 2 and 5 concurred with most of the factors and further introduced some that are peculiar to the South African automotive parts industry by exhaustively providing the factors taken into consideration by company XYZ when formulating the purchasing policy below:

Respondent 2

Customer controlled parts

We are strictly told by the customer where to obtain a certain part, and we do not have a say. For example, for driver airbags, the customer only wants us to obtain from Nippon Japan, we just must deal with Nippon and no one else. For Steering wheel switches the customer wants us to obtain from Panasonic, we do not have any liberty to obtain from our own choice of Suppliers.

Respondent 5

Customer direction

We have specific Safety critical parts where the customer tells us to buy from a particular supplier whether we like it or not, for instance, we can only buy airbag inflators from Nippon in Japan, and other safety products from other direct Suppliers. There are two levels in this type of direction, a Toyota-controlled part and another part that is directed but not so controlled. With the controlled part, Toyota does all the price negotiations and then communicates the approved pricing. With the part that is controlled but directed, the Supplier, us in this case does the price negotiations with the Tier 2 Supplier and they agree.

Respondent 2

Customer technical requirements

We source with Suppliers that have firstly the capability and capacity to produce the part that our customer has specified. At times that can be a major constraint for complex parts as there may be limited suppliers who are capable of making the part. We haven't struggled with capacity issues in South Africa for our types of products.

Respondent 5

Customer requirements

Our customer is specialised, and we cannot just buy from anywhere, the requirements point us to the rightful place to buy from.

Respondent 2

Transit time

Transit time is the total time it takes for a shipment to get from our supplier to our premises. Some Suppliers have very large transit times, and it means we need to know how to handle those if we cannot avoid them completely. They may be a monopoly, or our sourcing may be directed by the customer.

Respondent 2

Complexity of part, material

The complexity of a part determines who can make it and who can’t. Some suppliers will be too slow in making a complex part especially if it’s not their usual core business, but some will make it well and the lead time will be good.

Respondent 2

Compliance and regulations

Some products like airbags are also influenced by the United Nations' Laws of transporting explosives. Airbags have an explosive part called the inflator, and steering wheels use an airbag called the driver airbag, A vehicle has several types of airbags. In our company, we make the Driver airbags, the Passenger airbags, and the Knee airbags which we make for Toyota. This commodity is classified under the regulation of UN 3268 as Class 9 Dangerous Goods.

Respondent 5

Trade regulations

Different commodities or automotive parts are affected by different regulations. For instance, some items are restricted by the South African Government for import, and some will attract a higher import tariff than others, hence when importing this has to be considered. Some items are regulated internationally by the UN, like seat belt retractors and airbag inflators. Their packaging is also regulated.

Respondent 2

Culture and ethics

At times cultural differences may be a hindrance or an advantage. An unethical supplier or country is a no-go area.

Respondent 2

Competitiveness

Maybe this is one of the key expectations of every customer in this competitive global village.

Respondent 5

Cost

This is a very critical factor. The cost of the product has to be in line with our cost targets, otherwise, there's no deal.

The following responses were unique to Respondent 2:

OEM experience

This is very critical. Generally, suppliers with no OEM experience take a lot to manage, however, if they have the capability of making what we want, and all the KPIs are met, we will train them to meet our expectations eventually.

BBBEE compliance

Broad-based black economic empowerment (BBEE) is a government policy to advance economic transformation and enhance the economic participation of black people (African, Coloured, and Indian people who are South African citizens) in the South African economy. Toyota's target is for us to be BBEE level 4, and for us to achieve that, we need to be sourcing with Suppliers that are BBEE level 4 and below. It is also a South African Government requirement.

The following responses were unique to Respondent 5:

Quality

If sourcing from a current supplier, we can easily verify their Quality performance. If it is a new Supplier, we would audit them with the audit criteria being our Quality output results, if they pass the audit, we would then sign them up provided that all the other criteria are met.

Safety

Same as Quality, if sourcing from a current supplier, we can easily verify their Safety performance. If it is a new supplier, we would audit them with the audit criteria being our Safety targets, if they pass the audit, we will then sign them up provided that all the other criteria are met.

Supplier location

The closer the better. We usually consider within a 100km radius from us for non-specialised purchases, however, there are some parts were we just cannot help it but source globally. We would consider closer first, then we go further and further away if we cannot obtain what we want.

Logistics capability/cost

Is the Supplier able to ship to us on time?
Is the Logistics cost acceptable?

Environmental impact

The world is going carbon zero, hence the Suppliers that we source from should show their efforts on this. Also, the closer to us, the better as this reduces the carbon footprint.

4.4.1.3 Sub-theme 3: Supplier location

The respondents in the one-on-one interviews acknowledged that the supply network for company XYZ spans around the world in line with According to (Min, 1993) cited in Cheraghi *et al.* (2004), the globalization of the world economy has resulted in an increase in the number of firms that have shifted their concentration on domestic sourcing to development of supplier bases around the world. Verdier (2021) concurred that buyer-supplier relations can span across the world; however, supplier location influences the relationship with the buyer since locations can be linked to various advantages or lack thereof. Consequently, the respondents also agreed with Ward (2014: para. 4 line1) who supported close proximities of suppliers in the automotive industry by analyzing the advantages thereof. First, there is logistics cost: it is easier and cheaper to ship raw materials or simple components than large complex assemblies. Just how much that matters depends on the size, geometric complexity, and fragility of the component concerned, relative to its value. The higher the first three relative to the last, the more it makes sense to minimize travel distances. As a result, big, bulky, but relatively simple components are obvious candidates for local assembly. The one-on-one responses about supplier location from respondent's responses are listed below:

Respondent 5

Supplier location

Steering wheel Suppliers are located mostly in Europe. We obtain a few components from Asia Thailand to be more specific. There are some clips that we have localized with a Supplier in Port Elizabeth, South Africa. We also obtain the Steering Frame washing chemicals from South Africa. Some parts are also from South America in Brazil.

Respondent 1

Breakdown of procurement by country

Mostly from South Africa and a few from China. I'm not sure of the actual percentage split, maybe 90:10. You can obtain this information from Purchasing.

The information pertaining to the breakdown of procurement by country below was acquired by Respondents 2, 3, 4, and 5 from the purchasing department during the course of the meeting.

Respondents 2, 3, 4 and 5

Romania - 32%, Czechoslovakia – 10%, Brazil – 6%, China – 18%, Thailand – 13%, Japan – 9% and South Africa – 12%

The supplier distribution map of company XYZ in KwaZulu Natal South Africa is depicted in Figure 44.

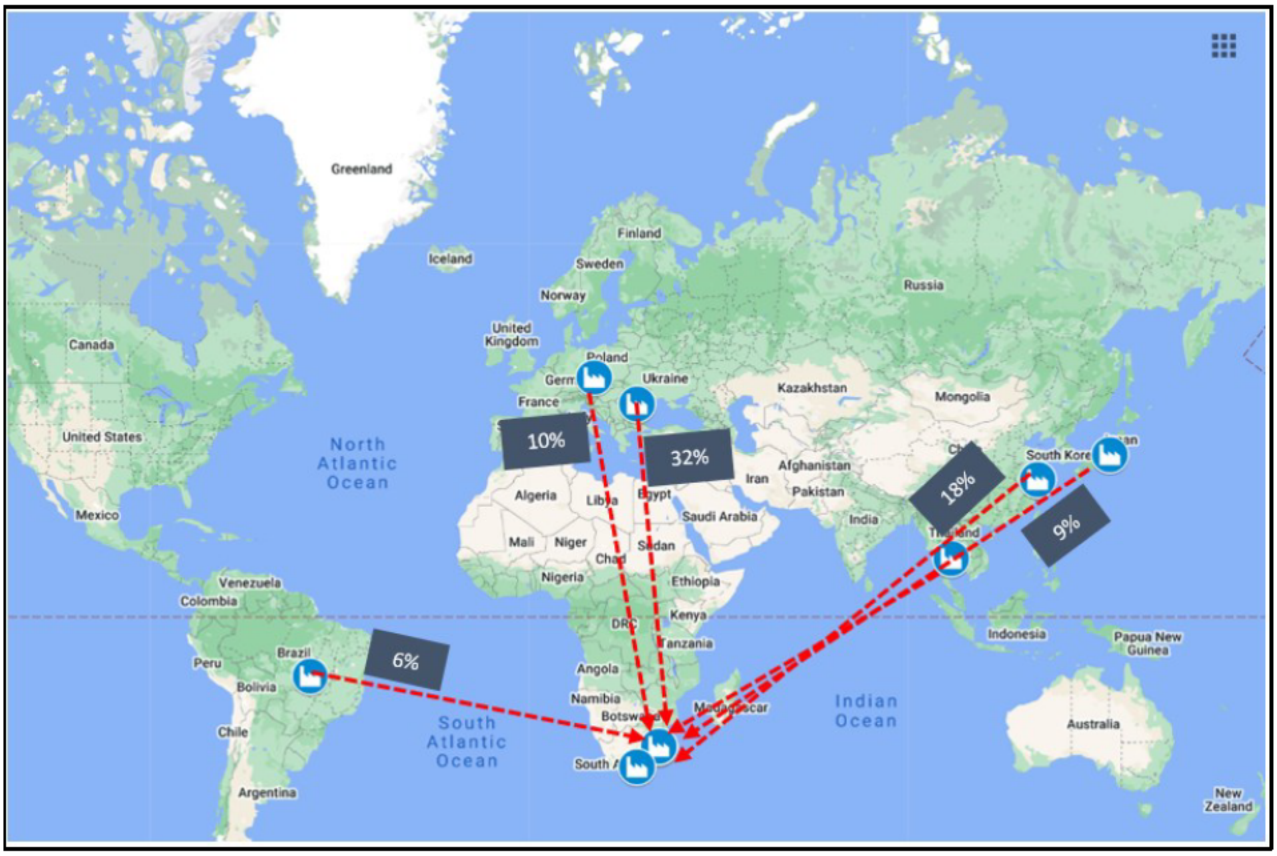
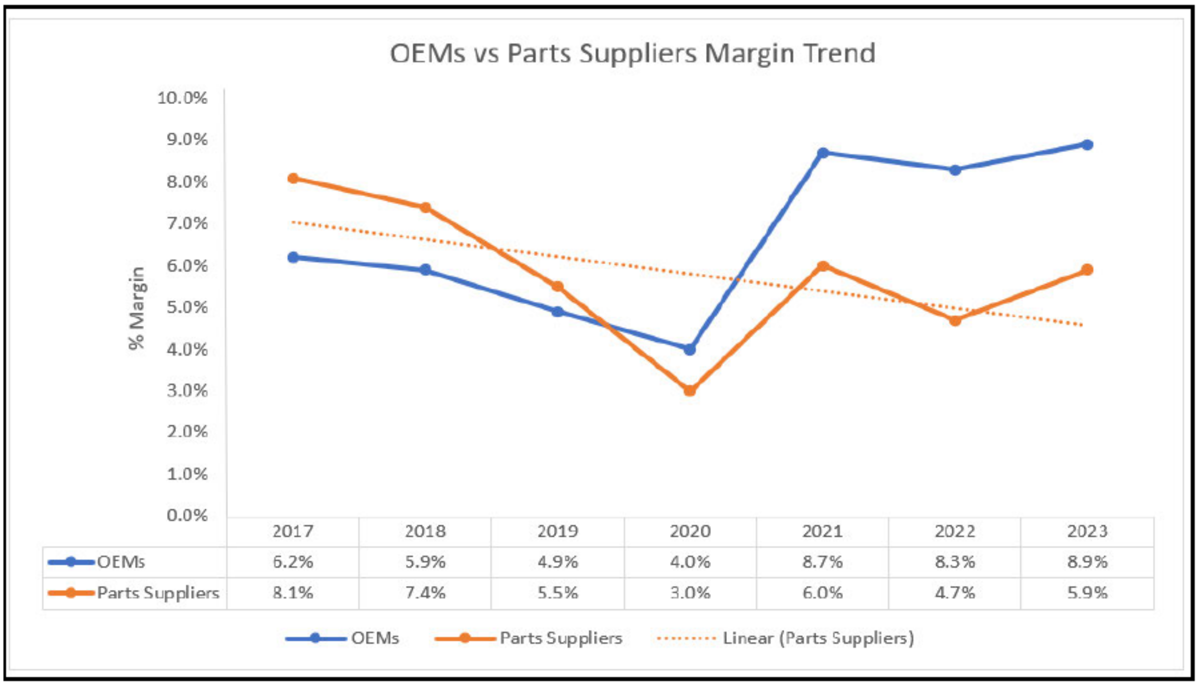


Figure 45: Company XYZ and supplier distribution map

Source: *Researcher's own construction*

4.4.1.4 Sub-theme 4: Supplier margins

According to Zhang (2020: para 4 line1), unit price should not be the only factor in determining supplier selection, but the total cost of ownership should be considered. The total cost of ownership does not only include the unit price of the material but also the labour cost, payment terms, cash discount, logistics cost, maintenance costs, and other more qualitative costs inclusive of the supplier margin. Stricker and Correa (2023: para. 1 line 2) discussed the margin trend for two decades leading up to 2019 and indicated that automotive suppliers' margins were on average one to two percent higher than those of OEMs. Then came massive supply chain disruptions with the COVID-19 pandemic and global chip shortage, plus higher raw material and energy prices, and now rising borrowing costs and wage bills due to inflation. Automotive OEMs were able to ride out the supply shortage by focusing production on the highest-margin models and raising prices, but suppliers had no such strategic options.



	2017	2018	2019	2020	2021	2022	2023
OEMs	6.2%	5.9%	4.9%	4.0%	8.7%	8.3%	8.9%
Parts Suppliers	8.1%	7.4%	5.5%	3.0%	6.0%	4.7%	5.9%

Figure 46: OEM vs parts suppliers margin trend

***Source**: Adapted from Stricker and Correa (2023)*

Consequently, company XYZ must pay careful attention to margin trends to ensure effective management of their margins with customers as well as those of their suppliers. The margin allowed by company XYZ is between 7-10% of the piece price as established in the one-on-one interviews. The responses below reveal that only Respondents 2 and 5 were cognizant of this information.

Respondents 1, 3 and 4 respectively

I'm not sure, please verify with Purchasing.

I'm not sure, please confirm with Purchasing.

Please consult with Purchasing or Finance for this one.

Respondents 2 and 5 respectively

Yes, 7-10% profit margin.

Yes, 7-10% profit margin. We have the same margin with Toyota

Most of our suppliers conform. We allow 7 profit margins with our suppliers. Not all of them declare a detailed cost for us to see the margin calculation though unfortunately. A few suppliers do conform, especially the smaller suppliers. Bigger *suppliers have an attitude of take it or leave it. If we had bigger volumes, we would negotiate better and have more power.*

4.4.1.5 Sub-theme 4: Supplier selection methods

Suraraksa and Shin (2019) conducted an empirical study to ascertain the criteria for selecting automobile part suppliers. The study consisted of 14 experts from eight OMEs in Thailand. The experts worked as senior managers, managers, and specialists in the purchasing, production, supply chain, and manufacturing departments. They had a five-year or longer experience working in the selection of and monitoring their suppliers. The results of the study were tabulated in Table 21 showing the weights in terms of the importance of the criteria for supplier selection and then plotted on a Pareto chart shown in Figure 46.

Table 23: Important criteria for supplier selection

Dimension	**Important Criteria**	**Global Weight**	**Cumulative %**	**Rank**
Cost	Product cost	0.1324	13.24%	1
Quality	Quality level	0.1121	24.45%	2
Quality	Certification and QMS	0.0961	34.06%	3
Cost	Logistics	0.0516	39.22%	4
Quality	Investment in quality improvements	0.0486	44.08%	5
Capacity	Flexibility in production	0.0461	48.69%	6
Cost	Reliability in delivery service	0.0455	53.24%	7
Quality	ISO 9001 implementation	0.0431	57.55%	8
Cost	Ordering cost	0.0419	61.74%	9
Service	Speed and timeliness of communication	0.0399	65.73%	10
Capacity	Manufacturing capability	0.0385	69.58%	11
Service	Warranty	0.0362	73.20%	12
Capacity	Capability enhancement	0.0280	76.00%	13
Capacity	Technological capability	0.0221	78.21%	14
Finance	Financial stability	0.0201	80.22%	15

Source*: Adapted from Suraraksa and Shin (2019)*

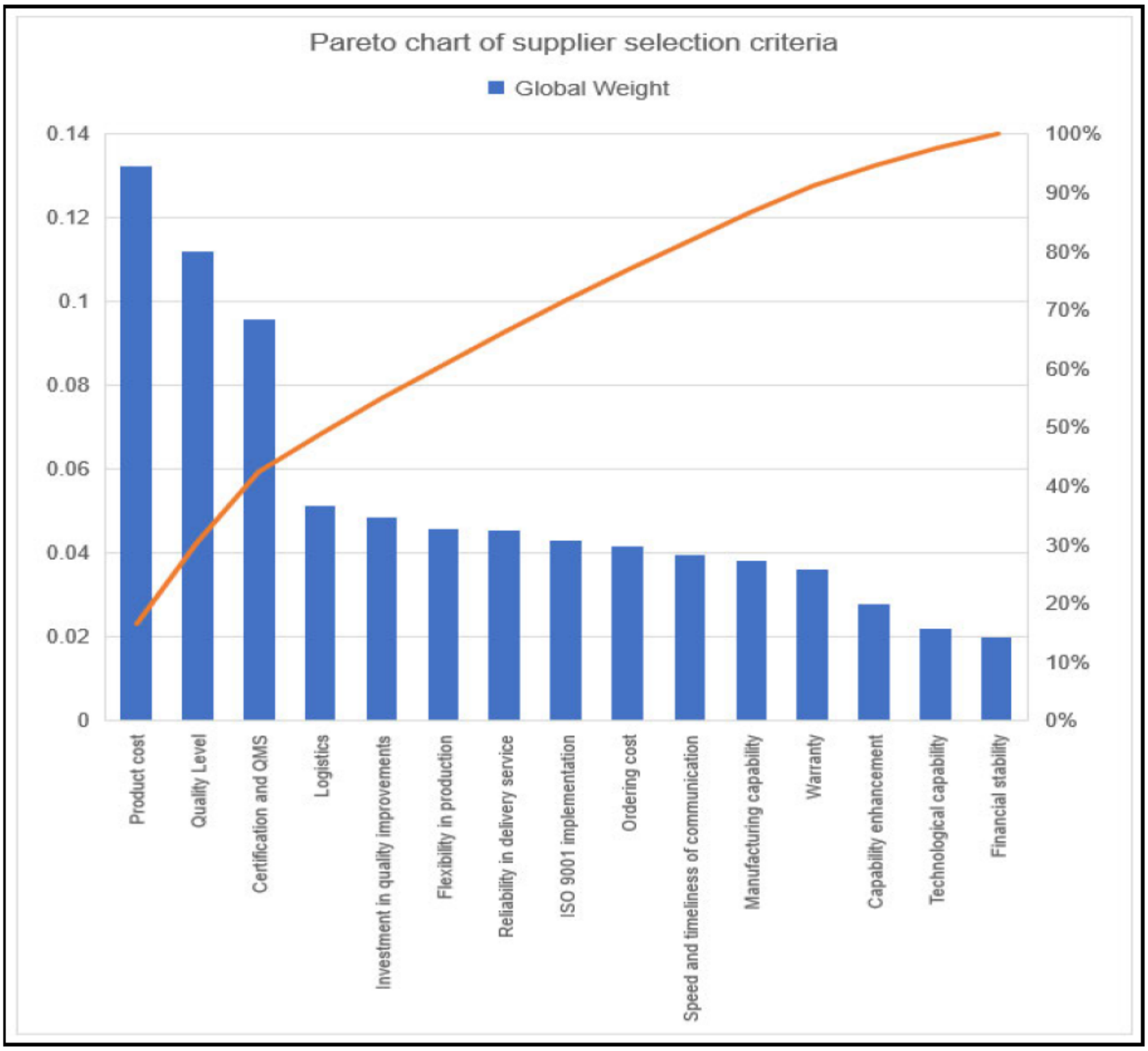


Figure 47: Pareto Chart of supplier selection criteria

Source: *Adapted from Suraraksa and Shin (2019)*

In line with Suraraksa and Shin (2019), Zainal *et al*. (2016) conducted an empirical analysis of infotainment parts in the automotive parts industry and deduced that when selecting a supplier, the buyer should consider 3 factors namely, exceptional product quality, agile delivery performance and fair price.

The one-on-one responses from the respondents, 1,2,3,4 and 5 predominantly yielded similar results as shown below:

Respondents 1 and 4 respectively referred this question to the Purchasing department.

Respondent 1

We usually would look around for something that we want, if we find it, we pass the information about the Supplier to the Purchasing Department, who will then look for two more quotations if they would like to compare the pricing. They will then advise us that they obtained a similar part from a cheaper supplier and then they would raise a Purchase order to the selected Supplier.

Respondent 4

The Purchasing Department will better answer this question.

Respondent 2 proposed the inclusion of payment terms as a supplementary criterion, building upon the aspects previously identified by other researchers.

Respondent 2

We follow the guidance of the following criteria:

Capability

The Supplier should be able to make our request.

Capacity

There should be a detailed capacity study to show that all our requests will be produced without any difficulty.

Price

Usually, we also run a competitive bid, and the selected Supplier should satisfy our cost targets.

Payment Terms

Our customer pays us 30 days from the statement date; hence we also extend the same stance to suppliers. Some especially the smaller suppliers may want to be paid immediately after delivery or weekly, which may not be feasible.

Financial Stability

We have an obligation to supply Toyota, and if our supplier is Financially unstable, this poses a huge supply risk to us and hence to Toyota, so we would not like that type of a Supplier.

Respondent 3

We carry out capacity and capability studies in line with our supplier needs. For a new supplier, we adopted the Toyota NSER process – New Supplier Evaluation Request.

Respondent 5

We carry out capacity and capability studies in line with our supplier needs. For a new supplier, we adopted the Toyota NSER process – New Supplier Evaluation Request.

4.4.2 Theme 2: Assessing technological capability of the local company

This theme resonates with the perspectives of many literature reviewers who have investigated the interplay between South African technology and the Fourth Industrial Revolution (4IR) in the context of developed countries.

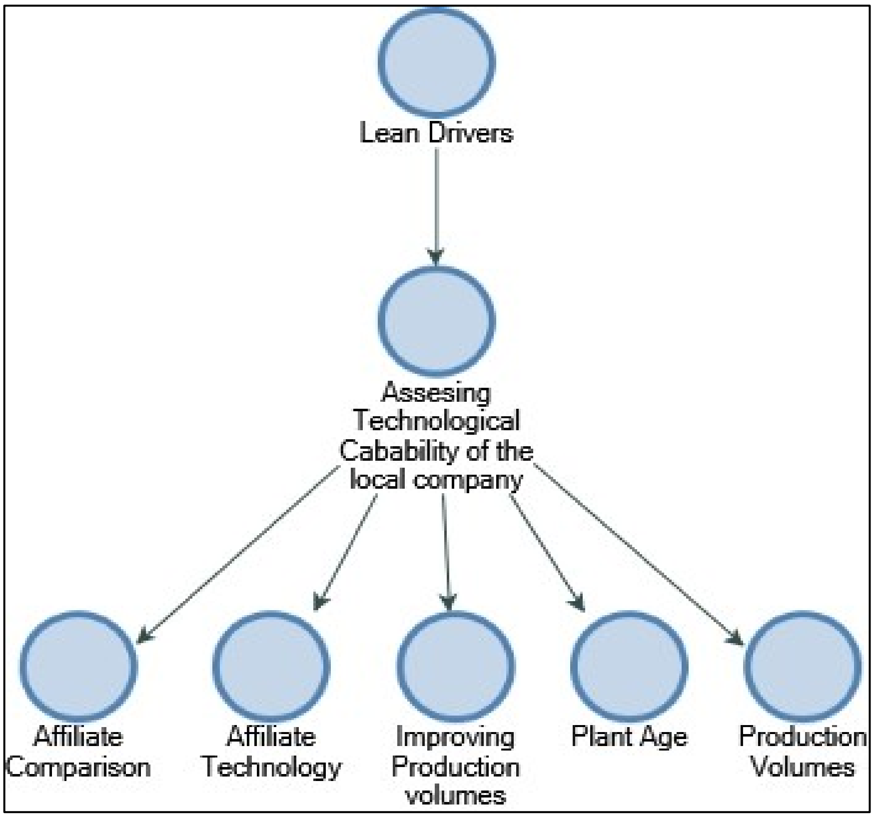


Figure 48: Map virtualization showing the assessing technological capability of the local company
***Source**: Reseacher's own construction*

4.4.2.1 Sub-theme 1: Affiliate comparison

The one-on-one interview revealed that in terms of the volume comparison of the overseas affiliates, company XYZ has the least volume allocation in line with the assertion of Naude and Badenhorst-Weiss (2011) that the South African automotive industry is not competitive due to its low percentage (an average of 35%) of local content in the final product (30% to 40% more expensive manufacturing than China and India), and hence the lowest production volumes in comparison.

Respondent 1

I understand we are the least in terms of Production volumes, I'm not too sure by how much. Please verify that with the Managing Director.

Respondent 2

The South African market is much smaller than all the affiliates. I will give our percentage contribution to the group by commodity:
Steering wheel - 2.2%, Airbags - 0,98%, Seat Belts - 1,27%

Respondent 3

The South African market is much smaller than the European Market

Respondent 4

Based on the reports from our last Management Meeting, my understanding is that we are less than 5% of the Global volume contribution in our Global company. I am not sure of the affiliate split.

Respondent 5

Information extracted from the 2022 End of Financial year Report shared by the MD is as follows:
Steering wheel – 2.2%, Airbags - 0,98%, Seat Belts = 1,27%

4.4.2.2 Sub-theme 2: Affiliate technology

This theme was designed to explore the extent to which differences in technology among the affiliates influenced the disparities noted during the benchmarking process.

The majority of respondents indicated that South African technology lags behind that of its European counterparts.

Respondent 1

South Africa is backward, I've been to China and Thailand plants. Most of their processes are robotic. They use the latest technology and software.

Respondent 2

Plants are more automated in Europe and all the other affiliates.
That is why they have lower process costs. The tasks that are done by people in South Africa are done by robots elsewhere.

Respondent 3

How different is the Technology to that of the affiliates?
We are a manual operated plant, right from the wash bay, the loading into the PVC injection, the stitching process and the airbag and switches processes, there is a high level of human operations.

Respondent 4

From our plant's perspective, we have not advanced that much when it comes to the new Manufacturing technology, for instance, we even delayed sending quotations for the Toyota Cross model because we did not have the systems to support the Toyota New Generation Architecture (TNGA) that was a pre-requisite for their project, we still need a lot of improvements.

Respondent 5

Our SA Plant is very manually based as compared to the rest of our affiliates; hence our process times are longer, and our process costs are very high.

4.4.2.3 Sub-theme 3: Improving production volumes

This subtheme is consistent with the literature review in section 2.3.1, where the growth of market share is recognized as one of the principal key drivers of LM. The market share increase is directly proportional to the increase in production volumes.

All the respondents in the one-on-one interviews agreed that company XYZ's volumes were far below their affiliates, and one of the ways to improve them is by penetrating the South African OEM market. Exhibits of the interview responses concur with the literature review below from two of the respondents.

Respondent 1

*My understanding is that our total production is less than 5% in the global contributio*n.

Respondent 5

We are currently in quotation stages with other local OEMs for their projects and we hope to increase production volumes as we incorporate them in. Toyota seems to be increasing their volumes already, this is an advantage to us.

4.4.2.4 Sub-theme 4: Plant age

This sub-theme is in line with the literature review section 2.3.1 by Logu *et al*. (2021) items 1 and 3, where the drivers of LM were listed as investments in plant and equipment. Consequently, Shah and Ward (2003) in section 2.3.1 of the literature review empirically deduced that the older plants would implement LM than the newer plants. In this study, all the respondents evinced that plant XYZ is very old, and its age has consequences on productivity and maintenance costs.

Respondent 2

We first came here and did our initial installations in 2012 and we started Production in 2013. We came with almost all our machinery from Cape Town, we only replaced a few. Besides, most of our machinery is always donated to us by our affiliates when they scrap it, it usually is usable. We take it and refurbish it.

Respondent 5

Yes, given that we use what some other plants have scrapped. Unfortunately, some spares are no longer available, it takes us a long to make plan B, and it's usually costly.

4.4.3 Theme 3: Indirect cost-cutting measures

According to Norfleet (2007), the United States of America Federal Acquisitions Regulations (FAR) defined direct costs as any cost that can be identified specifically with a particular final cost objective, such as a contract, project, or job. In contrast, the FAR also defined indirect costs as any cost not directly identified with a single, final cost objective, but rather identified with two or more final cost objectives or an intermediate cost objective. According to Anand (2022: para. 16 line 1) expenses that cannot be traced back to a specific cost item are considered indirect costs. They comprise the costs related to running the company, beyond those expenses incurred to manufacture a product. While many of the typical indirect costs are common amongst companies, each company is also unique, and indirect costs for a particular company are dependent upon its business structure, therefore, in line with Norfleet (2007), the unique indirect costs identified from the one-on-one interview themes included the following:

- Maintenance-related expenses
- Water expenses
- Electricity expenses
- Depreciation of plant and machinery

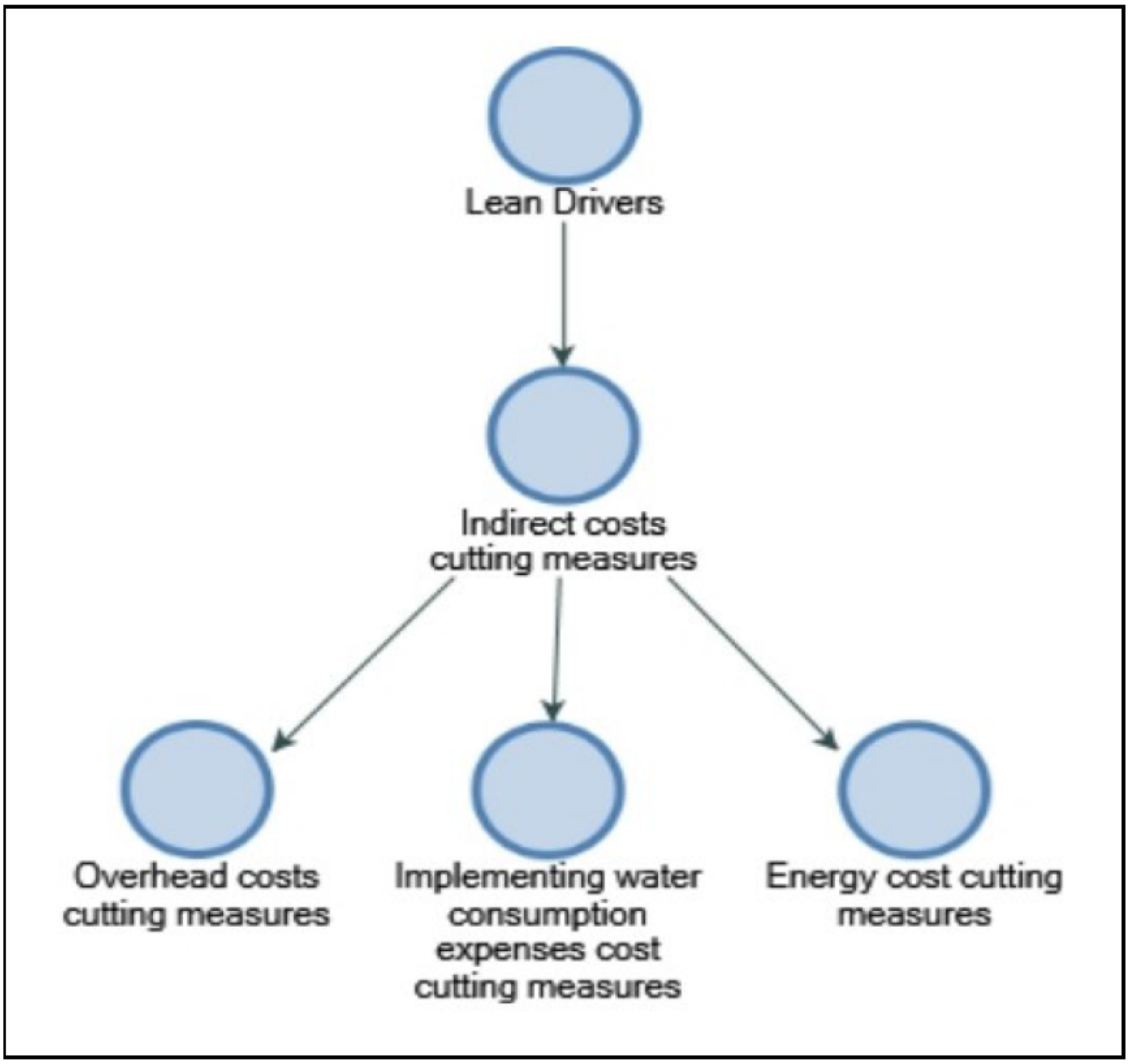


Figure 49: Map virtualisation of indirect costs sub-theme and the emanating sub-sub-themes

Source: *Reseacher's own construction*

4.4.3.1 Sub-theme 1: Energy cost-cutting measures

This sub-sub theme asserts the literature review finding in section 2.3.1 by Niemann *et al*. (2018) item 2. This sub-sub theme identified electrical energy as the only type of energy used by company XYZ. According to Varzaneh (2017), electricity consumption in the production line can be divided into different states including start-up and idle, working and energy consumption is a function of both time and state. Krones and Muller (2014) emphasized that there is a research need to develop an approach for the systematic identification of energy efficiency measures without the high efforts of acquiring energy consumption data. The responses that emanated from the one-on-one interviews with company XYZ however did not show any systematic identification of energy efficiency measures, even though energy cost reduction efforts were identified and listed. The exhibits listed below from most of the respondents indicate similar cost reduction efforts in line with the company's Maintenance department's responses.

Respondent 2

The following are options that we have adopted so far:

1. *Using natural airflow – to prevent power usage from using air-cons and fans.*
2. *Replace existing lights with LED – not yet complete but this is a work in progress, we have completed almost 40% of our plant and offices.*
3. *Using natural lighting – by increasing clear roofing as much as possible, we have done most of the stores area.*
4. *Improve insulation – especially in areas where heating is required.*
5. *Turn off equipment that is not in use.*

4.4.3.2 Sub-theme 2: Overhead cost-cutting measures

According to Norfleet (2007), overhead is synonymous with indirect costs in that it cannot be assigned to a specific contract without some method of allocation. Conceivably, there can be an all-inclusive overhead designed to include all indirect costs into a single expense pool. The respondent's understanding of the inputs of the overhead costs were all similar and is summarized by one of the responses below which categorically listed the overhead costs into fixed and variable overheads:

Respondent 1

Fixed overhead costs will comprise of:

Salaries, wages, rentals, taxes, assets depreciation and Licence fees.

Variable overhead costs consists of:

Utilities (Electricity and water), Maintenance costs, Cleaning supplies.

Labour costs always goes up and down depending on customer requirements.

Office Supplies and stationery.

4.4.3.3 Sub-theme 3: Implementing water consumption expenses cost-cutting measures

Hundertmark *et al.* (2020) noted that the water issue is the reverse of the carbon problem; the cause is global, but its manifestation is highly spatial and can be addressed in a concentrated way, and identified the following strategies to reduce water consumption by Manufacturing plants:

1. Implementation of water measurement and reporting practices, including water consumption as a company's key performance indicator (KPI).
2. Identify and eliminate water leaks.
3. Introduce new technologies that reduce water stress.
4. Using their influence to ensure that all their tiered suppliers are equally rigorous about their contributions to water stress.

With the advent of automation in line with 4IR, there has been an increase in interest in the use of smart water metering to plan and manage water (Sachidananda *et al.* 2016: 4). This implies that real-time monitoring and logging of water with the help of automated meter reading (AMR) technologies make use of a water data logger and transfer system to remotely transfer the data via internet, mobile, or radio. The data is analysed and the results regarding leak detection and water-saving potential are communicated back. Whilst it could not be proved in this study that there was an interest in adopting real-time water consumption monitoring, there was a concurrence of the literature reviewed as exhibited by the one-on-one interview responses. It was noted that some of the respondents preferred that this question be responded to by the Maintenance department. However, there was a consensus among the two respondents that contributed as follows:

Respondent 3

We are currently doing the following activities:

(1)Jojo tanks to capture rainwater that we use in the toilets and for our plants and garden's watering purposes. (2) Recycling water from the sinks and basins for garden use. (3) We have installed high-pressure and low-volume nozzles in our steering wheel washing bay and this has proved to be very effective. (4) Attend to all leakages on time. (5) Using urinal blocks instead of water in male ablutions.

Another respondent articulated the following measures taken by Company XYZ:

Respondent 4

Firstly, we began to measure our water usage monthly and we aim to reduce usage month on month, quarter on quarter, and year on year. The following are the activities:

(1) Eliminating all water leakages timeously. (2) Recycling water that is not oily and using it to water the plants. (3) Reducing the water pressure in toilet washing basins.

4.4.4 Theme 4: Localisation in relation to shipping expenses

This theme supports the data in Table 1 section 1.2 which depicts the level of localization of various processes by different steering wheel manufacturers in South Africa as it discusses the most prevalent items that affect steering wheel costing. Consequently, the cost increase associated with importing is also exhibited in the problem statement section 1.7 where the OEMs resort to cheaper imported steering wheels. The thematic data generated from the one-on-one interviews on this theme resulted in the identification of six sub-themes shown in Figure 49.

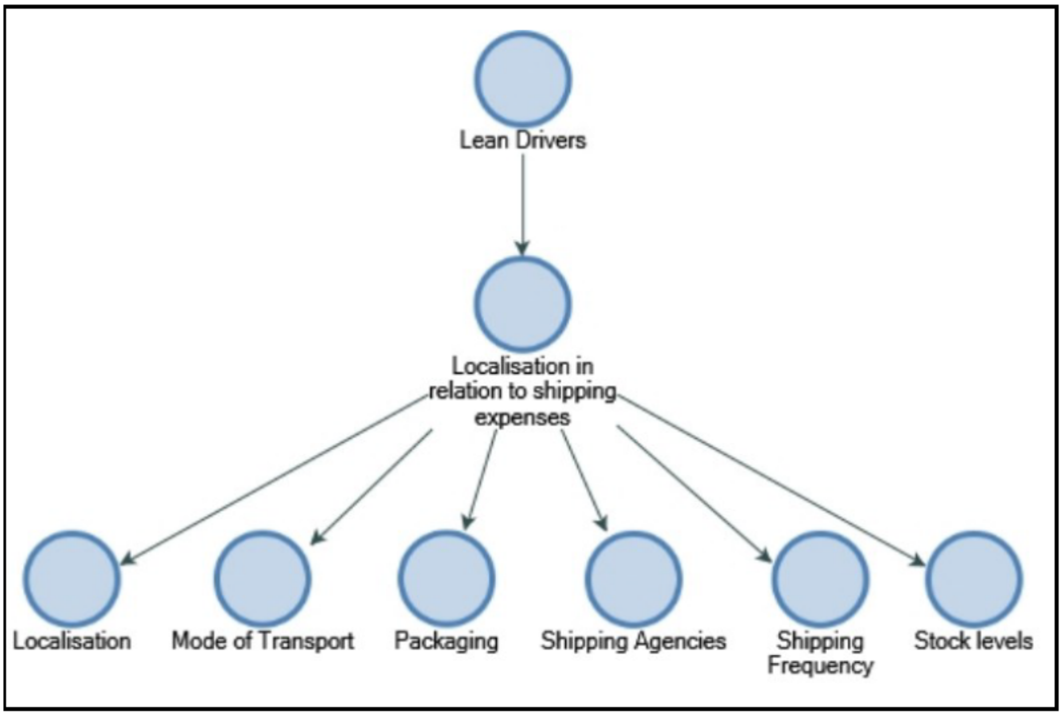


Figure 50: Map virtualization of localization in relation to shipping expenses theme

Source: *Reseacher's own construction*

4.4.4.1 Sub-theme 1: Localization

According to Kelly and Griesel (2021 para. 1 line 1), localization is the process whereby an increased percentage of the parts and costs of a motor vehicle is either assembled or manufactured in South Africa rather than imported and represents a significant opportunity to transform the automotive sector - while facilitating the entry of BEE participants in the automotive supply chain. According to Barnes *et al.* (2018), a highly contested issue in the development of the automotive sector both in South Africa and other developing countries has been the level of local content in domestically assembled vehicles. The government has been keen to promote greater depth of supply chain development by securing investment in first and second-tier suppliers and this was one of the stated objectives of the Automotive Production and Development Programme (APDP) which replaced the Master Information Delivery Plan (MIDP) in 2013. Based on information from NAACAM, Bulbulia (2023: para. 10 line 1) compared the South African localization level stated at 38% to the Thailand, Turkey, and Mexico localization levels stated to be at least 60% respectively and averred that the South African localization target is a minimum local content of 60%.

The respondents interviewed in the one-on-one interviews accentuated the significance of localisation as they predominantly stated some of the steering wheel components are imported and they believed could be obtained from South Africa instead. Some sample respondent responses are as below:

Respondent 3

1. *Leather - we have tried to obtain local leather, but the quality is not very good. We have however not exhausted the whole of South Africa though.*
2. *Leather Sewing thread - we have submitted a localization proposal to the customer and still awaiting feedback to source locally.*
3. *Airbag cushion – we are currently working with Toyota Localization to localize the cushion with GST.*
4. *The steering frame is currently from Czechoslovakia. South Africa cannot cast Magnesium alloy frames, however, if these frames are changed to Aluminium alloys, which I understand is the direction, this could be cast locally without any challenge.*

Sharing analogous perspectives while also emphasizing value engineering, another respondent suggested a kaizen initiative for the steering wheel frame and agreed with the other respondents on the additional topics.

Respondent 5

1. *We are looking at options for changing steering wheel frames from Magnesium to Aluminium. Magnesium is imported but Aluminium can be obtained locally.*
2. *Some chemicals for cleaning parts before the PVC process can be changed to local.*
3. *The PVC mixing chemicals – we are investigating on local equivalent.*
4. *South Africa has a lot of leather, we are exploring high-quality leather that can be used instead of expensive imported leather.*
5. *Screws and hardware can be localized.*
6. *Press parts can be localized.*

4.4.4.2 Sub-theme 2: Mode of transport

Automobiles constitute high-priced, custom-built consumer goods. Customers expect a high delivery service quality when buying a new car (Klug 2018) cited in Zlotnik *et al.* (2021). According to Kargudri and Malik (2019: para. 3 line 1), the rise of globalization over the last century coupled with a shift in the automotive industry dominance from the West to the East has resulted in increased logistics and long-stretched supply chains across the automotive industry. Globalization is a key factor in the overall strategy of automotive suppliers and has generated two kinds of suppliers in the automotive industry, namely global and local (Ambe and Badenhorst 2011). It is therefore deducible that the main modes of transportation on the global scale would be sea freight and air freight whilst the modes of transportation on the local scale can be seaport to port, air, road, and rail transportation. The respondents of the one-on-one interviews revealed that XYZ utilizes two of the four aforementioned modes of transportation from global destinations as illustrated below:

Respondent 1

1. *Import raw material by sea.*
2. *We only use air if there is for urgent purposes, for example if the customer increases orders abruptly and we want to replenish our stocks or if the shipment is stuck at the harbour or customs for whatever reason, or due to effects of natural disasters.*

According to the exhibit, the respondent's commentary underscores that the typical transportation plans of company XYZ have encountered challenges due to pandemics and natural disasters in prior instances.

Respondent 4

1. *Sea, we only air freight in emergencies.*
2. *Those emergency cases are usually a result of unforeseen circumstances like covid 19, wars, floods, earthquakes, harbour issues, etc.*

All the respondents revealed that company XYZ uses road transportation from the port to the Warehouse and or to the plant. Please refer to one of the responses below:

Respondent 2

1. *By Road from the Durban Harbour to our plant.*
2. *We also get to pick up our spares from our suppliers around the city.*

4.4.4.3 Sub-theme 3: Packaging

The efficiency and effectiveness of moving goods in the supply chain depend on packaging among other things (Szymonik, 2016) cited in Huynh (2019). According to Kouchek and Stojanoska (2017), automobile assembly requires numerous components and materials, which in turn require varied types of packaging to avoid damage and defects and for optimal economic transportation. Most of the respondents did not seem to have a lot of information about packaging efficiency as they parenthetically expressed that packaging studies are being carried out with Toyota South Africa Motors as illustrated by the exhibit below:

Respondent 1

Yes, improvements are being made such as packaging size optimization and volume optimization. We are working with the Toyota Packaging department on this regard.

A few respondents however made an inference to adopting returnable packaging. However, Silva *et al.* (2013) emphasized that when adopting returnable packaging, there is a need to consider the advantages and disadvantages of doing so. Mckerrow (1996), Twede and Clark (2004) cited in Kouchek and Stojanoska (2017) concluded that when adopting the returnable strategy, the benefits tend to exceed the disadvantages. According to Kouchek and Stojanoska (2017), the importance of returnable packaging has become crucial in the automotive industry as it is consistently facing cost reduction pressure to handle competition and lower profit margins, and the interplant shipments have further given incentives for returnable packaging for shipping parts for continuous automobile assembly. Below are two sample responses about returnable packaging from one of the respondents:

Respondent 1

Yes, some packaging ideas have been raised, for example:

Firstly, on dunnage – increasing the number of parts that we pack on any particular dunnage. Dunnage is supplied by the customer, but they are so few, and they cause a big bottleneck in our system.

Import packaging – We have proposed not to destroy Import packaging but to recycle it and reuse it. We are busy communicating this with our affected Suppliers.

Airbag packaging is very expensive, if we get to reuse international packaging, we would have overcome a big expense, at present, we use it once and destroy it.

4.4.4.4 Sub-theme 4: Shipping agencies

According to Mathuva (2018), shipping agencies are involved in activities that facilitate international seaborne trade. These activities include receiving, shipments from exporters, loading of cargo at the port of loading, planning sea passage of the ships, offloading cargo at the discharge ports, and facilitating the release and delivery of the cargo to the cargo owners or consignees. Alicke and Losch (2010) alluded to the fact that up to half the cost of many supply chains lurks ignored and unmanaged in outbound logistics and behind the closed doors of distribution centres. Much of that cost can be eliminated by applying lean manufacturing techniques. The literature review of the Shipping agencies that operate in South Africa revealed many agencies, however, it could not be ascertained that any of them have adopted any Lean Manufacturing Techniques in their business. The one-on-one interviews revealed that only two agents (Hellman and Morgan) are utilised by company XYZ, however, it was not ascertained why the company cinched contracts with the two agents. One of the responses from a respondent who attested to this is as below:

Respondent 1
We use Morgan and Hellman Cargo.

Furthermore, it became apparent that several respondents did not have information about the shipping agencies associated with the company, resulting in their referral of the matter to the Purchasing and Finance Departments, as shown in the following response:

Respondent 4
Please consult with Purchasing or Finance for this one.

Markelov (2021: para. 3 line 1) highlighted ten key criteria to consider when selecting a shipping agent as listed below:

1. Cost savings
2. Multi-carrier options
3. Dedicated support
4. Intuitive shipping solutions
5. Ability to scale with the customer’s business.
6. Shipment tracking
7. eCommerce integration
8. Industry experience
9. Ensure the service matches the customer's needs
10. A shipping partner the customer can trust.

4.4.4.5 Sub-theme 5: Shipping frequency

According to Vaz *et al.* (2008), studies on order patterns have evolved around considering shorter lead times, which constituting a major source of competitive advantage. In another study, order frequency was defined as measuring of the number of times a customer placed an order in each period, but the study did not relate to inventory days held. Order frequency is therefore a function of shipping frequency. Riza *et al*. (2018) outlined the use of the Economic order quantity in determining the order frequency and the shipping frequency, where Economic Order Quantity (EOQ) is the number of orders that minimize the total cost of containment and booking fees and EOQ according to Riza *et al.* (2018) is the oldest classical production scheduling method. Andelkovic (2017) explained two inventory management strategies that impact shipping frequencies, which are Just in Time (JIT) and Just In Sequence (JIS) using the schematic diagram in Figure 50.

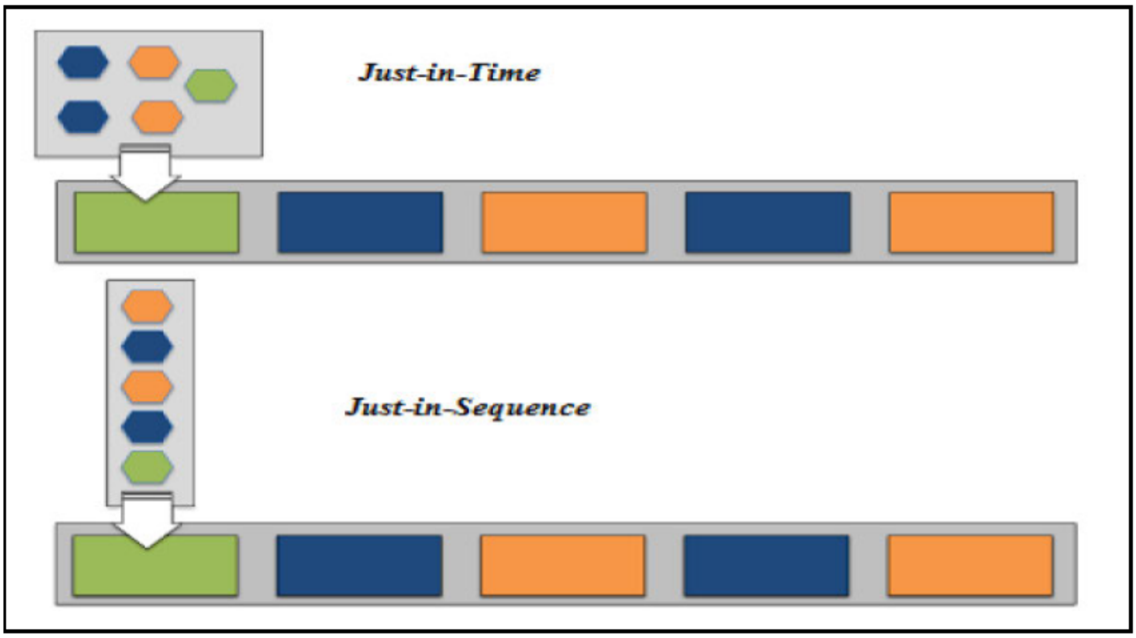


Figure 51: Schematic diagram of JIT and JIS

Source: *Adapted from Andelkovic (2018: 86)*

According to Xu (2021), JIT ensures that inventory arrives as it's needed to meet consumer demand, therefore, there is no need to prepare storage place. Since JIT revolves around delivering quality at the best possible prices, it relies on establishing long-term contracts with reputable suppliers. Unlike JIT, with JIS, line operators follow a simple sequence to assemble various parts. They don’t have to make decisions about what part they next need to attach to the main component, they know they just have to take the next component in the sequence and assemble it. Lemay (2022: para. 11 line 1). During the one-on-one interviews, some respondents generalized the shipping frequency to be between monthly and three monthly as per two of the responses exhibits below:

Respondent 1

Monthly at most

Respondent 2

Monthly and 3monthly by sea.

Consequently, some respondents highlighted that the differences in shipping frequencies are linked to the type of part being sourced from overseas, as shown in the exhibit responses that follow.

Respondent 3

Shipment varies from part to part. There are some parts that we order monthly, some quarterly, and some annually – like very small clips, etc.

Respondent 3

We usually have stock of our Preventative Maintenance Oils that we get from China. Shipment should be about once in six months. The local spares we usually do not stock much, we stock a month’s stock on maximum.

Whilst it could be conjectured that the philosophy that is driving company XYZ inventory Management and shipping frequency is based on JIT due to Toyota's history and records, it could not be ascertained from the one-on-one interviews.

4.4.4.6 Sub-theme 6: Stock levels

This subtheme is in line with the literature review section 2.3.1 key drivers suggested by Ambe (2017) item 2, Demeter and Matyusz (2011). The one-on-one interviews revealed that company XYZ probably follows the EOQ model and has a minimum order Quantity (MOQ) in place. The responses reveal that different parts have different minimum stock levels required. An exhibit of two of the responses is below:

Respondent 2

About a maximum of 90 days of Production parts stock. These can vary for different items. From a quality point of view, we recommend minimum stock as possible to be stored here. We check manufacturing and expiry dates of things that can expire like chemicals etc. Some materials also tend to degenerate with time.

Respondent 5

A month for Maintenance spares

4.5 One-on-one interview lean barriers themes and sub-themes

Lean Barriers is in accord with objective 3 (O3) and aligned to research question 3 (RQ3): as stated in section 4.4. This theme also aligns with the literature review. The thematic data generated from the one-on-one interviews resulted in the identification of two themes and 8 sub-themes shown in Table Figure 24.

Table 24: One-on-one interview lean barriers theme and sub-themes

Theme	Sub Theme
Staff	Skill
	Staff Turnover
	Union affiliation
	Training and Learning
Customer	Customer Involvement
	Customer Profitability
	Lean Information

Source: *Researcher's own construction*

The thematic data generated from the one-on-one interviews on these themes resulted in the identification of sub-themes shown in Figure 51 below:

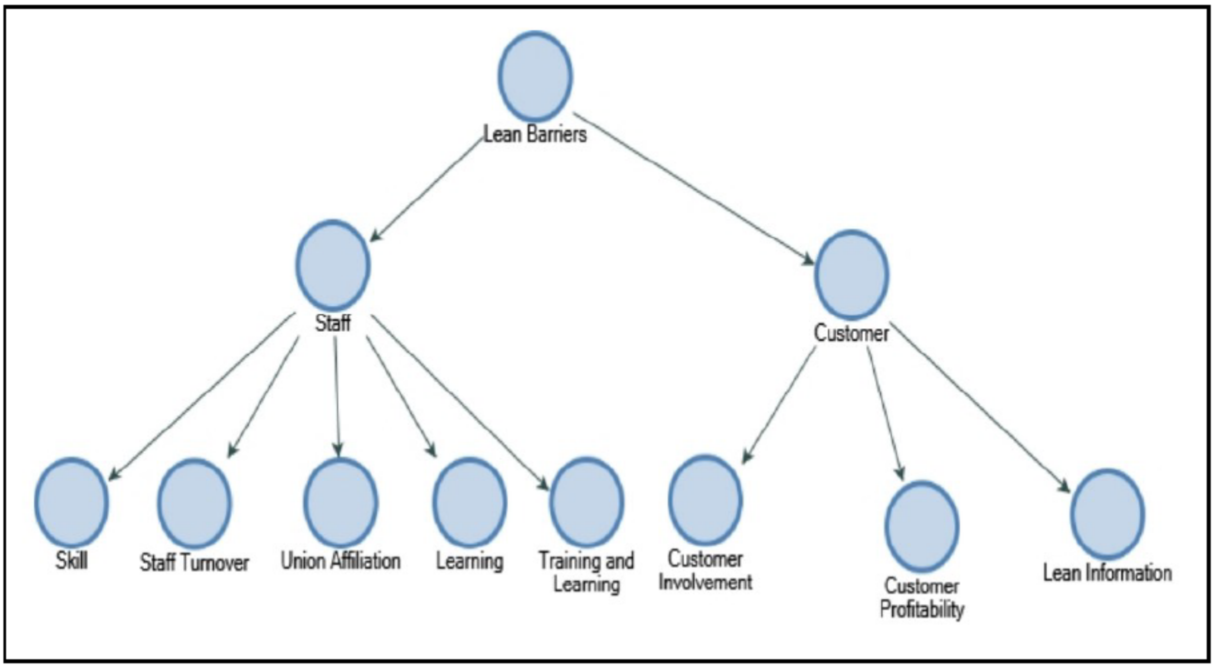


Figure 52: Map virtualization showing the theme, sub-themes, and sub-sub themes of barriers of LM

Source: *Researcher's own construction*

4.5.1 Theme 1: Staff

This theme is in accord with the literature review in section 2.3.4 by Abu *et al.* (2021), Moradlou and Perera (2017), Maware and Parsley (2022),Gaikwad *et al.* (2020), Jadhav *et al.* (2014) and Leeson (2023: para 4 line 1) in emphasizing that staff training is of paramount importance in fostering the necessary skills and competencies among employees. Furthermore, the theme draws from the literature review that effective staff management hinges on understanding the myriad factors that contribute to employee development, emphasizing the need for continuous training and professional growth opportunities. The subthemes that emanated from the thematic study under this theme are shown in Figure 52.

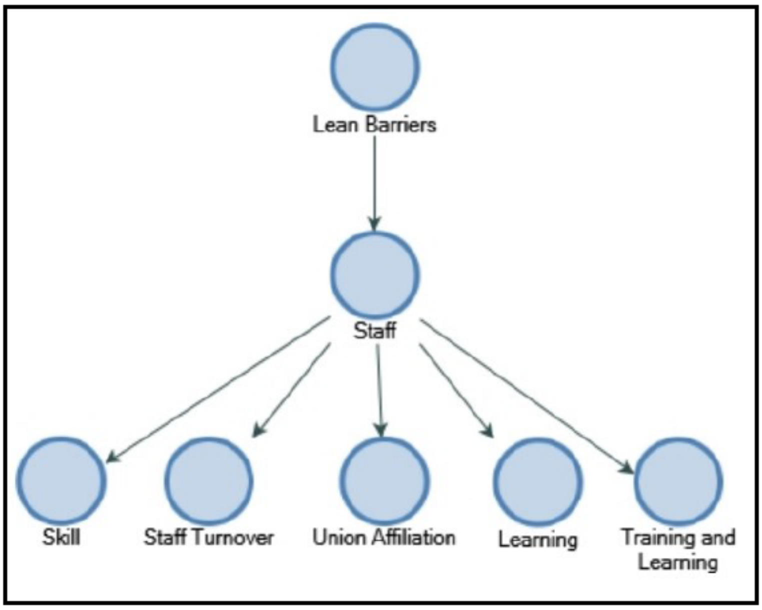


Figure 53: Map virtualization showing the staff sub-theme

Source: *Researcher's own construction*

4.5.4.1 Sub-theme 1: Skill

This sub-theme corresponds to the literature review references alluded in section 4.5.1. Omran and Abdulrahim (2015) empirically concluded that inadequate knowledge and skill is a major barrier that strongly influences worker's productivity. The one-on-one interview responses revealed that all the respondents concurred that the steering wheel manufacturing process is a specialized field that requires a special skill set, hence not obtaining that skill set is a major barrier. The response exhibits from two of the respondents are below:

Respondent 1

There is a lot of training associated with this operation. Besides training, you need someone dedicated and can do neat finishes in their operation. It's difficult to easily obtain such type of people.

Respondent 4

This is a very specialized skill, if not mistaken, only two companies in South Africa have Steering Process Plants. It's either our operators are from the other company in Cape Town, or they are fully trained by us.

4.5.4.2 Sub-theme 2: Training and learning

The literature reviews in section 2.3.1 by Logu *et al.* (2021) item 7, Meshref *et al*. (2022) LM No 14, identified training and learning as a LM driver of LM. Consequently, literature reviews in section 2.3.2 by Roos and Kiohling (2021), Chan *et al.* (2019) item 3 and 5 and Favi *et al*. (2017) and section 2.3.4 by Gaikwad *et al.* (2020) identified training and learning as a LM barrier. The one-on-one interviews were consistent with the LM barriers. The respondents however described the skill they wished they could have to perform better. Two of the responses is below:

Respondent 2

Excel spreadsheets and MS Access and Project

Respondent 5

Corporate Governance, Leadership for Managing Directors and Strategic partnerships courses

The respondents unanimously expressed the learning curves presented to them in the advent of the COVID-19 pandemic in agreement with Eldem *et al.* (2022) who noted that the pre and post-COVID-19 era brought new opportunities for more sustainable business transition, as well as the need for enhancing the supply chain network and production systems.

The subsequent submissions emanate from two of the respondents in the study.

Respondent 2

Covid 19 affected our plant. Raw material for Production was delayed. When Production was running, we had a breakdown that required a part from Czech and most of Europe was shut down. We had to learn to improvise by machining an alternative ourselves and we got the plant to run again.

Respondent 3

Covid 19 was a big learning curve. We learnt to operate with scarce resources and made it work. We also had issues with our manpower in terms of absenteeism, people were scared.

4.5.4.3 Sub-theme 3: Union affiliation

This sub-theme is in concurrence with the literature review section 2.3.1 of the conclusion by Shah and Ward (2003) item 1 which discussed the impediment in LM implementation common in most unionized organizations. One possible reason could be that the union representatives are being manipulated and do not understand the real consequences of lean. They just accept the fancy rhetoric presented by the lean promoters (Womack & Jones, 1996; Womack, *et al*. 1990) cited in Rolfsen and Ingvaldsen (2012) that the lean concept has to do with influence and participation, but without realizing that work conditions are getting worse, people are laid off because of lean, and the work is increasingly Characterized by stress. During the one-on-one interviews, the respondents did not say further than the union that they belonged to. One of the responses quoted shows that they only stated the name of the union that they belonged to.

Respondent 1

Motor Industry Bargaining Council MIBCO

In the article *Motor Industry Bargaining Council* (2023: para. 1 line 1) MIBCO is a Bargaining Council as envisaged in the Labour relations Act whose mission is to create and maintain industrial peace and stability in the Motor Industry. In the article *Numsa signs wage increase agreement for motor sector workers* (2022: para. 1 line 2) MIBCO falls under a bigger umbrella called The National Union of Metalworkers of South Africa (NUMSA).

4.6 Emerging themes and sub-themes from the focus group interviews

The data gathered from the one-on-one interviews were analyzed to identify the themes and subthemes highlighted in Table 25. Where applicable, however, the names of interviewees have been changed to Respondent A, B, C, etc. to ensure anonymity.

Table 25: Table 7: LM drivers themes and sub-themes generated from focus group interviews

Theme	Subtheme
Production related	Quality
	Production
	Poke yoke and fail safe
	Maintenance
	Manufacturing set up
	Housekeeping
	Kanban
Process related	Process
	New process
	Equipment
	Lean adoption
	Commitment
Customer related	Customer demands
	Customer satisfaction
	JIT

Source: *Researcher's own construction*

Similar to section 4.4, and in supporting the discussion on themes, relevant quotes from the data generated from the focus group interviews were used. Data from the focus group interviews was transcribed verbatim and used as such during discussion. An NVivo analysis of the themes produced the map virtualization exhibited in Figure 53.

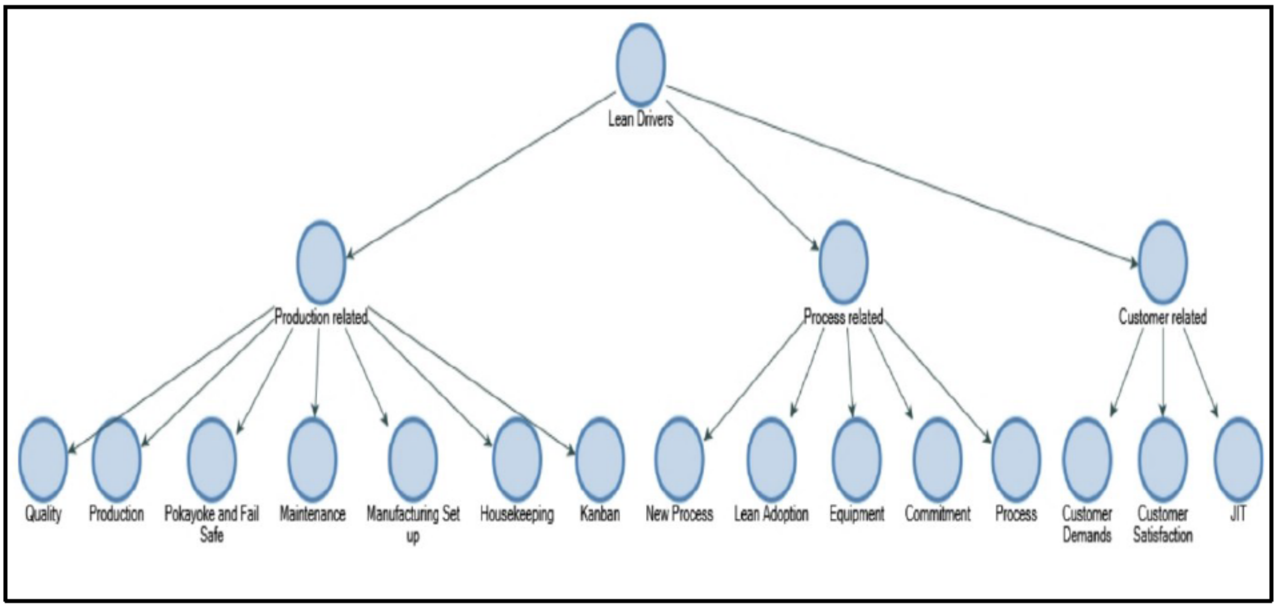


Figure 54: Map virtualization showing the themes of focus group LM drivers

Source: *Researcher's own construction*

4.6.1 Theme 1: Production related theme

This theme concurs with the literature review section 2.3.5 by Almanei *et al.* (2018). Lean manufacturing is currently a dominant production strategy in global manufacturing (Hu *et al.* 2015) cited in Schmitt *et al.* (2021) The Production related theme generated seven sub - themes in figure 54.

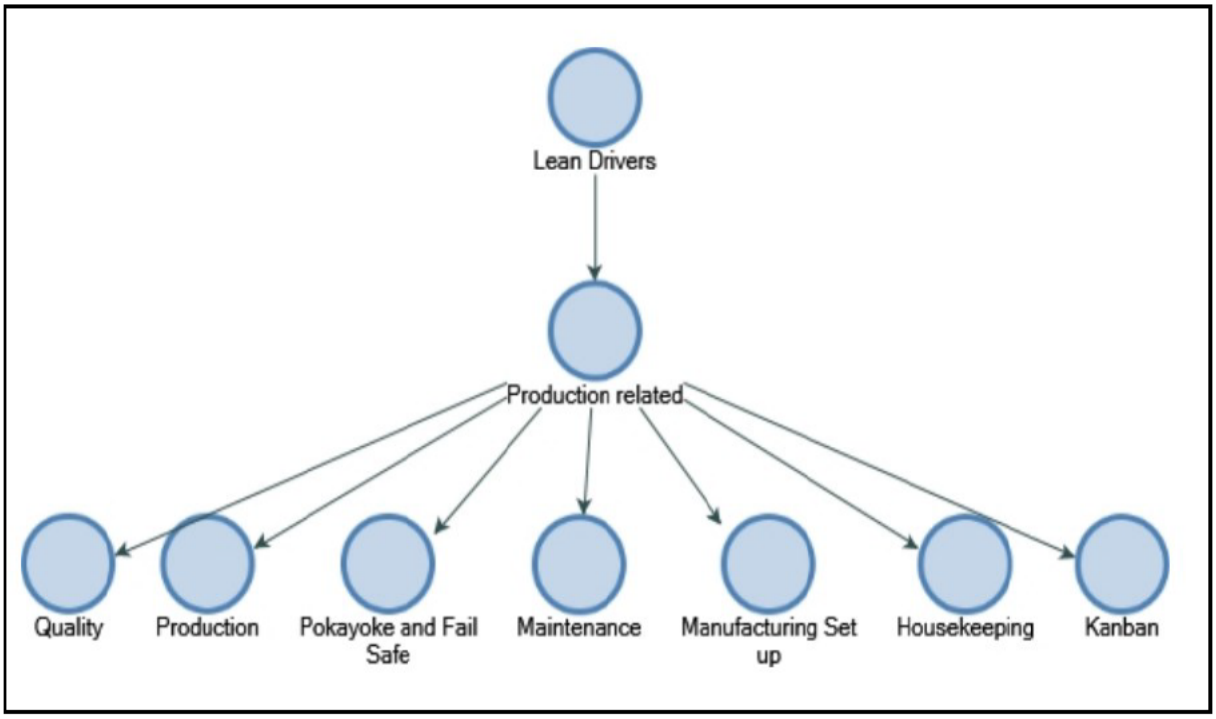


Figure 55: Map virtualization showing the production related themes from the focus group interviews

Source: *Researcher's own construction*

4.6.1.1 Sub-theme 1: Quality

This sub theme is in accord with section 1.1 literature review by Maharaj *et al*. (2016). The benchmarking exhibited in Table 1 of section 1.1 Coetzee *et al.* (2019) expressed Quality as a key LM driver, whilst Hwang *et al.* (2020) in section 2.3.3 emphasized Quality as one of the key metrics for evaluating the manufacturing process. Consequently, this sub-theme contributes additional depth to the aforementioned discourse by investigating how quality affects the various activities involved in the steering wheel manufacturing process, including those that occur before, during, and after production. Based on the Quality sub-theme, customer returns and re-work were prevalent.

According to Juhard and Pammer-Schindler (2022), ISO 9000:2015 defines rework as all actions on a non-conforming product needed to make it conform to the requirements.On tracking customer returns and reworks, one of the respondents confirmed that the information about the rework is collected, and a root cause analysis is carried out.

Respondent 3

Yes, this information is collected from the performance monthly report. Mainly if the leather is cracked or if there is a problem with the electronics, we propose finding the root cause of these and solving them before they go out to the customer.

Teli *et al.* (2012) emphasized a system of recording and tracking non-conformances and corrective actions to determine the effects of the previously adopted corrective actions. On investigation, almost all the respondents mentioned tracking and year-on-year evaluation of the non-conformances.

Respondent 1

Yes, this is tracked per shift, daily and monthly. There are also, comparisons made with the previous period last year or the years past for us to see if we are improving or becoming worse.

The respondents also brought in another term called the Obeya. Obeya also spelt as Oobeya, is a Japanese word that translates to “Big room”, this tool is commonly described as a meeting room that utilizes simple visual tools to support effective decision-making and problem-solving during development processes (Aasland and Blankenburg, 2012; Appell, 2011; Flinchbaugh, 2016; Jusko, 2016; Liker, 2004; Liker & Morgan, 2011) cited in Alaasar (2017). An exhibit from one of the respondents about the Obeya is below:

Respondent 1

This is reflected in our performance measurement under customer quality control. We can also visualize it in the Obeya room that has screens that reflect our performance in different areas.

4.6.1.2 Sub-theme 2: Production

Ambe (2017) in section 2.3.1 enlisted Production as the top key LM Implementation driver and concurred with Almanei *et al*. (2018) in section 2.3.5, whilst Chan *et al*. (2019) argued and enlisted production-related communication as a glaring barrier of LM. In this study, the respondents revealed that instead, daily production communication is a driver of lean. A response from the group pointed out that, despite the existence of communication at Company XYZ, its effectiveness might be questionable.

Respondent 3

Production plans and schedules are prepared by the Production Planner and e-mailed to the Production Manager who also sends them to the Supervisors. The Supervisors then print and post them on the notice board of each line or section that they supervise. The shopfloor employees in our opinion may not have time to check the notice boards for the detailed plans, hence a better method is required for this issue.

Conversely, another group that was interviewed contended that the outlined plans are straightforward and easy to comprehend, as indicated in the following response:

Respondent 5

The daily Production plan is very clear and simple to follow. It is shared every morning by the Planner. Generally, it caters for all the shifts. If there are any changes to the plan, there is information that is sent to the Supervisors as well.

Consistently reflected in the responses was the identification of the Production Planner as the creator of the production plans, along with the timing of the information sharing, the parties notified, and the location of the posting.

4.6.1.3 Sub-theme 3: Poka-yoke and fail-safe

According to Lazarevic *et al*. (2019), the Poka-yoke concept was coined by Shigeo Shingo within the context of Toyota Production Systems, and it is a system that uses simple devices or work methods for error prevention in manufacturing, service, or other industries. The main purpose of Poka-yoke is to detect defects, stop the process, and define and eliminate the cause. It is a technique developed to reduce physical and cognitive demands of tasks in the manufacturing and assembly process that creates a connection between worker and process in the form of feedback so errors can be prevented in the future. Martinelli et al. 2022 concluded that a Poka-yoke systems run concurrently with LM implementation. The focus group interviews revealed that the respondents were already familiar with error-proofing methods and identified them as poka-yokes as per the responses from the two focus groups below:

Focus Group 3

Yes, most jigs and fixtures have error-proofing mechanisms called poka-yokes that stop the operators from loading the part that is being worked in the wrong direction, for example, the PVC injection molding jig, the sewing jig, and the driver airbag and switch jigs.

Focus Group 5

The error-proofing mechanisms are called Poke yokes. They are in different places in the steering wheel Manufacturing Process, for example:
Poka-yoke in the injection molding Process
Poka-yoke in the stitching jigs for the correct steering setup.
Poka-yoke in the driver airbag station for correct installation of components.
Poka-yoke in the steering switch jig for correct installation.

4.6.1.4 Sub-theme 4: Maintenance

This sub-theme is notably one of the important elements of 4IR as per the literature review section 2.3.3.1 study executed by Ruane (2023: para. 22 line 1). This sub-theme was also revealed as essential because it affects the total cost of ownership of the final product and the profit margins during the one-on-one interviews in section 4.3.1.4. According to Mostafa *et al*. (2015), LM should be extended from the shop floor or production level to other areas such as the maintenance department. The key behind this LM thinking is that service/maintenance departments and production processes are inseparable and complement each other to sustain the competitive edge of an organization. This investigation, however, uncovered that although preventative maintenance was organized, it was not typically performed as outlined in the plans. The concept of preventive Maintenance involves the performance of maintenance activities before the failure of equipment (Gertsbakh, 1977) cited in Rastegari (2015). Responses from the focus group interviews are as below:

Focus group 1 response

Yes, but the plan is seldom followed due to Production target pressures that Management is always emphasising. At times Maintenance staff is forced to stay after hours to attend to critical Maintenance if there is some anticipated problem with a Machine or if there's a breakdown already.

In addition to the aforementioned submission, findings from another focus group indicated that the failure to execute Preventative Maintenance schedules has been identified as a non-conformance during audits.

Focus group 5 response

The Preventative Maintenance schedule and checklists are available, but not always done on time. There have always been audit findings of some checks not being done as stated on the Plant Maintenance Manuals and checklists.

Equally, it was uncovered that at company XYZ the Preventative Maintenance programme is unique for each machine. Moubray (1997) cited in Rastegari (2012) defined Reliability Centred Maintenance as a process used to determine what must be done to ensure that any physical asset continues to do what its user wants it to do in its present operating context. The group 5 focus group interview response asserted this definition.

Focus group 5 response

Yes, there is a Preventive Maintenance Programme that is run by the Maintenance department for example lubrication of machines, and change of bearings before they break down. The frequency of Preventive Maintenance

4.6.1.5 Sub-theme 5: Manufacturing setup

This sub-theme is presented with a dual connotation, as the responses from the interviews explored Manufacturing setup in terms of both the organizational design and the arrangement of equipment and machinery. Focus Group 1 response revealed the former, Group 3 discussed both phenomena, whilst Group 5 revealed the latter.

Focus group 1 response

Partly yes. Training is required for the shop floor and Senior Management. The Shop floor is most likely to resist lean implementation due to not understanding the benefits, and the Senior Management is most likely to leave all the responsibilities to the Middle Management and the shop floor without having assumed any responsibilities themselves, hence this needs to be emphasized.

Focus group 3 response

The setup in terms of the process is conducive for lean implementation as it already follows Production optimization techniques of reducing process and cycle times. However, in terms of shop floor, some awareness may be required before implementation so that they can ask questions and be answered, it may also be advantageous to involve the union in such issues where they may feel that their jobs are at stake because of a project.

This subtheme also substantiates the Literature review discourse in section 2.3.1 by Bhat (2008) and Metternich *et al.* (2013) as evidenced by the focus group 5 response below

Focus group 5 response

The setup makes it very conducive to lean. The recent re-arrangement of equipment and machinery in most processes are mostly cellular, they may not necessarily be balanced in terms of line balancing.

4.6.1.6 Sub-theme 6: Housekeeping

This sub-theme validates the framework in section 2.3.5 by Deros *et al.* (2012). Saloniti and Tsinopoulos (2016) added to this discourse by concurring that the 5S housekeeping system provides a foundation for most other tools when implementing LM. According to Zvidyayi (2021), 5S is the backbone of LM and any productivity improvement strategy will depend upon a full understanding of 5S to reduce the eight types of waste. The 5S name stands for five Japanese words, i.e. Seiri/sorting, Seiton/set in order, Seiso/shine, Seiketsu/standardization, and Shitsuke/sustain (Osada, 1991; Ho, 1998) cited in Motghare *et al.* (2018). Proenca *et al.* (2022) summarized the main objective of 5S as to change attitudes and behaviours, eliminate waste and ensure competitiveness. The responses obtained from the focus group interviews predominantly revealed that company XYZ is aware of the 5S methodology as exhibited by the responses below:

Focus group 1 response

We follow the Toyota 5S way of housekeeping in the plant, which is:
(1) Sort, (2) Set in order, (3) Shine, (4) Standardize and (5) Sustain

One of the groups, however, revealed that 5S is an activity that is seldom done under normal production situations. The highest priority is reaching production goals. Consequently, productivity priorities such as performing quality work and being on time for work rank much higher than 5S.

Focus group 5 Response

Generally, we are supposed to be practising the 5S system, however, we usually stop working to do a thorough clean-up if there's someone from HQ or a customer who is coming for a visit to our plant.

4.6.1.7 Sub-theme 7: Kanban

Previous studies exhibited by the literature review emphasized the importance of Inventory Management which is further revealed in this theme. In section 2.3.1 Rahman *et al*. (2013) accentuated Kanban as a tool to control the levels of inventory in Production. Htun *et al*. (2019) added to this discourse that the premise of kanbans is entirely dependent on the customer sending a signal request for more material. Adnan (2013) concurred that Kanban synchronizes all manufacturing activities upon customer demand. This theme also aligned with the literature review in section 2.3.1.1

by Abbadi (2018) who highlighted the importance of Kanban and the evolution of Kanban to Kanban 4.0. Most of the respondents of the focus group interviews concurred with the above discourse as exhibited by an example revealed by Group 1 response below:

Focus group 1 response

Yes, we use the Kanban system for ordering parts from stores. When a person using the parts makes the order for the quantity indicated by the kanban stores provides the exact amount requested.

One Focus group's response resonated with section 2.3.1, where Htun *et al*. (2019) illustrated the Kanban as a visible record or part.

Focus group 5 response

Yes, Kanban is the system that is used to order parts. When a part is running low at a workstation, there will be a visual display showing how many parts are required from the stores' department. The operator makes the order for the quantity indicated by the kanban and stores supply the exact amount requested.

4.6.2 Theme 2: Process related theme

Primarily, this theme aligns with objective 3 which is to investigate the manufacturing performance of the current steering wheel manufacturing process about LM drivers and barriers by using focus groups, one-on-one interviews, and participant observation. Further alignment is with section 1.1 which expressed the application of LM as one of the ways to improve process-related costs in steering wheel manufacturing. This theme is further reinforced by Table 2 in section 1.1 which empirically reveals that from all the South African Steering wheel manufacturers, company XYZ has the highest level of local processing by the total percentage of local cost, hence it is imperative to explore the manufacturing process. Consequently, this theme aligns with sections 1.3 and 1.4 which further discuss the process flow of the steering wheel manufacturing process. This theme validates the research emanating from the gap identified in section 1.6 about steering wheel manufacturing process studies. This theme also identifies and adds to the discourse of (Ohno, 1988) cited in

Proenca *et al.* (2022) that LM specializes in improving processes through the removal of Muda (waste, e.g., everything that does not add value is waste and as such should be eliminated), Muri (excess or insufficiency, the organization should only do what is necessary when requested, based on a Pull system) and Mura (irregularity, it is eliminated by the standardization of work) in production. The map virtualization showing the Process related themes from the focus group interviews is shown in Figure 55:

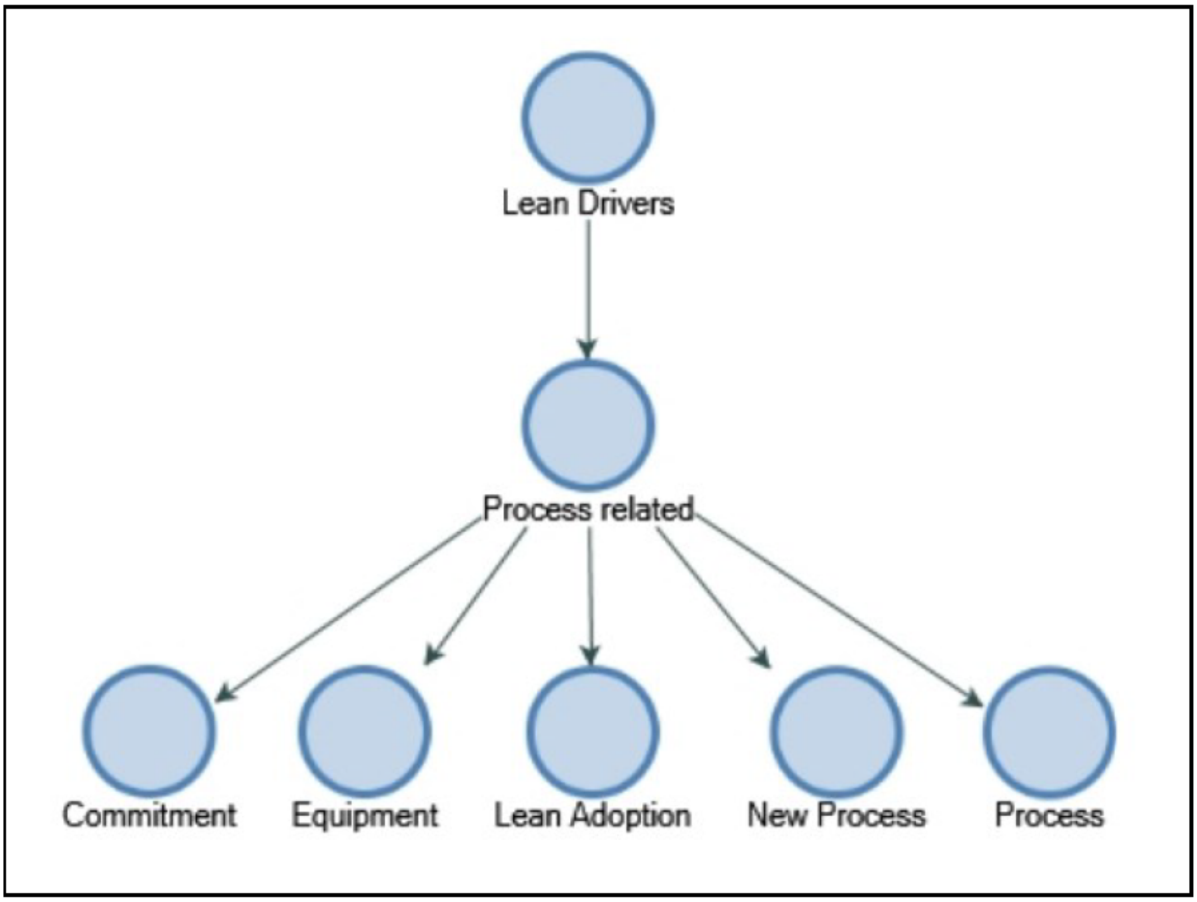


Figure 56: Map virtualization showing the process related themes from the focus group interviews

Source: *Researcher's own construction*

4.6.2.1 Sub-theme 1: Commitment

This sub-theme is in line with the Literature review (Landeghem, 2011), (Houti, 2019) and (Dat MINH, 2018) cited in Zvidyayi (2021) that Top Management Commitment, Middle Management Commitment, and Employees Commitment are one of the key drivers of LM. Consequently, section 2.3.2 by Roos and Kiohling (2021) and Abu *et al.*

(2021) identified a lack of commitment as one of the key barriers to LM. The Focus Group interviews revealed that at company XYZ Management and Staff are committed to the implementation of LM subject to the trepidation amongst the staff of the possibility of the only customer Toyota exiting their business if they remain uncompetitive the sample responses are listed below:

Focus group 1 response

Yes, people are realising that if Toyota exits, then the company will close, hence besides the usual union problems, these days conflicts are resolved quicker, and operators get back to work as soon as possible.

The consideration of Toyota's potential departure from the business landscape is accentuated by the possibility that the parent company could decide to terminate operations in the event of ongoing uncompetitiveness. This issue is highlighted in one of the focus group responses presented below:

Focus group 2 response

Indeed, people would not want this company to be closed down. Some people even work very long hours without demanding any additional compensation to it because they believe that this is our company and our future.

4.6.2.2 Sub-theme 2: Equipment

This sub-theme is in alignment with the Literature review section 2.3.3 according to Logu *et al*. (2021) that equipment is one of the critical transformation needs for the automotive industry that drive the implementation of LM. Adding to this discourse, Raji and Rossi (2019) cited equipment as one of the critical requirements necessary to adopt 4IR. This sub-theme presented three nodes as identified below

1. Equipment layout.
2. Material flow.
3. The Process flow.

Equipment layout node

The findings from the Focus Group Interviews indicated that company XYZ possesses a well-defined cellular plant structure, a consensus reached by all five groups. An excerpt from one of the Focus Groups is presented below:

Focus group 2 response

Most of the plant is arranged in a cellular manner. Similar processes are grouped together, for instance in the stitching area, all the processes that come after another are grouped together so that when one operator finishes, the work in progress is easily transferred to the next station or operator with ease.

Material flow-node

Consistent with the second identified node, this study revealed an additional significant factor concerning material movement: the safety of workers. This finding aligns with the observations made by Proenca *et al*. (2022) that a growing number of organizations are incorporating a sixth S into the 5S methodology. This sixth S, which pertains to Safety, is inherently linked to the preceding five S's and cannot be considered in isolation from them or from any operational activities.

Focus group 1 response

Yes, there is space on the aisles for the movement of materials from the start to the finish of all the processes without endangering the operator's safety.

Focus group 5 response

The layout is good, we also have not had any injuries due to poor layout.

Process flow node

In accordance with the third node of Process Flow, the first section of Proenca *et al*. (2022) articulates that the process or production flow entails exploring all tasks and sub-tasks. These tasks are subsequently organized from left to right, thereby establishing a flow of the process. As a result, one can discern the principal operations, ancillary steps, and tasks that occur simultaneously. The confirmation from all the Focus Groups is substantiated by the example provided below from one of the groups.

Focus group 3 response

Yes, similar processes and processes that follow each other are grouped in a cellular arrangement.

4.6.2.3 Sub-theme 3: Lean adoption

The Oxford Dictionary describes adoption as the action or fact of choosing to take up, follow, or use something. This definition aligns with the definition of LM drivers by Meshref *et al.* (2022) stated in section 2.3.1 of the Literature review section. Therefore, based on this similarity, it is safe to deduce that Lean adoption factors and LM drivers refer to the same concept. This sub-theme revealed five nodes listed below:

1. Ease of adoption by South African companies.
2. Ease of adoption by company XYZ.
3. LM knowledge.
4. Shop floor involvement.
5. Management commitment

Ease of adoption by South African companies' node

The results of the Focus Group interviews concurred with Coetzee *et al*. (2019) that South Africans require job security before lean implementation, and they believe aligned commitment between employees, company, and unions is required for successful lean implementation. In section 2.3, Womack and Jones (1996) distinctly outlined the birth of Lean Manufacturing (LM) since 1930 in Toyota's textile loom factory and further delineated the growth of lean at Toyota, implying that Toyota is the master in Lean Manufacturing at present. In line with this observation, most of the focus groups expressed that Lean Manufacturing is better understood by companies that deal with Toyota. Two of the responses on this sub-theme node are shown as examples below:

Focus group 1 response

Lean Manufacturing seems to be known by companies that deal with Toyota, and the understanding that those companies have is based on the knowledge shared by the relevant Toyota staff members. For Lean to be successful in South Africa, training *workshops are required that different levels of people within an organization can attend, maybe at different intervals.*

Focus group 4 response

Many companies know lean Manufacturing but may not exactly know how to go about it in their settings. We are privileged to copy Toyota in a lot of aspects like waste management, waste identification, and housekeeping for example, those are easy to copy.

Ease of adoption by company XYZ node

This node further corroborates the discourse presented in the section that examined the Ease of Adoption by South African companies, as detailed in section 4.6.2.3. In contrast to other organizations that do not engage with Toyota, Company XYZ exclusively serves Toyota as its sole customer.

Focus group 2 response

Yes, we have adopted a lot of Toyota processes. Lean is a Toyota philosophy and will make our customers happy, hence lean is good for us.

The observation of the responses also reveals a huge disparity in LM perception at company XYZ. For example, one of the focus groups interviewed was not confident that company XYZ may adopt LM as shown by the response below:

Focus group 4 response

Not sure. Our company has not done many good ideas that have been raised so far due to the bad financial condition, hence Management is generally reluctant to invest in improvement programs that will require some money initially even though the programs will be eventually good for the company. For instance, investing in less energy equipment and lighting has always been overlooked.

Another focus group articulated a sense of optimism concerning the adoption of LM at company XYZ, as reflected in the subsequent response.

Focus group 3 response

We think so, our Management is well travelled and well learned. They have also discussed with staff the differences that they have seen between us and the other affiliates. The idea is to ensure that all members of staff have the right and the same perspective about lean.

LM knowledge node

According to Almanei (2017), the quality of the consultant is also critical, and in many cases, superficial knowledge of the subject and lack of implementation practices results in confusion about LM and can become an obstacle in Lean Manufacturing implementation. It is thus evident that knowledge of the subject is of paramount importance as well. The absence of knowledge on lean philosophy and the various tools can be a great barrier in the implementation. In section 2.3.2 of the Literature review, Chong and Perumal (2020), Roos and Kiohling (2021) and Abu *et al.* (2021) identified knowledge as a key driver of LM and the absence thereof a barrier. Therefore, since the responses obtained from the Focus Group interviews reveal that there is a lack of knowledge about LM at company XYZ, this node can be treated as a lean barrier. Sample responses are below:

Focus group 3 response

Not quite, because of the perception that they will lose their jobs if the company adopts lean. They take it from the point that Lean will reduce headcount and make the same parts with fewer staff members, hence they would do anything in their power to ensure that Lean is not successful, for example, during a time study of the stitching process, the operators only completed 250 steering wheels per day as compared to 400 steering wheels. This was to prove that all the staff members were necessary for the process.

Focus group 4 response

There isn't much information. In this team we think about it differently too, examples: Reducing costs, reducing waste, making our products with less effort. Using less to produce more. The shop floor usually is concerned about losing their jobs when you talk about lean manufacturing, some think it means less staff.

Shop floor involvement node.

(Wrye, 2015) noted that Lean implementers emphasized the importance of employee engagement in every LM project that is being implemented. Roslin *et al*. (2019) concurred that the total involvement of employees is crucial and, the implementation process will not be augmented unless the workforce has acceded to the LM implementation. The Focus Group Interviews revealed that the shop floor is not comfortable with LM implementation. One of the groups revealed that the shop floor has a negative perception about LM as per the exhibit response below:

Focus group 4 response

Not at the present moment. The shop floor workers need some training before implementation because of their current perception. We have adopted a lot of good programs including ISO Management systems. It is difficult to get the shop floor by in unless the shop floor begins to appreciate the big picture.

A subsequent Focus Group indicated that employees on the shop floor harbor doubts regarding the likelihood of LM resulting in staff layoffs.

Focus group 5 response

No, the shop floor staff think of lean as the method used to trim staff. They are generally not concerned about the benefits because they do not understand lean manufacturing in the first place.

Management commitment node

This node is in alignment with the studies by (Landeghem, 2011), (Houti, 2019) and (Dat MINH, 2018) cited in Zvidyayi (2021) in the Literature review section 2.3.1 that Top Management, Middle Management and Employee Commitment are a crucial driver of LM implementation. Roos and Kiohling (2021: 8) and Almanei *et al.* (2018) in section 2.3.2 of the Literature review however argued that Top Management Commitment can also be regarded as an LM barrier. This study revealed that the Middle Management will support LM due to their education status and understanding of LM as per exhibit Focus Group response below:

Focus group 1 response

Yes, Middle Management has a good understanding of the purpose of Lean as they usually interact with Toyota and most of them have relevant educational qualifications and they read a lot.

On Senior Management support, there was a disparity between the group responses. Some Groups believed that Senior Management would support based on the historical support of other similar projects. An exhibit of such a response is as below:

Focus group 4 response

Yes, Senior Management has supported the implementation and certification of ISO 14001 and ISO 16949 where their commitment was essential and we passed, even though initially we had a few findings on Management commitment. However, this stage has been passed now.

Insights gathered from other Focus Groups highlighted a significant skepticism towards the dedication of senior management, as depicted in the response shown in the exhibit below.

Focus group 2 response

Yes, Senior Management is supposed to understand lean. However, we are not sure if the commitment to be involved in every aspect of lean implementation will be a success with senior Management. For example, in our opinion Management commitment is a challenge in this organisation.

4.6.2.4 Sub-theme 4: Process

According to the word count presented in section 4.3, the term "Process" emerged as the most frequently used word during the Focus Group interviews. This sub-theme is also consistent with the analysis found in section 4.6.2. The sub-theme identified six nodes, which are enumerated below.

1. Cycle Time Monitoring.
2. Factors that affect the speed of working.
3. Improvement of the factors that affect speed.

4. Administration Processes.
5. Process Flow.
6. Set up time reduction..

Cycle time monitoring node

In section 2.3 of the Literature review Taghizadegan (2013) defined LM as a technique for reducing the cycle time and non-value-added work, resources, steps, and others. Rhekha *et al.* (2017) defined cycle time or lead time as the time between the release of an order from the customer and the time taken for the customer to receive the finished product. According to (Taifa and Vhora, 2019), cycle time is one of the viable parameters for optimization when the aim is to improve efficiency, cost, and customer responsiveness. This study revealed that though cycle time is known, there may be no verity of its monitoring. This phenomenon further alluded to the importance of 4IR by Corfe (2018) in section 2.3.1.1 of the Literature review. Two of the responses are shown below:

Focus group 1 response

The cycle time is known from previous time and motion studies but not strictly monitored. However, we usually chase targets and solve problems that prevent us from achieving those targets.

Focus group 5 response

We do not monitor cycle time for any reporting, however, for production planning purposes, time study results are used to ensure that capacity is not exceeded.

Factors that affect the speed of working node

The study indicates that the working speed of employees is impacted by the distractions they experience in the workplace and the ambiguous nature of the requests they receive. Martin (2014: para. 2 line 1) outlines two categories of distractions that are prevalent in the workplace.

1. **Internal distraction**

   Refers to physiological, emotional, attitudinal, biological or physical discomfort.

2. **External distraction**

   Includes other people and technology.

According to Musheke and Phiri (2021), ineffective communication in an organization may result in uncertainty, apprehension, and dissatisfaction, and these result in, poor productivity. Perlow *et al.* (2017: para. 1 line 11) added to the discourse of productivity that meetings have increased in length and frequency over the past fifty years, to the point where executives spend an average of nearly twenty-three hours a week in them, up from less than ten hours in the 1960s. The sample responses from two of the focus groups list the factors that were revealed as causing distractions by the interviewed respondents.

Focus Group 3 Response

Phone calls, cell phone messages, interactions from colleagues coming for a social chat, social media like Instagram, and Facebook during working hours, unclear requests, many meetings, long meetings, and urgent adhoc requests.

Focus group 4 response

Breakdown Maintenance, absenteeism, Long toilet breaks, people extending tea breaks and lunch breaks and use of cell phones during working hours.

Another phenomenon that was revealed to affect the cycle time on this node was machine breakdowns. According to Ozkok (2013: 900), machines are key elements in manufacturing systems and their breakdown can dramatically affect system performance measures and the production planning process. This finding also concurs with section 4.6.1.4 in that lack of planned Maintenance affects productivity.

Improvement of the factors that affect speed

This node concurred with the findings of section 4.6.1.4 that Preventive Maintenance is scarcely executed. Fitch (2007: para. 6 line 2) noted that in organizations where Preventive Maintenance is not a priority, the blame tends to be on maintenance workers whilst the core of the problem is often more fundamental, relating to the business culture, lack of structure, ignorance, and behaviour issues. In many cases, the opportunities available from long-term investment in machine reliability are sacrificed in favour of short-term expedience driven by management's financial goals, hence the improvement of this phenomenon implies a complete culture change. Ellis (2019: para. 14 line 1) suggested that to change organizational unproductive culture habits, Management has to listen and bring staff together to redefine the components required for a vibrant culture and address ways of handling unproductive issues. In line with the literature stated, the respondents in this research suggested the following measures:

Focus group 1 response

Use Preventive Maintenance instead of over-reliance on breakdown Maintenance because there is no money for spares. Ban private chit-chat and use of cell phones during working hours. Toilet breaks should be monitored strictly. At present, operators do as they please and they say it is their basic human right when you try to correct them.

Focus group 2 response

Planning the Maintenance and sticking to the plan regardless of the production plan. Strong HR warnings are required for absenteeism, long breaks, and use of cell phones during working hours, maybe a complete ban on cell phones during working hours.

Administration processes node

The findings on this node concur with Douglas *et al.* (2015) and Radnor and Walley (2008) cited in Ruwanpura *et al.* (2023) mentioned the eight wastes of administrative processes as, delay, duplication, unnecessary movement, unclear communication, incorrect inventory, opportunity loss, errors and people in administrative processes.

Focus group 1 response

There can be some improvements, but they take too long to solve problems because everything waits for Management approval and most of the time we are told that there are no funds to carry out some of the proposed activities, for instance, we proposed the use of LED lights to save power, however, the authorization took forever and, in the meantime, power usage will still be high.

Consequently, this study confirmed that bureaucracies are stereotypically depicted as extremely static (Tsoukas, and Chia, 2002) cited in Duncan and Pelly (2022), contraindicative to entrepreneurship, and are assumed to be incapable of pivoting during environmental contingencies (Sabrosky *et al*., 1982) cited in Duncan and Pelly (2022). This is depicted in the exhibit response below:

Focus group 2 response

There is a very big hierarchy for small requests. Obtaining plant stationery for the plant should not be such a big thing that the Managing Director also has to sign it off.

Process flow node

This node is congruent with the discussions and findings presented in section 4.6.2 related to process flows. In the course of investigating the existence of process flows at company XYZ, this research established that such flows are present, primarily linked to the certifications of ISO 9001 and ISO 14001. The responses from the sample demonstrate a remarkable consistency, as depicted in the exhibit below:

Focus group 4 response

Yes, the process flow is shown in the ISO manuals.

Set up time reduction node.

This node aligns with the Literature Review in section 2.3.4 by Alyousef (2019) that set-up time is one of the most prevalent practices in LM implementation. Consequently, according to Esa *et al.* (2015), set-up time reduction is one of the LM activities with one main objective of eliminating waste. Set-up time reduction is also known as single-minute exchange of dies (SMED), and it is also known as the quick changeover. While previous studies indicate the momentousness of setup time reduction, all the conducted Focus Groups revealed that it is disregarded at company XYZ.

Focus group 3 response

There is no recording book to record and evaluate the set up time for now and previous times.

Focus group 5 response

Set-up time is not monitored. At times we have late production startups due to morning clean-ups and set-ups. This should be improved.

4.6.2.5 Sub-theme 5: New process

This sub-theme describes the inception of new processes at company XYZ. According to Wyman (2019: para. 1 line 1), to launch tomorrow's complex, innovative vehicle programs successfully, automakers and their critical suppliers need to consider Design for Manufacture (DFMA), and employ it consistently, from the start to the end of the project. This sub-theme presented two nodes listed below:

1. Clarity of the steps when running a new process.
2. Company XYZ Involvement when the customer launches a new product or process.

Clarity of the steps when running a new process node

Wyman (2015: para 5 line 1) articulated five important recommendations for the automotive industry aimed at improving launch efficiency and lessening waste as enumarated below:

1. Product maturity.
2. Process standards.
3. Training/Qualification.
4. Ramp up planning.
5. Supplier maturity.

The insights obtained from the focus groups suggest that the establishment of a new process is systematic and clearly articulated, serving as a replication of the Toyota method. The subsequent text highlights some of the language used by respondents in the interviews.

Request for make vs buy supplier selection (RMBSS)

Naicker (2021) posits that RMBSS marks the initiation of the sourcing process, during which the sourcing team evaluates the specifications of a new design. Subsequently, they determine whether to manufacture the component in-house or procure it from a designated supplier, based on assessments of internal and supplier capabilities.

Supplier parts tracking team (SPTT)

Van Zyl *et al.* (2016) describe SPTT as a collaborative team composed of experts from various departments, including purchasing, quality assurance, design, and production, who engage with suppliers to facilitate the introduction of new component manufacturing.

Focus group 1 response

Yes, Firstly, we receive an Engineering Change from Toyota Engineering or an RMBSS (Request for Make vs. Buy Supplier Selection) from Toyota Purchasing. After Toyota has approved our quotation and given us an LOI (Letter of Intent) or business confirmation, we then begin drafting the process and contact our Tooling Suppliers to make the Tooling.

From there we then adopt the SPTT (Supplier Parts Tracking Team) method of tracking the change of process from our side concerning the requirements of our customer. We will track the tooling and all the milestones and ensure that training is also done at the relevant times for the Start of the new process.

Company XYZ involvement when the customer launches a new product or process

The results of this research indicate that Toyota serves as the sole customer for company XYZ. Thus, the RMBSS and SPTT methodologies are implemented when new products or processes are introduced, as described in section 4.6.2.5. All respondents verified their involvement with the customer during the launch of new products or processes. Below is a statement from one of the respondents:

Focus group 4 response

Yes, we attend SPTT sessions that are scheduled by the Supplier Purchasing Engineering (SPE Engineer). Usually, they are a minimum of three sessions with each session concentrating on different milestones of the new project or session like tooling, first product, mass production trials, and start of production.

4.6.3 Theme 3: Customer-related theme

Innately, this theme concurs with (Maharaj *et al*. 2016) in section 1.1 that OEMS must improve inefficiencies to attract customers. Consequently, this theme also aligns with section 1.3 where the customer is indicated to be the decider of the final product. Section 1.3.1 discusses the proximity of supplier XYZ to its only customer Toyota. Section 1.4 further discusses the aesthetical drive of OEMs which is a requirement further cascaded down to their suppliers. This theme further aligns with section 1.5 which discusses that company XYZ steering wheels are designed are by the OEM customer.

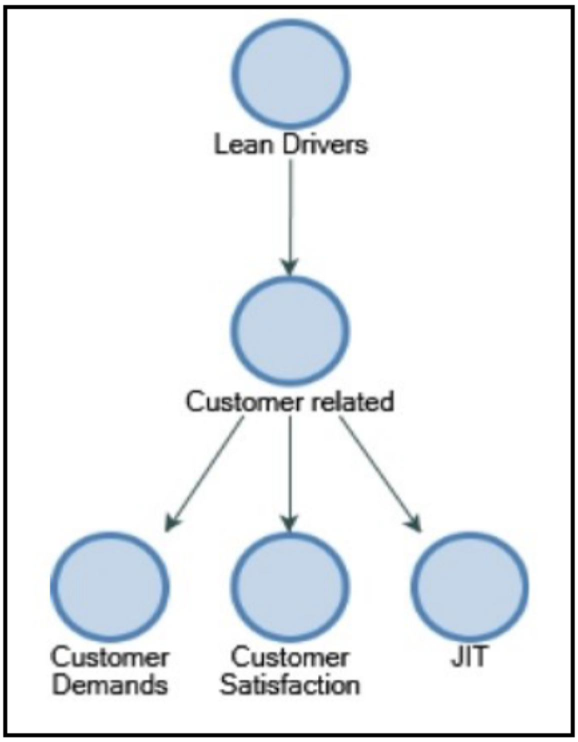


Figure 57: Map virtualization showing the customer-related themes from the focus group interviews.

Source: *Researcher's own construction*

4.6.3.1 Sub-theme 1: Customer demands

This sub-theme aligns with section 2.3 Literature Review According to van Assen (2018) LM is geared towards customer-oriented improvements. This view was concurred by Abid and Ozkan (2009) in section 2.3 that the ability to meet customer demand is critical. This research revealed that customer demands may not have been prioritized before the exit of one of the OEMs from the business, however, it is evident that this was a learning point, hence they are now being prioritized. The responses from the interviewed respondents are shown below:

Focus group 1 response

Yes, they may have been taken for granted when handling the Mercedes Benz account before they exited, but the company is very serious with Toyota and will make everything stop just to ensure that the customer is happy.

An additional group of respondents contributed to the discourse on prioritizing customer expectations, demonstrating that company XYZ undertook extensive initiatives to assist their customers during the aftermath of a natural disaster. The response is elaborated upon below:

Focus group 2 response

Yes, customer demands are a priority. The customer usually asks for back orders, and we would make every effort to ensure that we supply. Recently some floods affected Toyota, and we did not only support Toyota by supplying parts on time but extended a hand in going there to clean up the mess because they are our top priority.

4.6.3.2 Sub-theme 2: Customer satisfaction

This theme aligns with van Assen (2018) that LM is a practical approach to improve processes by identifying and eliminating non-value-adding activities from a customer perspective (Schonberger, 2007) cited in van Assen (2018) resulting in higher customer-focused performance such as quick response to customer inquiries, speed of complaint handling and customer satisfaction through the improvement of business processes. According to Brass (2015: para. 1 line 1) customer surveys may provide important insights into customer behaviours, knowledge and attitudes. Barker (2020: para. 1 line 1) emphasizes clause 9.1 of the ISO 9001:2015 standard as follows:

"ISO 9001:2015 requires organizations to monitor customer's perceptions of the degree to which their needs and expectations have been met. It is up to the organization itself to determine the methods to be used for obtaining, monitoring, and reviewing (using) this information."

The results of the Focus Group interviews showed a disparity in the perceptions of the respondents concerning company XZY’s measurement of customer satisfaction, with some of the groups revealing that there is a Kitaichi method to measure customer satisfaction, and others indicating that there is not enough effort to measure customer satisfaction. The sample response below shows respondents who were satisfied with utilizing the Kitaichi matrix.

Focus group 1 response

Yes, since our customer is only Toyota SA, we utilize the Toyota Kitaichi Matrix to review our customer satisfaction. The Kitaichi Matrix measures the 4KPIs, that is: Safety – is measured through the number of Lost Work Cases (LWC) and Lost Work Case Frequency Rates (LWCFR)

Quality – is measured in terms of parts per million rates of failure. Delivery – This is measured in terms of short shipment notifications.

Cost – is measured in terms of benchmarking our part with Toyota South Africa’s affiliate supplier. Toyota also measures our level of localisation and scores us accordingly.

The ensuing response reflects the sentiments of a focus group that felt that the measures taken by company XYZ to obtain customer satisfaction reports were not satisfactory.

Focus group 3 response

No, we have not come across customer satisfaction survey reports, though we have seen our performance reports based on the customer's KPIs.

4.6.3.3 Sub-theme 3: JIT

This theme aligns with section 2.3.1, Tarver (2023) identified JIT as one of the key LM drivers. Consequently, Chan *et al*. (2019) highlighted that the incompatibility of JIT with the reward system of a company is an LM barrier. This sub-theme also aligns with section 4.4.4.5 where JIT was identified as an LM driver. This sub-theme presented with two nodes listed below:

1. JIT when receiving raw materials.

2. JIT when delivering to the customer.

JIT when receiving raw materials node

This node is in alignment with section 4.3.1.4 literature review from Stricker and Correa (2023: para. 1 line 2) that discussed the impact of COVID-19 on global supply chains. The Focus Group interviews revealed that JIT was efficiently run pre-COVID-19 era, however, COVID-19 had a significant negative impact. This node showed some disparity in the responses as other groups believed that JIT is practiced, and others revealed that it was only successful pre-COVID-19 advent. Consequently, other groups revealed that JIT supply of raw material is not practiced at company XYZ. The responses below show the respective findings.

Focus group 5 response

Yes, for all our products we practise JIT delivery, however, for steering wheel, the JIT has been taken a step further to be JIS that is Just in Sequence delivery. This is because we deliver steering wheels every 45 minutes during the Toyota Production cycles. We cannot do otherwise the customer will be greatly inconvenienced.

Focus group 3 response

Before COVID we were almost practising perfect JIT, but when COVID hit and after COVID, things changed. At times we do not obtain parts from our local suppliers, some even closed and we have to find alternative sources overseas.

Focus group 1 response

In practise not quite, because at times we have more stock of a particular raw material than the proposed 3-month stock, and at times we run out of some stock waiting for its arrival until we end up having to air freight some materials from overseas if they are not available locally.

JIT when delivering to the customer node

Slack (2022) noted that OEMs demand reliable delivery and unreliable providers are punished, with Tier One suppliers first in the firing line. Although there are moves for closer collaboration between OEMs and suppliers, often the only realistic option for the latter is to maintain large inventories of buffer stock. Indeed, this is something that OEMs are insisting on. According to Choi *et al*. (2023), JIT assumes a relatively stable environment, enabling closer collaboration. However, with turbulence and day-to-day variability in the supply chain, Toyota shelters its manufacturing plants and those of its Tier-1 suppliers by using buffers upstream (e.g., stockpiles of chips) and downstream (i.e., finished cars) while retaining traditional JIT practices in its plants. Responses from all the focus groups revealed that JIT is practiced simultaneously with JIS by company XYZ when delivering to Toyota. This is in line with the discussion revealed in section 4.4.4.5. The results of one of the focus group interviews are depicted below:

Focus group 1 response

JIT is practiced, plus steering wheels are sequenced, that is they are called in every 45-minute cycle to be delivered to Toyota through an automated system. Toyota is very strict about Just in Time Delivery as they do not have any room to store any part, hence the parts only arrive there in time for assembly.

4.7 Focus group interviews lean barriers themes and sub-themes

An exploration of the literature relevant to this theme is presented in section 4.5. The analysis of data derived from the focus groups culminated in the identification of the themes and subthemes detailed in Table 26.

Table 26: Focus groups interviews lean barriers theme and sub themes

Theme	Subtheme
Cost Markers	Profitability
	Cost Reduction
	Kaizen
	Maintenance
HQ	
Teamwork	
Supplier involvement	
Surveys	
Targets	
Customer complaints	
New customers	
Decision making	
Training and growth	
Muda	
Bottleneck	

Source: *Researcher's own construction*

The map virtualization showing the theme, sub-themes, and sub-sub-themes of barriers of LM from Focus Groups is shown in Figure 57.

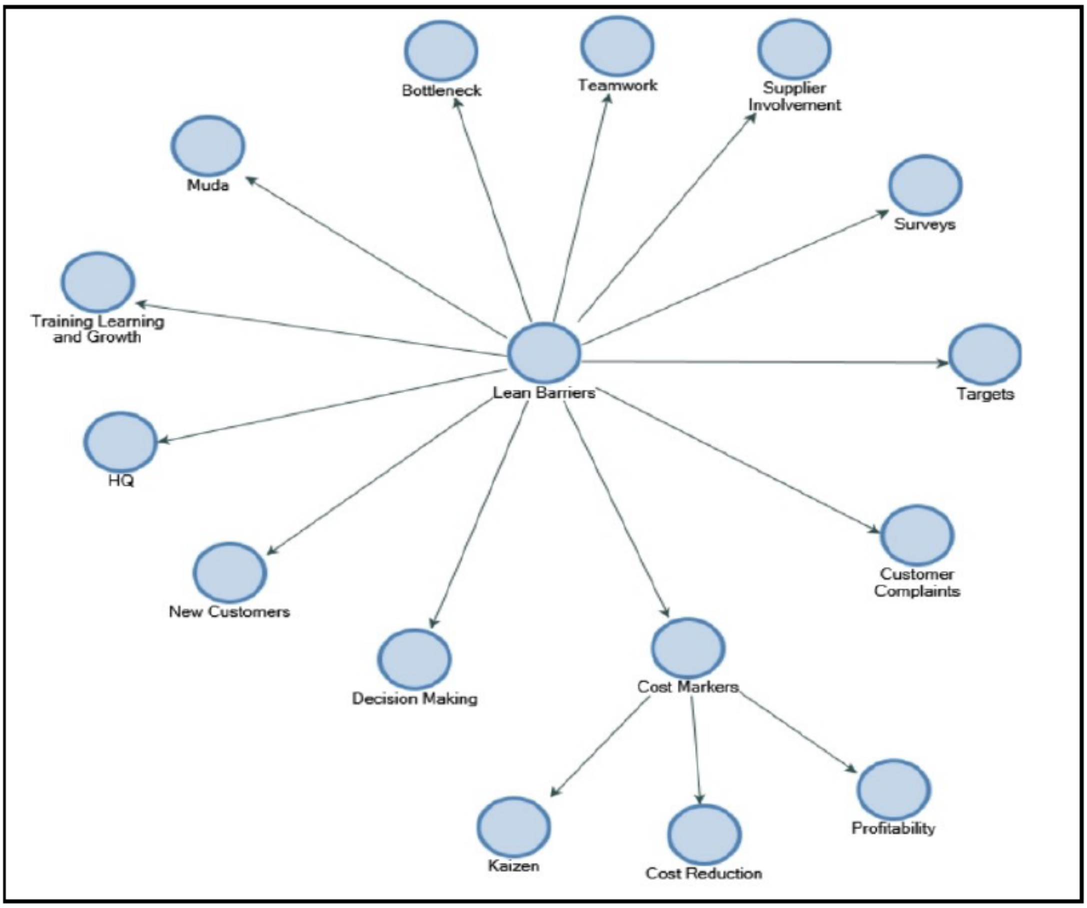


Figure 58: Map virtualization showing the theme, sub-themes, and sub-sub-themes of barriers of lm from focus groups

Source: *Researcher's own construction*

4.7.1 Theme 1: Cost markers

This theme is in accord with the discussion in section 1.1 that OEMs are exerting immense pressure on Tier 1 suppliers to reduce costs. In section 2.3, the definition of LM is stated by many writers as a philosophy to reduce costs. The word cloud in section 4.3 also revealed that cost was the second largest discussion point based on the cost word count during this research. The Cost Markers theme revealed 3 sub-themes as per Figure 58 virtualization.

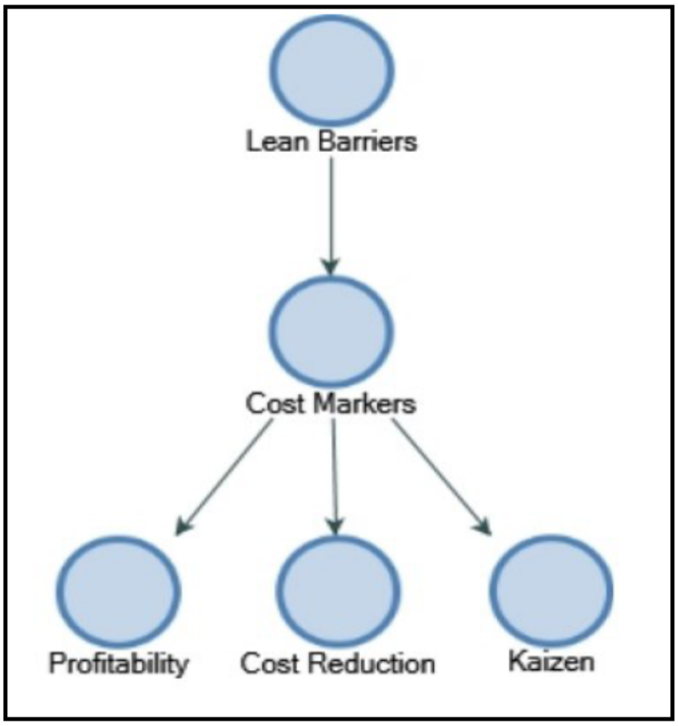


Figure 59: Map virtualization of cost markers sub-theme and the emanating sub-sub-themes

Source: *Researcher's own construction*

4.7.1.1 Sub-theme 1: Kaizen

In Section 2.3, Ismyrlis (2021) articulates that kaizen is synonymous with continuous improvement. Shang (2017) addressed the significance of kaizen in the implementation of LM, emphasizing its role as a key tool in this process. The focus group interviews yielded four sub-subthemes connected to this topic, which are presented below:

1. Platforms used to encourage Kaizen.
2. Awareness of Kaizen Targets.

3. Management Support.

Sub-Sub theme 1: Platforms used to encourage kaizen

Gomez (2019) contends that the frontline team members have the most comprehensive understanding of a product or service, given their daily interactions with both manufacturing and customers. According to (Boyer, 2018), while the principles of Kaizen should be practised by all members of an organization continually, scheduled Kaizen events may be necessary to tackle larger problems, also, to maintain a culture of solving the root cause of problems before they become bigger key. Ramezani and Razmeh (2014) assert that one of the most important factors of all staff participation in Kaizen is using the suggestions system. Suggestions seldom have rapid financial reimbursement but will enhance moral ascendancy. The responses of all the focus groups concurred with each other in terms of the platforms used when raising improvement ideas.

Focus group 3 response

Suggestion boxes are placed in strategic places all over the company. People are also free to discuss their proposals with their line Management. Attendance of Cost Reduction Tracker Meetings is also open to those who would like to understand the progress of their cost reduction ideas.

Sub-sub theme 2: Awareness of kaizen targets

Despite its practical relevance, the issue of the lack of adaptation of costing systems to LM is still unresolved (Hansen and Mouritsen, 2007) cited in Ruiz-de-Arbulo-Lopez *et al.* (2013) and it has been scarcely discussed in the academic literature. Contrary, this research revealed that Toyota costs LM targets and shares them with their Tier 1 suppliers who then work on achieving them.

Focus group 4 response

Yes, Toyota shares a cost reduction target for the financial year, which Management uses to divide and allocate per section/department. The internal targets are also added to the Toyota targets.

Sub-sub theme 3: Management support

Lean promises cost savings, although management in many cases fails to understand that cost savings are the result and not the objective of implementing lean. As a result of this, once the enthusiasm for the new philosophy has calmed, and the results are not as promising as expected, Management commitment and follow-up is a desideratum (Alefari *et al.* 2017). This research showed a disparity in the responses with some groups revealing that Management supports LM and other groups revealing the contrary. The following are extracted exhibits from NVivo

Focus group 3 response

Yes, all ideas are managed through the CRT (Cost Reduction Tracker). It is systematic and will follow through on an idea until it is closed out, either if the saving is realized or if at the costing level, the cost of implementation is deemed not to be of a cost-saving benefit. Hence based on that method, the Departmental team leader or member who is present in the CRT will then inform the originator of the idea why the idea was dropped if it was dropped or inform them about the implementation.

Conversely, some groups expressed the opinion that Management was insufficiently supporting and implementing the proposed Kaizen initiatives.

Focus group 5 response

On the calendar, there are fortnightly CRT meetings that are scheduled. This is the platform where Management engages with the staff. However, at times these meetings are never held due to Management attending to other priorities.

4.7.1.2 Sub-theme 2: Cost reduction

This sub-theme aligns with section 4.7.1. The three sub-sub-themes identified are as follows:

1. Awareness of companywide cost reduction initiatives.
2. Departmental cost reduction initiatives and tracking.
3. The kaizen implementation.

Sub-Sub-theme 1: Awareness of companywide cost reduction initiatives

This sub-theme is in alignment with the discussion in section 2.3.2 by Chan *et al.* (2019), which points out that ineffective communication between management and employees constitutes a barrier to LM. All respondents acknowledged the organization's cost reduction strategies, as demonstrated in the sample responses below:

Focus group 3 response

Yes, most of us are part of the Toyota-driven Big 5 activities that are aimed at reducing organizational costs in the five following areas of the company:
Parts costs, Plant Variable Costs, Logistics Costs, Fixed Costs and Volume increase

Focus group 4 response

Yes, we are aware, that these happen through our Kaizen activities, our Quality circles, Gemba activities, Toyota Big 5 Challenge activities, and Toyota CIM 1.05 activities. All of these have the aim of improving parts in the whole plant and coming up with a cost saving. Many brilliant ideas come up; however, the only issue is that they are not followed until savings are realized, they just stop somewhere and mostly there is no clear explanation.

The focus groups articulated the concepts of the Toyota Big 5 and CIM 1.05 activities, as described in the subsequent list:

Focus group 5 response

Big 5 Activities are activities that were initially initiated by Toyota South Africa to responsibly reduce the cost of parts by eliminating waste and optimizing the five elements that make up the prices of parts from Tier 1 suppliers. The five elements are Parts Costs, Plant Variable Costs, Logistics Costs, Fixed Costs, and Volume increase. Consequently, five departments are involved in this activity from the OEM and the Tier 1 supplier, namely, Purchasing, Supplier Engineering, Research and Design, Logistics, and Quality Departments. CIM 1.05 activities were cost reduction efforts initiated by Toyota South Africa on Value Engineering Value Addition activities to reduce Tier 1 parts pricing to the target CIM of 1.05 against the affiliate.

Sub-sub-theme 2: Departmental cost reduction initiatives

This sub-sub-theme aligns with section 4.4.4.3. Lean manufacturing emphasizes the flow of materials from when a product begins to be manufactured until it is completed (McNair *et al*. 1989) cited in Ruiz‐de‐Arbulo‐Lopez *et al.* (2013). According to Womack and Jones (1996) cited in Ruiz‐de‐Arbulo‐Lopez *et al.* (2013), a lean company has to view its processes as value streams and make products flow down the value stream and continuously improve the system. All the Focus groups revealed awareness of their specific departmental cost-reduction initiatives. The focus groups alluded to the utilization of the CRT for this purpose. The departmental cost reduction initiatives. The responses also revealed the use of an Obeya. According to Aasland and Blankenburg (2012), Obeya is a Japanese word for a large room. It is a term used in connection with project work in industry. The exhibit sample responses are as below:

Focus group 2 response

Yes, each leader of a project is supposed to present to leadership the progress of each idea which has been assigned to their responsibility every fortnight. The meetings happen on Teams or in the MS Obeya. However, of late there has always been a lot of rescheduling of those meetings.

Focus group 3 response

Yes, we use a document called the Cost Reduction Tracker to record and follow up on our cost reduction ideas. Anyone in the department can raise any idea through the group leaders, supervisors or suggestion box.

Sub-sub-theme 3: The kaizen implementation

This sub-sub-theme is associated with sub-subtheme 2 in section 4.7.1.1. All Focus Groups referenced the procedure for managing kaizen from its inception to the point of implementation. An example of a response is provided below:

Focus group 5 response

There is an approval process that takes place after all the aspects of the idea have been verified and the cost-benefit has been calculated by the relevant departments, *usually the Operations/Marketing office where the Toyota Portfolio Key Manager sits. Only after this can the operators implement the ideas in their daily work.*

Sub-sub-theme 4: Additional cost reduction ideas

This sub-sub-sub theme aligns with the broad Kaizen activities and reveals some additional ideas that the respondents would not have necessarily formally raised. The responses from the focus groups as shown in the exhibit below were in concurrence.

Focus group 3 response

1. *Switching off the kitchen boilers when not in use.*
2. *Use LED lights for the offices and meeting rooms with sensors that make the lights switch on when people enter and off when people leave the room.*
3. *Use light allowing roofing material to allow natural light instead of using factor lights.*
4. *Prevent oil leakages from machines by regular maintenance.*
5. *Prevent reworks by emphasizing doing it right the first time.*
6. *Reduce factory overtime by ensuring targets are met during working hours.*
7. *Reduce staff absenteeism.*
8. *Investigate recycling of PVC trimmings.*

4.7.1.3 Sub-theme 3: profitability

This sub-theme is consistent with section 1.3.1, which indicates that the only manufacturing plant for magnesium steering wheel frames in Cape Town was closed due to financial unviability. Subsequently, the three die-casting machines that were utilized for the entire South African OEM market were moved to the parent facility in Germany. This sub-theme has revealed the following sub-sub themes:

1. Awareness of the company's profitability.
2. Is staff aware of how to contribute to profitability?

Predominantly, the investigation revealed that the staff is aware that company XYZ is making a loss, and almost all the Focus Groups alluded to the fact that the Managing Director periodically cascades this type of news through the company’s communication structures. The following is an example of the respondents' response:

Focus Group 5 Response

We are making a loss. Our Management informs us about our performance in comparison to the other group branches. They tell us that we need to work hard and pull our socks to survive and avoid being shut down.

4.7.2 Theme 2: Decision Making

According to (Griffiths, 2023), a lean organizational structure is a streamlined and efficient framework that minimizes hierarchy, reduces bureaucracy, and focuses on essential roles and functions. This structure emphasizes simplicity, agility, and cost-effectiveness by eliminating unnecessary layers of management and decision-making. It encourages direct communication, and quicker decision-making, and empowers employees to take ownership of their work. Lean organizations often have cross-functional teams, flexible job roles, and a strong commitment to continuous improvement. This structure aligns with Lean principles, fostering a culture of efficiency, waste reduction, and customer-centricity. Jedynak (2015) added to this discourse that, intuitive rather than analytical decision-making is a huge hindrance to LM implementation. The results obtained during the Focus Group interviews showed a disparity in responses between the five groups. Three groups revealed that decisions are only made by Top Management, one of the statements was that even the Production Manager level of Management could not make decisions. An exhibit of one of those responses is paraphrased below:

Focus group 3 response

No, we do not think even our Production Manager has a full right to decision-making because he always has to go and check with senior Management before, we can implement some changes to our process.

Conversely, the other two Focus Groups perceived their role in the decision-making process as being somewhat limited, as demonstrated by one of the responses presented below:

Focus group 4 response

Yes, we are encouraged to submit Kaizens or new ideas and a formal process of authorizing it commences.

4.7.3 Theme 3: New customers

This theme is congruent with the literature referenced in section 4.6.3. The Focus Group Interviews brought to light three sub-themes, listed below:

1. Number of new customers.
2. Sales to new customers.
3. New Customer surveys.
4. Number of new customers referred by existing customers.

Sub-theme 1: Number of new customers

This sub-theme concurs with the results in section 4.6.3.1 that Toyota is the only customer since Mercedes Benz exited XYZ, and further confirms that there have not been any additional customers since then. All five focus groups were in concurrence with the exhibit of one of the focus groups below:

Focus group 3 response

We have not signed any new customers since we relocated to Durban, in fact Mercedes Benz has exited, and we now have one customer left.

Sub-theme 2: Sales to new customers

This sub-theme aligns with 4.7.3.1 Sub-theme 1, indicating that there has been no transaction with a new customer, as no new clientele has been incorporated into the business. An illustration of the responses is provided below:

Focus group 5 response

No customers have joined us in the past 10 years, we only sell to Toyota South Africa Motors.

Sub-theme 3: New customer survey

This sub-theme is congruent with section 4.7.3.1, particularly Sub-themes 1 and 2, indicating that there have not been any new customer surveys. Findings from the focus groups demonstrate that the reporting practices at company XYZ do not fulfill this criterion. Below is a representation of the results:

Focus group 3 response

No, we haven't had new customers as yet. Marketing has not shared with us the relevant feedback when prospective customers come over to view our operations.

Sub-theme 4: Number of new customers referred by existing customers

This sub-theme is in harmony with section 4.7.3.1, particularly sub-themes 1, 2, and 3. The absence of new customers implies that the business has not signed up any additional clients. The feedback from the focus group was predominantly similar, reinforcing the conclusion that the lack of new sign-ups indicates there are no referred customers. Below is an exhibit showcasing the results from the focus group:

Focus group 2 response

We have not signed any new customers since we relocated to Durban, in fact Mercedes Benz has exited, we now have one customer left.

It was noted by one of the groups that Toyota had referred the OEM council to company XYZ. Subsequently, a collective of OEMs, organized by the OME council, visited company XYZ to assess new business prospects. The results from the focus group are illustrated in the exhibit below:

Focus group 4 response

Toyota has referred the OEM council and all the OEMs who are members of the council have come to view our plant. Our understanding is that some have even submitted some drawings for Quotation. There hasn't been any official word as to what happened or what will happen in the future.

4.7.4 Theme 4: HQ

As a global leader in mobility safety, XYZ Global provides critical components, systems, and technologies essential for safety in both automotive and non-automotive sectors. Headquartered in Auburn Hills, Michigan, USA, the company employs around 43,000 people in 25 countries, with annual revenues nearing $5.0 billion (Anon. 2023). This analysis sought to explore the perception of the headquarters regarding XYZ. The focus group interviews highlighted two sub-themes that correspond with this overarching theme.

1. Information about HQ's perception.
2. Frequency of the information.

Sub-theme 1: Information about HQ's perception

This theme aligns with section 1.1 literature from (Barnes *et al*. 2017) and Subhanij and Annonjarn (2016) that the South African ACMs are dominated by multinational ACMs and their performance is monitored by their headquarters. In section 4.6.2.4 4, Musheke and Phiri (2021 highlighted the importance of effective communication to reduce incidents of uncertainty, apprehension, and dissatisfaction, which result in poor productivity. Most of the focus groups except for one revealed that there is effective communication at company XYZ as the staff confirmed obtaining the HQ feedback about the South African Operations. The exhibits from one of the Focus groups that cited effective communication, and the other counter view are shown below:

Focus group 1 response

Yes, our Managing Director often has meetings with HQ and then cascades down the information through relevant departmental meetings, Staff briefs, e-mails and Memos. That way we get to have knowledge of what HQ thinks about our South African operations, our profitability and our future.

The following focus group presented a perspective that diverged from the viewpoints expressed by the other focus groups.

Focus group 5 response

We do get the information from many sources, at times through the grapevine. Our understanding is that our Top Management meets with HQ very often, and after those meetings if there is information that we are supposed to know, it is then passed on to us.

Sub-theme 2: Frequency of the information

While one focus group reported receiving feedback at least once a month, the remaining groups collectively affirmed that they are informed whenever there is pertinent information that the staff and shop floor should be aware of.

Focus group 1 response

Usually, it's monthly. If there is any meeting in between or if any member of the Management team visits HQ, we would also get feedback on how the meeting went and how our projects are received.

The exhibit provided below encapsulates the perspectives of focus groups, highlighting that information is exchanged as frequently as the need arises.

Focus group 5 response

When there is a need to inform us of anything, Management usually schedules meetings. At times it could be very frequent where there may be information gathering and they report back to HQ. At times it could be as little as 3 months, hence it depends on what HQ wants.

4.7.5 Theme 5: Training, learning and growth

This theme concurs with the literature review in section 2.3.3 where Kaplan and Norton (1992) discussed innovation and learning as a pillar of LM and the absence thereof as a barrier. In section 2.3.5 Sangode and Hedaoo (2018) discussed the cost and time of training as a barrier to LM implementation. Kunnen *et al.* (2023) concurred with the mentioned disposition that lack of knowledge and training is a key barrier to implementing and sustaining LM. The focus group interviews revealed 5 sub-themes enlisted below:

1. Training offered by the organization.
2. Training requirements by staff.
3. Training for new starters.
4. Training for new Processes and Procedures.
5. Recognition after training.

Sub-theme 1: Training offered by the organization

The consensus among all focus groups indicated that, owing to cash flow limitations, training has ceased to be a priority at company XYZ.

Focus group 1 response

This used to happen when a while ago, for the past 6 or so years training is not being emphasized anymore due to cashflow constraints.

Certain Focus Groups emphasized that, despite the existence of training programs for new employees, the extent of this training has diminished compared to approximately six years ago, when new employees in Japan received more comprehensive training.

Focus group 2 response

Operators are trained when newly recruited. In the past, they would even be taken to Japan, but this has not happened in a long while, maybe five or six years now.

Sub-theme 2: Training requirements by staff

This sub-theme further collated data on what the staff members individually and collectively require skills enhancement on. Where line managers have relinquished significant control, and workers have had the requisite levels of literacy, more powerful forms of learning have occurred, and the outcomes are mutually beneficial (Sterling and Boxall, 2012). Most of the focus groups revealed that they require training in soft skills and Microsoft Office, whilst a few others also added Management Development programs to the discourse. The sample responses are listed below:

Focus group 1 response

Microsoft Excel is a powerful tool if you know it very well. We also need to be trained in the most efficient ways of production that our affiliates are using, we might still be using the old ways that we know yet the world has progressed.

Focus group 4 response

SAP, Toyota systems, MS Office especially Advanced Excel.

Focus group 5 response

Microsoft Excel, Soft Skills, Management Programmes

Sub-theme 3: Training for new starters

According to Lai *et al*. (2022) in LM, training should be compulsory for all new direct workers in the organization, and further training is required when there are improvements or process changes related to the worker. The investigation on this sub-theme revealed that some training is conducted for new starters even though the respondents preferred the training levels that were subjected to most of them when they were onboarded. Two of the examples are shown below:

Focus group 2 response

The new employees no longer have Japan trips like we did when we joined, those were very good as you would see how your job is done in the first world. However, they are trained locally on how their job is done and how the processes are maneuvered.

In addition to the aforementioned discussion, one of the groups proposed exploring training focused on the more intricate aspects of the job to bolster the confidence of new employees.

Focus group 4 response

The newly recruited staff are trained before they start. However, because of the urgency of doing the tasks, some finer details are always overlooked in our opinion.

They are given a few trial runs, and then a certificate to do the job. The training is not even for a long time but just one session. Maybe this may need a review to ensure that the newly recruited members are very confident and are executing their work excellently.

Sub-theme 4: Training for new processes and procedures

Lai *et al.* (2022) asserted that addressing workers' fear of new methods or procedures taking over their jobs is paramount when planning for improvement and innovation in a manufacturing environment as there have been indications that workers fear that LM implementation leads to job losses, and therefore tend to resist any required changes. Consequently, it is hard to assume that workers will openly accept any continuous improvement effort, even if it is for the good of the organization. The focus group interviews revealed that there is some form of training at the inception of a new project or procedure as guided by the Toyota systems. One of the focus groups responses is shown below:

Focus group 5 response

The process of introducing a new process or procedure is very thorough. We have adopted the Toyota way. We use the 1A when one part is produced, all checks are done, and all learnings are recorded. Then we produce the Goshi parts, meaning more than one part is produced just to check the consistency of the process. When there is a green light, we then move on to MPT, which is a Mass Production trial where the mass production will be mimicked. After the MPT has passed, then we proceed to SOP, which is the Start of Production. During all these stages, the operators will be trained, and improvements and Kaizens will also be noted and implemented in the process. By the time production starts, all members are ready.

Sub-theme 5: Recognition after training

Lai *et al.* (2022) empirically established that supervisors' support and recognition of the workers is beneficial for an intense lean production environment. According to (Murphy, 2023), the approach an organization takes to recognition must be linked to strategic objectives and communicated to all employees, and essentially, for recognition to be impactful it does not have to be grand gestures. In fact, regular, genuine, and personalized affirmations are more motivating and are likely to enhance engagement and loyalty. The responses of the focus group interviews revealed that all the respondents mentioned that remuneration review should be part of the recognition. One of the examples is quoted below:

Focus group 2 response

Salary increases to match the level of knowledge and skill.

We spend more than 8 hours at work, and we have no other means to make other sources of income, hence this workplace should make us live comfortably.

At times simple things like free lunch or small gifts after completion also go a long way.

4.7.6 Theme 6: Muda

This theme aligns with Fliedner (2016) quoted in the abstract that Muda is one of the types of waste that can impede process efficiencies. According to Arunagiri and Gnanavelbabu (2014), mostly there are seven types of industrial Muda in lean systems such as defects, overproduction of things not demanded by actual customers, inventories awaiting further processing or consumption, unnecessary over-processing, unnecessary motion of employees, unnecessary transport and handling of goods, waiting for an upstream process to deliver, or for a machine to finish processing, or for a supporting function to be completed. Ramkumar *et al.* (2019) concluded that the identification and quantifying of waste makes management more cautious about practicing waste reduction. In concurrence, Pienkowski (2014) concluded that waste measurement is a key component needed to achieve a successful LM implementation, and empirically validated the three main conditions for effectively adopting a waste measurement system as listed below:

1. Complex waste identification, which facilitates the elimination of root causes of waste, and not symptoms only.
2. Using quantified waste metrics, which allow proper control of a process.
3. Developing response standards for all detected problems, which supports and accelerates the decision-making process.

Insights from the focus group interviews demonstrated that, although waste can be detected, there is no established methodology for quantifying Muda. One of the groups emphasized that waste quantification involves considerations beyond simply tallying the number of rejects. The results from the focus groups are outlined below:

Focus group 2 response

The system for counting waste is not so clear. It is easy to count the rejects, but the waste in mass, in litres, in minutes, in manpower, etc. is never accounted for. There is more to waste.

4.7.7 Theme 7: Bottleneck

According to Urban and Rogowska (2018), bottlenecks limit the capacity and throughput of the production system, resulting in, among others, stagnant production, local accumulation of stocks, and above all reduced productivity of the system. According to Ghatorha and Sharma (2019), bottleneck analysis involves the collection of complete data followed by a detailed analysis of the manufacturing flow of a product or process in a production line and suggested the following bottleneck analysis steps:

1. Data collection: In this step, the data related to workflow in a particular process is gathered in the form of process charts. These charts show every activity of the process sequence-wise.
2. Measurement of cycle time: In this step, the information regarding the time required to complete every activity of the process is gathered.
3. Identification of bottleneck activity: In this step, the activity with the highest processing time is identified. That activity is responsible for setting the overall cycle time of the process. Any reduction in the cycle time of the process will be possible only through improvement in the processing time of that activity.

The investigation has uncovered two bottleneck-related sub-themes, which are:

1. Definition of the bottlenecks.
2. Current operators' work plan.

Sub-theme 1: Definition of the bottlenecks

A bottleneck is the congestion point in the production system that reduces productivity (Urban and Rogowska, 2018). This research revealed that at company XYZ, bottlenecks are not clearly defined on paper, but they are known by the staff members.

According to (Simpson, 2017), bottlenecks vary in severity, from temporary hold ups caused by employee absence to more serious structural issues that need in-depth analysis to correct. The results from all the focus groups were all in concurrence with each other.

Focus group 1 response

Yes, the major bottleneck in the steering wheel process that is observable visually is the leather stitching process. This depends solely on the skill, the availability, and the mood of the stitching operators. It's a very specialized task and hence the operators feel very entitled and have higher demands than the rest of the staff. Recently they lobbied that their grades be changed.

Focus group 2 response

They are not defined on paper, but we can see them.

The stitching station is a bottleneck, you would find many work-in-progress queues. The dispatch is a bottleneck as some parts get stuck in the production line when they are ready to be dispatched because there's no space at dispatch.

Sub-theme 2: Current operators' work plan

This sub-theme aimed to explore the allocation of workload within the steering wheel process at company XYZ. The participants exhibited varying levels of consensus on the matter.

Focus group 2 response

No, this is a major issue to the operators, major bottle neck is in the stitching process, then followed by the frame washing bay.

Focus Group 3 Response

The distribution of the workload is fair, even though certain stations do show to be bottlenecks based on parts that are waiting. For instance, only one person can stitch a particular side of the steering wheel, you will not be able to put two operators in that type of process.

4.7.8 Theme 8: Teamwork

According to Kozlowski and Ilgen (2006), a team can be defined as two or more individuals who are brought together to perform organizationally relevant tasks. This theme is consistent with section 2.4.1 literature reviewed from Lodgaarda *et al.* (2016) which states that lack of Teamwork is a barrier to LM implementation. This was concurred by Almanei *et al*. (2018) in section 2.4.4 where Teamwork was asserted as an LM driver implying that the absence thereof impedes LM. This theme displayed two subthemes, namely:

1. Group problem solving.
2. Cross-Functional Teams

Sub-theme 1: Group problem solving

According to Kozlowski and Ilgen (2006), the task determines the workflow structure and coordination demands. Some advantages of Group problem solving cited by Burke (2011) are listed below:

1. Groups have more information than a single individual. Groups have a greater well of resources to tap into and more information available because of the variety of backgrounds and experiences.
2. Groups stimulate creativity. Regarding problem-solving, the adage that two heads are better than one can be applied.
3. Group work allows people to gain a more accurate understanding of how they are perceived by their colleagues. The constructive feedback received may help them evaluate their interpersonal behaviour.

(Smart, 2024) concluded that Team-building activities can make a difference when it comes to job satisfaction, employee engagement, and organizational success. This research revealed that Management encourages Group problem-solving and cross-functional teams, however, these are not happening practically. The respondents confirmed their observation and admiration of the Toyota group's solution and wished it could apply to company XYZ.

Focus group 2 response

Yes, it is encouraged but not happening as much as we have seen it happening at Toyota when we go for plant tours and visits. Solving a problem within a team is easy, it gets complicated when there is collective effort required between different departmental teams.

Sub-theme 2: Cross-functional teams

According to Lovelace *et al*. (2001), cross-functional teams facilitate in solving an information processing problem by bringing persons from different disciplines and functions who have pertinent expertise about the problem at hand. Through an empirical investigation, Daspit *et al.* (2013) concluded that the internal environment influences cross-functional team effectiveness directly through shared leadership and cohesion. The focus group interviews revealed that the cross-functional teams at company XYZ are not effective as departments do not prioritise them as they focus only on their departmental KPIs.

Focus group 1 response

Not really, each department focuses on its KPIs and at times it's very difficult to get the consensus of the other department, for example when carrying out cost reduction activities, the Quality department is absent most of the time because they claim that their job is to ensure Quality control in production, and they usually refuse to allow any changes to the parts or raw material because they are too careful that the new parts or raw material will fail.

4.7.9 Theme 9: Supplier involvement

Suppliers that develop lean practices will tend to perform better than suppliers that do not (Cudney and Elrod, 2011) cited in Manfredsson *et al.* (2019). Collaboration built by the company with suppliers is a form of partnership as a strategic relationship that aims between the company and suppliers to share compatible goals strive for mutual benefit and recognize a high level of interdependence (Tanuwijaya *et al*: 2021) cited in Riofiandi and Tarigan (2022). This investigation revealed two sub-themes listed below under the main theme of Supplier involvement.

1. Involvement of suppliers in Quality Improvement activities.

2. Involvement of suppliers when launching a new product or service.

Sub-theme 1: Involvement of suppliers in quality improvement activities

Insights gained from the focus group interviews indicate that suppliers are involved in activities related to quality enhancement, as exemplified by one of the responses listed below:

Focus group 2 response

Yes, our suppliers are involved as early as we obtain a Request for Quotation until the End of Life of the project. For new processes, our Engineers work together with our suppliers should there be a process change on a particular part or component. Not much for steering wheels so far, but many examples for other parts.

In addition to this discourse, another Focus Group added that bigger companies are tardy in cooperating, which is in line with Bhasin (2012) that the Lean benefits are not always obvious since the connection between financial and non-financial measures is fragile, hence larger organizations tend not to be driven by smaller customers to conduct Lean.

Focus group 3 response

It's easier to monitor and involve smaller suppliers. Bigger Suppliers are difficult to monitor as they usually don't give us enough opportunity to interact with the relevant departments and staff members.

Sub-theme 2: Involvement of suppliers when launching a new product or service

Due to increasing complexity, it is difficult for each firm to know all of the technologies that are implemented into their products (Grant and Baden Fuller, 2004) cited in Melander (2014). By collaborating and using supplier involvement in new product development, firms can tap into and take advantage of the suppliers' knowledge Melander (2014). The Focus Group results reveal that suppliers are involved as early as the new product is shared with company XYZ until the end of life of that product.

Focus group 2 response

Yes, our suppliers are involved as early as we obtain a Request for Quotation until the End of Life of the project. For new processes, our Engineers work together with our suppliers should there be a process change on a particular part or component. Not much for steering wheels so far, but many examples for other parts.

4.7.10 Theme 10: Surveys

This theme is consistent with section 4.6.3.2 that customer surveys may provide important insights into customer behaviours, knowledge and attitudes, Brass (2015: para. 1 line 1). Two sub-themes emanated from this theme and are listed below:

1. Customer Preference Surveys.
2. Customer Satisfaction Surveys.

Sub-theme 1: Customer preference surveys

While the automotive sector garners significant attention, the scientific literature available on the subject is surprisingly minimal and fragmented. In contrast to other disciplines, there is a lack of comprehensive research examining consumer preferences for automobiles (Ciasullo *et al.* 2019). All respondents unanimously noted that company XYZ does not undertake customer preference surveys. A selected response conveys the subsequent viewpoint:

Focus group 1 response

This is not tracked; we have never seen any survey of this nature.

Sub-theme 2: Customer satisfaction surveys

The retention of customers by a service provider is contingent upon its ability to satisfy their needs (Utama *et al*. 2020). All respondents indicated that customer satisfaction surveys are not implemented. A pertinent example is presented below:

Focus group 5 response

We have never seen the customer satisfaction feedback. This information is not shared in the Obeya as well.

4.7.11 Theme 11: Customer complaints

One important aspect of LM is the focus on continuous improvement, which means that companies must investigate customer complaints to identify the root cause of the problem and implement corrective actions to prevent it from happening again in the future (Hlungwane, 2023). According to Zairi (2000), customer complaints handling is not a substitute for abdicating the responsibility for managing quality and achieving customer satisfaction, although the former and the latter are nothing but synonymous expressions and quite compatible concepts. The focus group interviews intimated that there is a system used to handle customer complaints and almost all the focus groups concurred that Toyota issues the complaints which are then handled through the internal customer complaints systems. One of the focus group responses is exhibited below:

Focus group 1 response

Toyota issues us a performance report monthly. We use this information internally in our performance management system. We also get some steering wheels back from Toyota to repair, mainly if the leather is cracked or if there is a problem with the electronics, we restart the fault finding and solve it. However, our priority is not to have customer returns.

4.7.12 Theme 12: Target visualisation

This theme is congruent with the conclusions of the literature review found in section 4.7.1.1, particularly sub-theme 2, which asserts that there has been minimal discourse surrounding LM targets. It encompasses two sub-themes, as detailed below:

1. Visualisation of performance targets
2. Adherence to daily performance targets

Sub-theme 1: Visualisation of performance targets

This theme is corroborated by the literature discussed in section 4.6.1.1, specifically the findings of Alaasar (2017), which characterize the Obeya as a space for visualization. The research indicates that company XYZ has progressed from using manual notice boards to employing digital andons that showcase real-time information. Treville *et al.* (2023) define andon as a visual mechanism that signals where action is needed. It is a standard tool in the application of the Jidoka principle, or autonomation, which involves promptly identifying issues to implement countermeasures and avert recurrence.

Focus group 2 response

We use the Obeya room for all the targets. The Obeya room now has digital screens that display real-time data from all the lines and very essential information.

Sub-theme 2: Adherence to daily performance targets

Soliman (2014) defined lean metrics commonly known as performance measures in five different metric categories: Time metric, Cost metrics, Quality Metrics, Output metrics, and Process Complexity metrics. This research revealed that Production targets are strictly adhered to, unlike other targets. The subsequent examples showcase two response exhibits:

Focus group 2 response

For Production yes daily targets are adhered to. For Maintenance, maybe not quite, because at the time Production does not release machines for Maintenance as scheduled and then Maintenance has to be postponed. Other departmental targets can be subject to the requirements to meet that target for instance a target to localize all the imported parts of the steering wheel can be subject to the availability of the required parts in the market.

Focus group 4 response

Production targets are prioritized. Quality targets are not met at times, we have got a yellow card from our customer. Maintenance targets are usually a finding in ISO Audits, most checklists are not completed well or filled and have dates when checks were not even done. Marketing and Logistics targets are usually not shared on these platforms.

4.8 Chapter summary

This chapter focused on the presentation of findings derived from the data collection process, which employed the three research instruments outlined in Chapter 3. The demographics of the participants were examined under subheadings that categorized participant types, including educational attainment levels, company grade, age, inclusion and diversity, and ethnicity. A word cloud was employed to illustrate the most significant data in a visual format, arranged from largest to smallest. The thematic analysis involved the identification of codes, themes, and sub-themes. Data from focus group interviews and individual interviews was imported into NVivo, where the identified codes, themes, and sub-themes were utilized to explore the drivers and barriers of LM.

CHAPTER 5

DATA TRIANGULATION

This chapter evaluates the validity of the qualitative research strategy by examining the convergence of data obtained from one-on-one interviews, focus groups, and participant observation methodologies.

5.1 Introduction

The purpose of this chapter is to formulate a framework that supports the identification of convergences and divergences arising from a range of research instruments, drawing upon a detailed review of the literature.

5.2 Triangulation

The concept of triangulation has a long history in the field of social sciences, encompassing scholars who use quantitative, qualitative, and mixed methods (Campbell *et al.* 2020). Hopf *et al.* (2016) defined triangulation as investigating the same subject using disparate modus operandi. Hopf *et al. (*2016) defined triangulation as investigating the same subject using disparate modus operandi. According to Donko and Mensah (2023), triangulation is derived from the triangle analogy and implies considering a single point from multiple independent sources. According to Mercedes and Valencia (2022), triangulation can be defined as the combination of multiple methods in studying the same object or event to better address the research objectives. Multiple sources of data triangulation enhance reaching data saturation, mitigate bias, enhance reaching data saturation, and add depth to the data that is collected (Fusch *et al.* 2018).

5.3 Types of triangulation

Denzin (1989) cited in Fusch *et al*. (2018) deduced the following types of triangulations:

1. Methodological triangulation for correlating data from multiple data collection methods.
2. Investigator triangulation for correlating the findings from multiple researchers in a study.
3. Data triangulation for correlating people, time, and space.
4. Theory triangulation for using and correlating multiple theoretical strategies.

Fusch *et al.* (2018) concluded that data triangulation has three subtypes, i.e.
time, space, and persons, whereas methodological triangulation can entail within-method and between-method triangulations. According to Tokin-Crine *et al.* (2016), a triangulation protocol can enhance the findings validity and assess if the data agree

(convergence), complement one another (complementarity), or contradict each other (divergence). Tokin-Crine *et al*. (2016) identified the four types of triangulation protocols to be the same as the methods of triangulation deduced by Fusch *et al.* (2018) in section 5.2, hence it can be deduced that triangulation methods and triangulation protocol can be used interchangeably.

5.3.1 Methodological triangulation

According to Morse (1991), methodological triangulation is the use of at least two methods of data collection and can involve the use of both qualitative and quantitative data collection methods. Donko and Mensah (2023) concurred that methodological triangulation employs multiple approaches within the same research approach, for example, in one study, the researcher may use documentary analysis, observation, and focus group interviews as research instruments. Denzin (2009) cited in Fusch *et al*. (2018) stated that methodological triangulation is utilized to account for flaws and deficiencies of each research instrument used by combining them.

According to Jahanzeb *et al.* (202), the three most important features of methodological triangulation are:

1. Consistency (seeing if there are same results).
2. Contrast (seeing if the findings contradict each other).
3. Complementarity (seeing if the findings add a new perspective to the findings already conceived from a different method).

5.3.2 Investigator or researcher triangulation

More than one investigator conducts the data collection, analysis, and or interpretation of data to evaluate how the investigators conclude similarly. (Campbell *et al.* 2020). According to Donko and Mensah (2023), two or more investigators or researchers, conduct different roles in the conduct during data gathering, and teamwork and collaboration between the researchers are paramount. If the findings from the different researchers provide the same conclusion, then the Confidence in the research would be heightened Guion *et al*. (2022).

5.3.3 Data triangulation

According to Campbell *et al*. (2020), Denzin defined data triangulation as collecting data from multiple sources which can be people or stakeholders, across time, space, and person. Guion *et al*. (2022) added to the discourse that extensive follow-up interviews could be conducted with each of the stakeholders to gain more understanding of their perspectives on the subject being investigated and feedback from the stakeholders would be compared to determine convergence or divergence. Donko and Mensah (2023). According to (Turner, 2016), what people share in a focus group may be limited by issues of privacy and fear of victimization than what they would reveal in a one-to-one interview, notwithstanding in a focus group, dynamic people can also be reminded of some issues they might forget to talk about otherwise.

5.3.4 Theory triangulation

According to Guion *et al.* (2022), in theory, triangulation multiple perspectives are utilized to interpret a single set of data, and this method typically entails using professionals outside of a particular field of study, unlike investigator triangulation. (Turner, 2016) added to this discourse that in theoretical triangulation, a variety of theories are used to explicate the data. Theory triangulation involves testing alternative explanations, rival theories, or rival hypotheses obtained through research Donko and Mensah (2023). Fusch *et al*. (2018) added to the discourse that a strategic approach is for the researcher to utilize the raw data to establish a new theory.

5.4 LM case study

The research methodology of this experiment was Qualitative Research explained in section 3.2. In line with the Methodology stated in Section 3.5.3, objectives 3 and 4, data collection was undertaken by using focus group interviews, one-on-one interviews, and participant observations. Thematic analysis was executed, and data analysis was conducted using NVivo. According to section 5.2, the selected triangulation method for this research was Data triangulation elucidated in section 5.2.3.

5.4.1 Convergence coding scheme

The convergence coding scheme used was adapted from Farmer *et al.* (2006) and summarized in Table 27 below:

Table 27: Convergence coding

Coding label	**Convergence coding**
Agreement	The finding has been identified
Partial agreement	The finding is covered partially
Disagreement or divergence	The finding is contradicted
Silence	The finding does not appear
Not applicable	Not mentioned in any data source

Source: *Adapted from Farmer et al. (2006)*

The five coding labels derived from each pairwise comparison of data sets, as adapted from Tokin-Crine *et al.* (2016) and illustrated in Figure 59, were employed in the triangulation process.

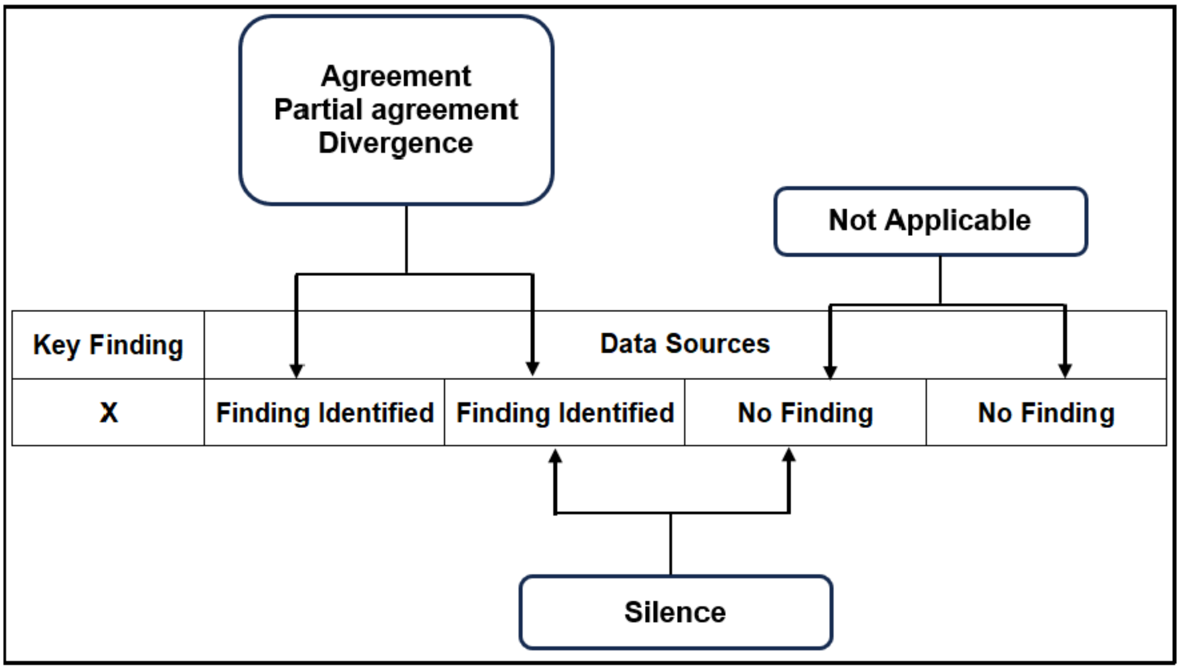


Figure 60: The five coding labels as a result of each pairwise comparison

Source: *Adapted from Tokin-Crine et al. (2016)*

5.5 Results

The data triangulation protocol was enacted by leveraging the themes and sub-themes generated from the thematic analysis. This triangulation was validated through comparison with the literature review, focus group discussions, individual interviews, and participant observations.

5.5.1 Triangulation of the LM drivers

The results of the LM drivers triangulation are tabulated in Table 28 below:

Table 28: Overview of identified key LM drivers and how they triangulate across the literature review and the three studies adapted from Hopf et al. (2016)

Theme	Subtheme	Literature review	One-on-one Interviews	Focus Group Interviews	Participant Observation
Factors affecting Supplier selection	Supplier Margins	Partial agreement	Agreement	Silent	Partial agreement
	Supplier selection methods	Agreement	Agreement	Silent	Agreement
	Material costs	Agreement	Agreement	Silent	Agreement
	Purchasing policies	Partial agreement	Partial agreement	Silent	Silent
	Supplier location	Agreement	Agreement	Agreement	Agreement
Assessing technological capability of the local company	Plant age	Agreement	Agreement	Silent	Agreement
	Affiliate technology	Agreement	Agreement	Silent	Agreement
	Affiliate comparison	Agreement	Agreement	Silent	Agreement
	Production volumes	Agreement	Agreement	Agreement	Agreement
	Improving production volumes	Agreement	Agreement	Agreement	Partial agreement
Indirect costs cutting measures	Costs cutting measures for energy and water expenses	Silent	Agreement	Agreement	Agreement
	Overhead costs cutting measures	Agreement	Agreement	Agreement	Agreement
	Implementing water consumption costs cutting measures	Silent	Agreement	Agreement	Agreement
	Energy costs cutting measures	Agreement	Agreement	Silent	Partial agreement
Types of energy	Types of energy	Silent	Silent	Silent	Silent

	Alternative energy sources	Silent	Silent	Silent	Silent
Localization in comparison to shipping expenses	Localization	Agreement	Agreement	Agreement	Agreement
	Mode of transport	Agreement	Agreement	silent	Partial agreement
	Packaging	Agreement	Agreement	Silent	Agreement
	Shipping agencies	Silent	Silent	Silent	Silent
	Shipping frequency	Agreement	Agreement	Silent	Agreement
	Stock levels	Agreement	Agreement	Silent	Agreement
Production related	Quality	Agreement	Agreement	Agreement	Agreement
	Poke yoke and Fail Safe	Agreement	Silent	Agreement	Agreement
	Maintenance	Agreement	Agreement	Agreement	Agreement
	Manufacturing set up	Silent	Agreement	Agreement	Agreement
	Housekeeping	Agreement	Agreement	Agreement	Agreement
	Kanban	Agreement	Agreement	Agreement	Agreement
Process related	Process	Agreement	Agreement	Agreement	Agreement
	New Process	Agreement	Agreement	Agreement	Agreement
	Lean adoption	Agreement	Agreement	Agreement	Agreement
	Commitment	Agreement	Silent	Agreement	Agreement
Customer related	Customer demands	Agreement	Silent	Agreement	Agreement
	Customer satisfaction	Agreement	Silent	Agreement	Agreement
	JIT	Agreement	Agreement	Agreement	Agreement

Source: *Researcher's own construction*

As illustrated in Table 28, the triangulation protocol led to the discovery of 35 pivotal findings linked to eight sub-themes of Lean drivers, which were recognized across all four studies, highlighting a substantial level of agreement among the findings. Findings showed near-perfect agreement (full, partial, or with at least one silent) between the research instruments (28/35, 80%). Total Silence was reflected in (3/35, 9%) of the findings. The other (4/35, 11%) represented mixed findings. No disagreement on any finding was noted between the qualitative studies.

The following sub-themes in Table were not supported by the literature review, nevertheless, all the utilized research instruments revealed the sub-themes to be very essential drivers for LM implementation for company XYZ.

Table 29: Sub-themes not supported by literature review

Subtheme	Literature review	One-on-one Interviews	Focus Group Interviews	Participant Observation
Costs cutting measures for energy and water expenses	Silent	Agreement	Agreement	Agreement
Implementing water consumption costs cutting measures	Silent	Agreement	Agreement	Agreement
Manufacturing set up	Silent	Agreement	Agreement	Agreement

Source: *Researcher's own construction*

The sub-themes outlined in Table 30 were substantiated by the literature review and all research methodologies applied, with the exception of the one-on-one interviews, where these themes were not mentioned. Nonetheless, they are acknowledged as key elements driving the implementation of LM at company XYZ.

Table 30: The sub-themes not supported by one-on-one interviews

Subtheme	Literature review	One-on-one Interviews	Focus Group Interviews	Participant Observation
Poke yoke and Fail Safe	Agreement	Silent	Agreement	Agreement
Commitment	Agreement	Silent	Agreement	Agreement
Customer demands	Agreement	Silent	Agreement	Agreement
Customer satisfaction	Agreement	Silent	Agreement	Agreement

Source: *Researcher's own construction*

The sub-themes presented in Table 31 received validation from the literature review and all research instruments employed, with the exception of the focus group interviews, where these themes were not mentioned at all during the discussions. Nevertheless, they are considered critical factors for the implementation of LM at company XYZ.

Table 31: The Sub-themes not supported by focus group interviews

Subtheme	Literature review	One-on-one Interviews	Focus Group Interviews	Participant Observation
Supplier selection methods	Agreement	Agreement	Silent	Agreement
Material costs	Agreement	Agreement	Silent	Agreement
Plant age	Agreement	Agreement	Silent	Agreement
Affiliate technology	Agreement	Agreement	Silent	Agreement
Affiliate comparison	Agreement	Agreement	Silent	Agreement
Packaging	Agreement	Agreement	Silent	Agreement
Shipping frequency	Agreement	Agreement	Silent	Agreement
Stock levels	Agreement	Agreement	Silent	Agreement

Source: *Researcher's own construction*

5.5.2 Triangulation of the LM barriers

The results of the LM barriers triangulation are tabulated in Table 32 below:

Table 32: Overview of identified key LM barriers and how they triangulate across the literature review and the three studies adapted from Hopf et al. (2016)

Theme	Subtheme	Literature review	One-on-one Interviews	Focus Group Interviews	Participant Observation
Staff	Skill	Agreement	Agreement	Agreement	Agreement
	Staff Turnover	Silent	Silent	Silent	Silent
	Union affiliation	Partial agreement	Silent	Agreement	Agreement
	Training and Learning	Agreement	Partial agreement	Partial agreement	Partial agreement
Customer	Customer Involvement	Agreement	Silent	Partial agreement	Partial agreement
	Customer Profitability	Silent	Silent	Silent	Silent
	Lean Information	Agreement	Partial agreement	Partial agreement	Partial agreement
Cost Markers	Profitability	Agreement	Agreement	Agreement	Agreement
	Cost Reduction	Agreement	Agreement	Agreement	Agreement
	Kaizen	Agreement	Agreement	Agreement	Agreement
	Maintenance	Agreement	Disagreement	Disagreement	Disagreement
HQ	Information about HQ Perception	Silent	Agreement	Agreement	Agreement
	Frequency of the Information	Silent	Agreement	Agreement	Agreement
Teamwork	Group Problem Solving	Agreement	Disagreement	Disagreement	Partial agreement
	Cross-Functional Teams	Agreement	Disagreement	Disagreement	Partial agreement
Supplier involvement	Involvement of suppliers in Quality Improvement activities	Partial agreement	Agreement	Agreement	Agreement
	Involvement of suppliers when launching a new product or service	Partial agreement	Agreement	Agreement	Agreement

Surveys	Customer preference surveys	Agreement	Silent	Silent	Silent
	Customer satisfaction surveys	Agreement	Silent	Silent	Silent
Targets	Visualization of performance targets	Agreement	Agreement	Agreement	Agreement
	Adherence to daily performance targets	Silent	Partial agreement	Partial agreement	Partial agreement
Customer complaints	Customer Complaints	Agreement	Agreement	Agreement	Agreement
New customers	Number of new customers	Silent	Partial agreement	Partial agreement	Partial agreement
	Sales to new customers	Silent	Partial agreement	Partial agreement	Partial agreement
	New Customer surveys	Silent	Partial agreement	Partial agreement	Partial agreement
	Number of new customers referred by existing customers	Silent	Partial agreement	Partial agreement	Partial agreement
Decision making	Decision making	Silent	Partial agreement	Partial agreement	Partial agreement
Muda	Muda	Agreement	Partial agreement	Partial agreement	Partial agreement
Bottleneck	Bottleneck	Agreement	Partial agreement	Partial agreement	Partial agreement

Source: *Researcher's own construction*

Based on the triangulation protocol shown in Table 32, a total of 29 key findings based on eight sub-themes of Lean barriers were identified across all four studies and the interstudy level of agreement. Findings showed near-perfect agreement (full, partial, or with at least one silent) between the research instruments (22/29, 76%). Total Silence was reflected in (4/29, 14%) of the findings. The other (3/29, 10%) represented findings that were mixed with disagreements.

The sub-themes presented in Table 33 were not corroborated by the literature review; however, all research instruments employed indicated that these sub-themes represent significant barriers to the implementation of LM at company XYZ.

Table 33: Sub-themes not supported by literature review

Subtheme	Literature review	One-on-one Interviews	Focus Group Interviews	Participant Observation
Information about HQ Perception	Silent	Agreement	Agreement	Agreement
Frequency of the Information	Silent	Agreement	Agreement	Agreement
Adherence to daily performance targets	Silent	Partial agreement	Partial agreement	Partial agreement
Number of new customers	Silent	Partial agreement	Partial agreement	Partial agreement
Sales to new customers	Silent	Partial agreement	Partial agreement	Partial agreement
New Customer surveys	Silent	Partial agreement	Partial agreement	Partial agreement
Number of new customers referred by existing customers	Silent	Partial agreement	Partial agreement	Partial agreement
Decision making	Silent	Partial agreement	Partial agreement	Partial agreement

Source: *Researcher's own construction*

The sub-themes presented in Table 34 received validation from the literature review and all research instruments employed, with the exception of the one-on-one interviews, which did not address these themes during the study. Nonetheless, they are still considered significant barriers to the implementation of LM at company XYZ.

Table 34: The sub-themes not supported by one-on-one interviews

Subtheme	Literature review	One-on-one Interviews	Focus Group Interviews	Participant Observation
Union affiliation	Partial agreement	Silent	Agreement	Agreement
Customer Involvement	Agreement	Silent	Partial agreement	Partial agreement

Source: *Researcher's own construction*

The themes derived from the Focus Group Interviews and Participant Observation, which demonstrated a near-unanimous agreement, did not uncover any silent subthemes.

5.6 Chapter Summary

Commencing with a succinct definition of triangulation, the chapter further investigated the various categories of triangulation documented in the literature. It concluded by affirming that data triangulation is the most effective strategy for this research initiative. Convergence coding labels were categorized into five distinct types: agreement, partial agreement, disagreement, silence, and not applicable. Subsequently, triangulation was applied to the LM drivers and barriers that were outlined in Chapter 4.

CHAPTER 6

CONCEPTUAL MODEL AND THEORETICAL FRAMEWORK

This Chapter extends the discourse of the philosophical ideas that were postulated in Chapter 2 in conjunction with this research's findings in line with the Thesis objectives.

6.1 Introduction

This chapter links the concepts, variables, and all the literature review phenomena that apply to LM implementation and how they can be utilized to form a framework that can be used for a steering wheel manufacturer. This study aimed to develop and implement a lean manufacturing framework at a selected South African steering wheel manufacturer, and the following objectives were deduced to achieve the aim:

1. To explore the key drivers for implementing LM.
2. To explore the possible barriers to implementing LM concerning a systematic literature review.
3. To investigate the manufacturing performance of the current steering wheel manufacturing process with regard to LM drivers and barriers by using focus groups, one-on-one interviews, and participant observation.
4. To explore the prevalence of overcoming the LM barriers and challenges.
5. To develop a conceptual LM implementation framework based on the drivers and barriers.
6. To empirically validate the LM implementation framework.

Chapter 2 of this study validates the successful fulfillment of Objectives 1, 2, and 4 through an extensive literature review. The achievement of Objective 3 was made feasible by employing focus group interviews, individual interviews, and participant observations, as described in Chapters 3 and 4. Additionally, the proposed conceptual framework is applied to meet the requirements of Objectives 5 and 6.

6.2 Alignment with the context of research

In Chapter 1, section 1.1, the research postulates a detailed description of the context of research and implementation of a lean manufacturing framework at a selected South African steering wheel manufacturer. This furnished the research with a meticulously defined knowledge of Lean implementation by examining the existing frameworks and further expounding through the data analysis chapter and succeeding data analysis chapters. The researcher affirmed credibility by adopting section 3.7.1 of the thesis into practice during the execution of the data collection and analysis phases. Additionally, the respondent's statements have not only been utilized in the research but also quoted to allow the reader to comprehend the anecdotal experience described by the respondents.

6.3 Juxtaposing results against previous studies

Previous studies were expounded in the literature review section of the Thesis. Several LM Implementation Frameworks were discussed, however, none was conducted for a steering wheel manufacturing component manufacturer in South Africa and beyond. The results of this research were therefore juxtaposed against some automotive component manufacturers or researchers who had studied similar phenomena. The ability of this research to fill this gap in literature exhibits the efficacy of this study in the field of Lean Manufacturing Implementation in a steering wheel manufacturing setup.

6.3.1 Lean manufacturing drivers reported in the selected literature

The LM drivers were assessed via a literature review, and the results were systematically arranged in Table 35. This assessment provided the researcher with insights into the significant areas that required focus.

Table 35: The LM drivers explored through the literature review

Item	Lean Manufacturing Drivers	Description	Literature Support
1	Improved competitiveness	To improve Manufacturing processes to reduce costs and improve competitiveness	Niemann *et al.* (2018)
2	Resource efficiency for cost-saving	To improve and optimize the allocation of resources	Niemann *et al.* (2018)
3	Fast, flexible, and efficient processes	To improve Manufacturing processes to reduce costs	Coutinho (2021)
4	Innovative products.	Varie and reliable	Coutinho (2021)
5	Operational flow	Stable and uninterrupted operational flow	Coutinho (2021) Yandell (2012)
6	Employees	It includes enhancement motivation, engagement, and multi-functionality of employees to improve their output.	Coutinho (2021) Logu et al. (2021) Zvidyayi (2021)
7	Performance indicators	Constantly stimulated	Coutinho (2021)
8	Process Errors	Enhancements of the manufacturing process to reduce errors and defects.	Yandell (2012)
9	Single Minute Exchange of Dye (SMED)	To conduct many change-over steps externally while the equipment runs, thereby simplifying and streamlining the remaining steps.	Yandell (2012)
10	Rationalization of companies, plants, and models	Reorganization of companies to increase operational efficiencies.	Logu *et al.* (2021)

11	Benchmarking Product Quality	Meeting world standards of product quality	Logu *et al.* (2021)
12	Benchmarking Plant and equipment	Major investment in plant and equipment to meet world-class standards	Logu *et al.* (2021)
13	Reorganizing supply chains	To achieve supply advantages from distinct geopolitical locations where the suppliers are based.	Logu *et al.* (2021) Ambe (2017)
14	Production Improvement	Identification of wastes and improving efficiencies	Ambe (2017)
15	Inventory Management FIFO/LIFO, EOQ, Kanban	Application of the push technique, the pull technique, and JIT.	Ambe (2017) Tarver (2023) Htun *et al. (*2019) Rahman *et al*. (2013)
16	Sourcing	Improving the identification of sources for raw materials, optimizing processes, and adapting to changes in the market landscape	Ambe (2017)
17	Demand Forecasting	Optimisation of systems for predicting the amount of inventory a business will need to meet future customer demand	Tarver (2023)
18	Top management, Middle Management, Junior Management involvement and commitment	Provision of adequate resources to support change, external support from consultants and effective communication and engagement"	Zvidyayi (2021)
19	Culture Change	The sustainability of driving continuous improvement efforts	Zvidyayi (2021)
20	Suppliers, vendors, and customers	Support from Suppliers, vendors, and customers	Zvidyayi (2021)
21	Cost Quality and Time	The relationship of cost quality and time in LM implementation	Varghese (2020)
22	Unionization	The effect of employee union organizations in LM and continuous improvements.	Shah and Ward (2003)
23	Plant age and size	The contribution of plant age and or size to LM implementation.	Shah and Ward (2003)
24	Cellular Manufacturing	Grouping part families and processes to reduce transportation waste and improve efficiency.	Bhat (2008)
25	Customer Demands	Implementation of optimized processes to improve customer demands.	Coetzee *et al*. (2019)

Source: *Researcher's own construction*

6.3.2 Barriers to lean manufacturing identified in relevant literature

An in-depth examination of the literature was undertaken to explore the barriers associated with LM, with the outcomes summarized in Table 36. The identification of these barriers was instrumental in highlighting the critical areas that required further investigation.

Table 36: The LM barriers explored through the literature review

Item	Lean Manufacturing Barriers	Description	Literature Support
1	Lack of LM understanding and knowledge	Lack of training and coaching	Chong and Perumal (2020) Abu et al. (2021) Lodgaarda *et al.* (2016) Moradlou and Perera (2017) Bashir *et al*. (2010 Chan *et al.* (2019) *Jadhav et al. (2014)*
2	Management	Limited Management Commitment Lack of Succession Planning Lack of strategic planning	Lodgaarda *et al*. (2016) Tiwari and Tiwari (2018) Moradlou and Perera (2017) Nwaki *et al.* (2021) Chan *et al.* (2019) Maware and Parsley (2022) Jadhav *et al.* (2014)
3	Organising for lean	No roles and responsibilities were defined, lack of involvement, teamwork, motivation, and planning.	Lodgaarda *et al*. (2016) Tiwari and Tiwari (2018) Moradlou and Perera (2017) Jadhav *et al.* (2014:344)
4	Lean Tools and practices	Failure to prioritize LM and best practices	Lodgaarda *et al*. (2016: 598)
5	Resource Constraints	Lack of resources for implementation	Tiwari and Tiwari (2018) Chan *et al.* (2019)
6	Behavioural issues	Resistance to change, stubborn employees	Tiwari and Tiwari (2018) Chan *et al.* (2019) Jadhav *et al.* (2014)
7	Financial capabilities	Organizational Financial position	Moradlou and Perera (2017) Bashir *et al.* (2010
8	Governmental or political	Policies	Nwaki *et al*. (2021)
9	Communication	Unclear instructions	Chan *et al*. (2019) Jadhav *et al.* (2014)
10	Lack of Information Sharing	Lack of information sharing within and without the organization. Cross-functional conflict.	Chan *et al*. (2019) Jadhav *et al*. (2014)
11	Technical Knowledge	Lack of clear processes Ineffective data collection	Maware and Parsley (2022)
12	Culture	Lack of development of a sustainable organizational culture	Maware and Parsley (2022)
13	Employee	Employee welfare	Maware and Parsley (2022)
14	Sales	Poor Sales Forecasting	Jadhav *et al*. (2014)

Source: *Researcher's own construction*

6.3.3 Lean manufacturing frameworks explored in the selected literature

Section 2.4.4 Table 10 illustrated a taxonomy of LM frameworks adapted from Anand and Kodali (2010). Withal, the researcher identified and extensively studied other networks included in the literature review and summarized in Table 37 below:

Table 37: Lean manufacturing frameworks in this thesis literature review

Item	Framework	Description	Researcher
1	LM Implementation Framework based on housekeeping principles	Reducing Manufacturing Costs	Deros *et al.* (2012)
2	LM Implementation Framework based on reducing the barriers	Reducing the complications of lean that are driven by executive management, cultural, managerial, implementation and technical barriers.	Mostafa *et al.* (2013)
3	LM Implementation Framework based on Change Management principles	Evaluating and utilising Change Management principles	Almanei *et al.* (2018)
4	A theoretical framework for the lean social pillar	Continuous Process Improvements	McMackin and Flood (2019)
5	LM Framework based on Lean Barriers	Reduction of risk management when implementing LM	Zvidyayi and Chikuruwo (2023)
6	LM Framework of culture change	Improving visual controls	Van der Merwe *et al.* (2014)
7	Lean Six Sigma Framework	To improve the competitiveness of specific ACM organizations in the KwaZulu Natal region.	Rathilall and Singh (2018)

Source: *Researcher's own construction*

6.4 The developed lm framework

Although LM is highly adaptable to various business types and situations, Womack & Jones, 1996; and Hines *et al*. (2008) cited in Pierce and Pons (2017) concur that change management is intrinsically difficult, so businesses regularly fail to sustain the necessary lean practices, hence issues with regards to change management across the proposed frameworks remain unaddressed. Many frameworks as exhibited by the sampled ones in Table 37 revealed that many organizations implement lean by focusing on a single or few aspects of LM. The LM Framework was created during this study. The elements of the framework are aggregated from an assortment of sources, which include conference papers, web articles, scholarly research documents, individual interviews, focus group interviews, and questionnaires. Several scholarly articles delve into the drivers and barriers related to the implementation of LM. Thus, the frameworks that were investigated predominantly centred on either the drivers of LM or the barriers to its successful execution. Thus, this framework encapsulates the interplay of LM barriers and drivers, which occur in tandem during the implementation phase of LM.

LEAN MANUFACTURING DRIVERS | LEAN MANUFACTURING BARRIERS

DRIVERS		MAIN THEME	BARRIERS	
Subtheme	**Theme**		**Theme**	**Sub-Theme**
Supplier Margins Supplier selection methods Material costs Purchasing policies Supplier location	Factors affecting Supplier selection	SUPPLIER	Supplier involvement	Quality Improvements New Product launch
Plant age Affiliate technology Affiliate comparison Production volumes Improving production volumes	Assessing technological capability of the local company	BENCHMARKING	HQ Decision making	HQ Perception
Energy and Water Overhead	Indirect costs cutting measures	COST	Cost Markers	Profitability Cost Reduction Kaizen
Localisation Mode of transport Packaging Shipping agencies/Frequencies Stock levels	Localisation in comparison to shipping expenses			
Quality Poke yoke and Fail Safe Manufacturing Set Up Kanban Maintenance House Keeping (5S)	Production related	PRODUCTION	Targets Staff Teamwork	Visualisation Adherence Skill Turnover Union Affiliation Training and Learning
Existing Process/New Process Lean adoption Commitment	Process related	PROCESS	Bottleneck Muda	Bottleneck Muda
Customer Demands Customer Satisfaction JIT	Customer related	CUSTOMER	New customers Customer Customer Complaints Surveys	Number Sales Surveys Customer involvemment Lean Information Customer Profitability

LEAN MANUFACTURING

Figure 61: Conceptual model for the lean manufacturing framework developed by the researcher

Source: *Researcher's own construction*

6.5 Main themes of the proposed LM framework

The framework shown in Figure 60 outlines six significant themes related to LM drivers and barriers, which are underpinned by the principles of Change Management. The following list details the six main themes identified:

1. Supplier
2. Benchmarking
3. Cost
4. Production
5. Process
6. Customer

6.5.1 Suppliers drivers and barriers

This investigation uncovered that Suppliers possessed the highest word count, as shown in Section 4.3, Figure 40. Cheraghi *et al*. (2004) and Mwikali and Kavali (2012) indicated as essential for LM and that quality, cost, and delivery are the most critical factors to be addressed. While this research is consistent with earlier literature reviews, it further elucidates the role of suppliers in affecting the drivers and barriers of LM. The sub-themes identified are as follows:

1. Supplier Margins

   This framework posits that transparency from suppliers is crucial, emphasizing the necessity for the steering wheel manufacturer to have a clear understanding of the profit margin. This study ascertained that the acceptable profit margin for suppliers of Toyota South Africa Motors is set at 7% of the total cost, indicating that a profit margin around this figure is deemed adequate. The methods for selecting suppliers are also discussed.

2. Material Costs

   This framework is in line with Stanley and Gregory (2001) cited in Mwikali and Kavali (2012), who state that the significance of material cost as a critical factor in supplier selection cannot be overstated, necessitating diligent monitoring throughout the procurement process.

3. Purchasing Policies

   This framework underscores the essential role of organizational purchasing policies, as articulated by Tsao and Tai (2013), and recommends the incorporation of the purchasing policy guidelines proposed by Toyota OE purchasing.

4. Supplier Location

   The proposed framework emphasizes the importance of supplier location in line with (Min, 1993) cited in Cheraghi *et al.* (2004) and Verdier (2021) that supplier proximity can lead to buyer-supplier relationship advantage or disadvantage thereof.

Subsequently, this research also identified one of the main LM impediments as Supplier involvement arising from two identified subthemes listed below in line with the findings of (Grant and Baden Fuller, 2004) cited in Melander (2014):

1. **Supplier involvement in quality improvements**
   Suppliers tend to minimize efforts because quality improvements are considered capital investments, according to Bhasin (2012), Suraraksa, and Shin (2019). This research suggests a method to lessen the effect of the subtheme, which the framework identifies as a barrier to LM.

2. **Involvement of suppliers when launching a new product or service**
   The research findings indicated that a barrier to implementing LM is the absence of supplier involvement during the launch of a new product or service. As Melander (2014) suggested, this framework suggests working together and utilizing supplier involvement in new product development to benefit from the suppliers' knowledge.

6.5.2 Benchmarking drivers and barriers

Delbridge and Lowe (1995) assert that a crucial aspect of benchmarking processes involves diagnosing weaknesses to pinpoint potential areas for enhancement. The findings of this research uncover that company XYZ competes with first-world nations that manufacture comparable steering wheels. Consequently, the benchmarking activities identified were significantly influenced by the technical competencies of company XYZ, which were categorized under specific subthemes that emerged as key factors driving the implementation of LM as enlisted.

1. Plant age.
2. Affiliate technology.
3. Affiliate comparison.
4. Production volumes.

This framework proposes an analysis of the South African manufacturing process in relation to that of associated steering wheel manufacturers, aiming to capitalize on the identified disparities between the two. The research has pinpointed and categorized two primary aspects under LM barriers that company XYZ must observe and enhance to ensure its continued viability as a corporate entity in South Africa.

1. HQ perception.
2. Decision making.

The developed framework emphasizes the importance of improving HQ's perceptions of company XYZ. It hastens the decision-making process, thus decreasing the duration of time involved in waiting for a decision.

6.5.3 Cost drivers and barriers

Salman *et al.* (2024) assert that the necessity to conserve resources and minimize operational expenses has significantly increased the adoption of LM practices within the automotive industry. The study delineates the drivers of LM, categorized primarily under the cost theme into two distinct groups: Indirect Cost and Localization, as illustrated in Figure 61 below.

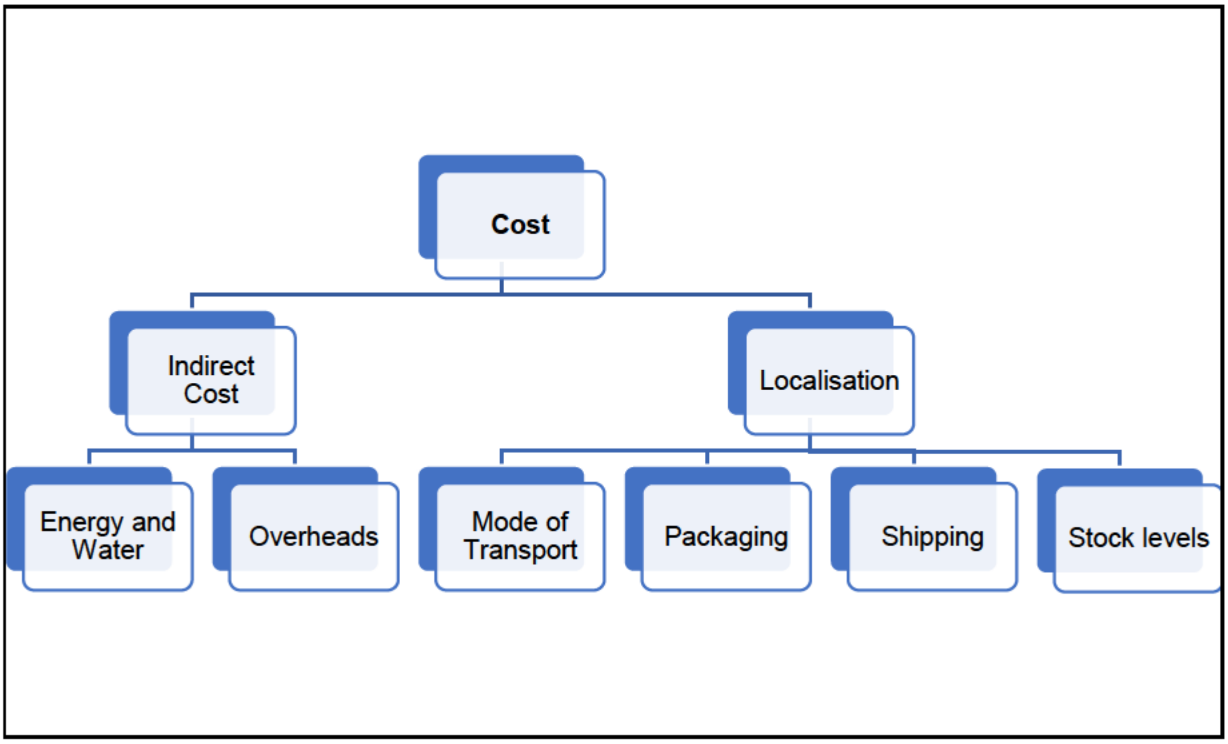


Figure 62: Cost theme LM drivers

Source: *Researcher's own construction*

Echoing the theme of cost considerations, the study brought to light multiple barriers that affect the successful implementation of LM.

Profitability

Businesses that are seeing a decline in profits typically steer clear of LM, believing that they cannot afford it, (Scott, 2022). This framework suggests lessening this thinking, which will increase LM engagement.

Cost reduction

The following influence Cost reduction efforts, as inferred in section 4.7.1.2:

1. Awareness of companywide cost reduction initiatives
2. Departmental efforts to reduce costs and monitoring
3. The application of kaizen

This framework offers ways to lessen the barriers impediment effect through improvement mechanisms.

6.5.4 Production-related LM drivers and barriers

The following LM drivers were inferred to be required for the suggested LM framework based on their consistency with section 2.3.5 of the literature review and the experimental analysis in section 4.6.1.

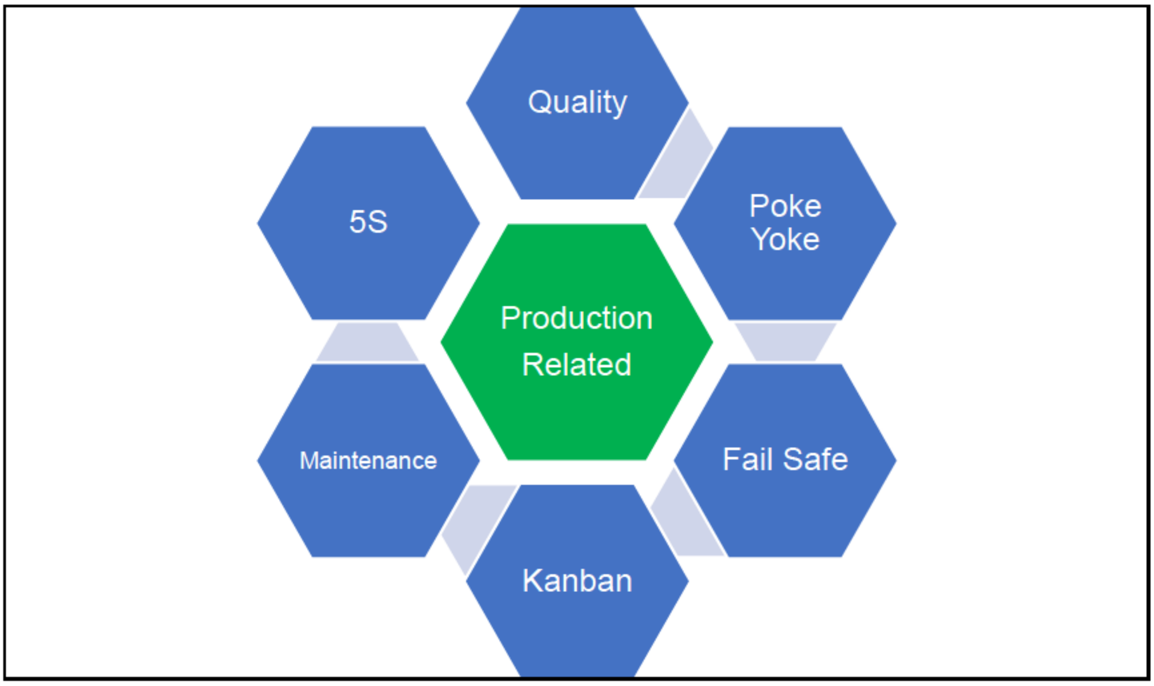


Figure 63: Production-Related Theme LM Drivers

Source: *Researcher's own construction*

In addition, the research under the same faculty identified the obstacles that were noted at XYZ in accordance with the literature review; these have been included in this framework as lean barriers to lessen the perceived detrimental impact of these barriers. Figure 63 below provides an illustration of these barriers:

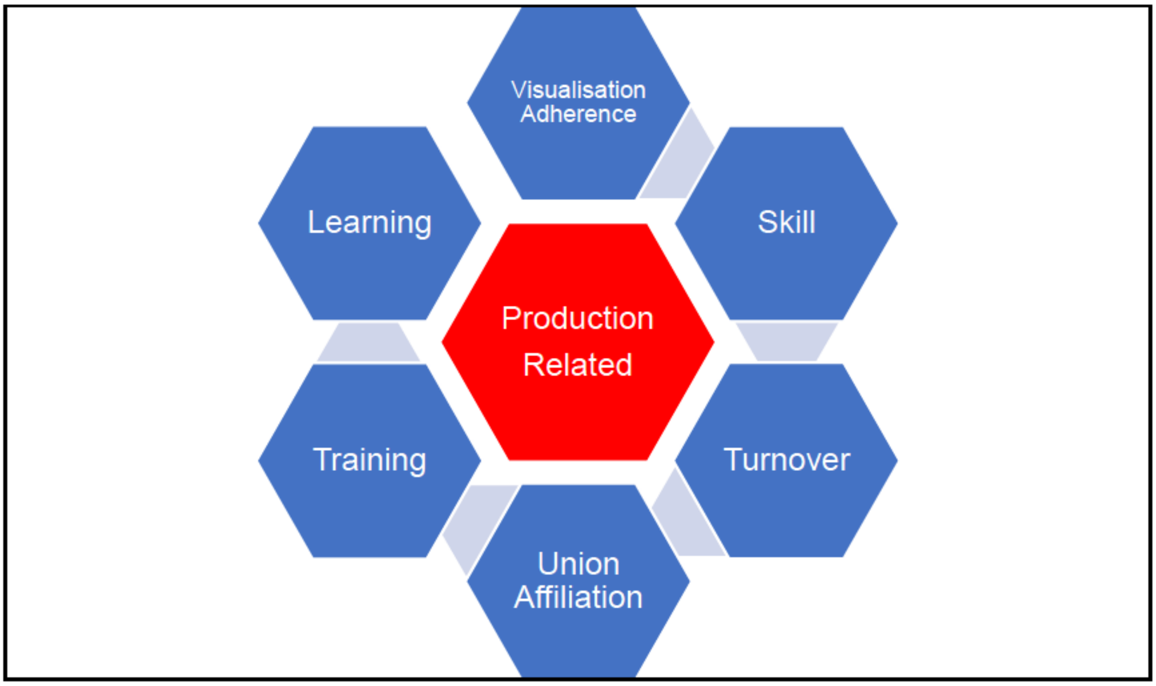


Figure 64: Production-related theme LM barriers

Source: *Researcher's own construction*

6.5.5 Process-related drivers and barriers

Section 4.6.2 analyzed the findings pertinent to this theme, which align with the discussions presented in sections 1.1, 1.3, 1.4, and 1.6 of the literature review. These sections have been identified as critical factors influencing the adoption of LM.

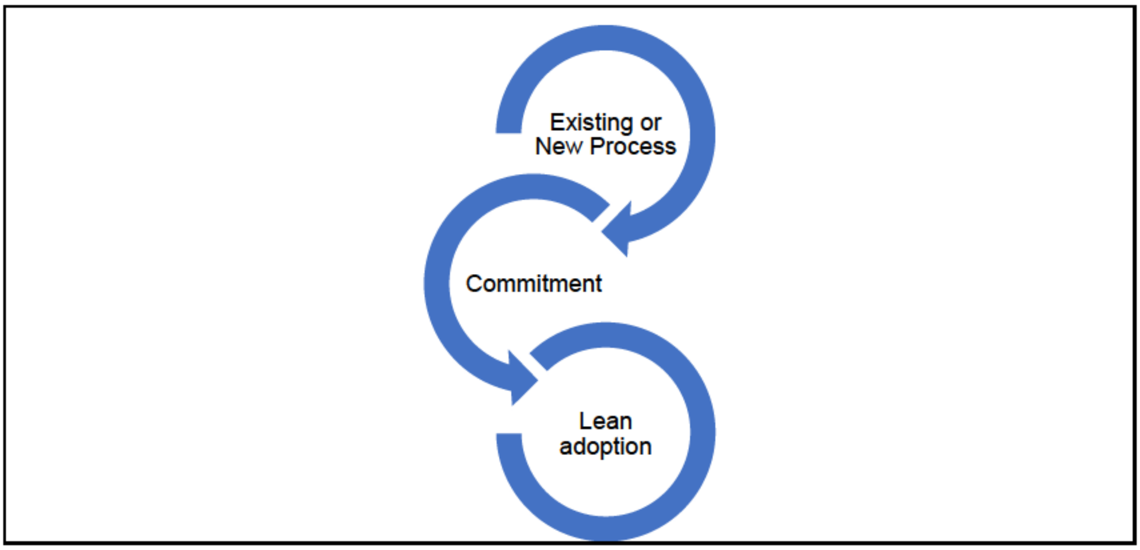


Figure 65: Process-related theme LM drivers

Source: *Researcher's own construction*

Concomitantly, bottleneck and muda were deduced to be common barriers to LM implementation by this research, and this framework aims to lessen their perceived impact.

6.5.6 Customer-related drivers and barriers

Sections 1.1, 1.3, 1.4, and 1.5, in addition to Section 2.3 of the literature review, provided an in-depth exploration of this theme. The findings about this subject were scrutinized in Section 4.6.3 before the triangulation phase. The framework highlights the critical nature of three primary themes, as shown in Figure 6 below, and advocates for their meticulous application to achieve successful outcomes in LM.

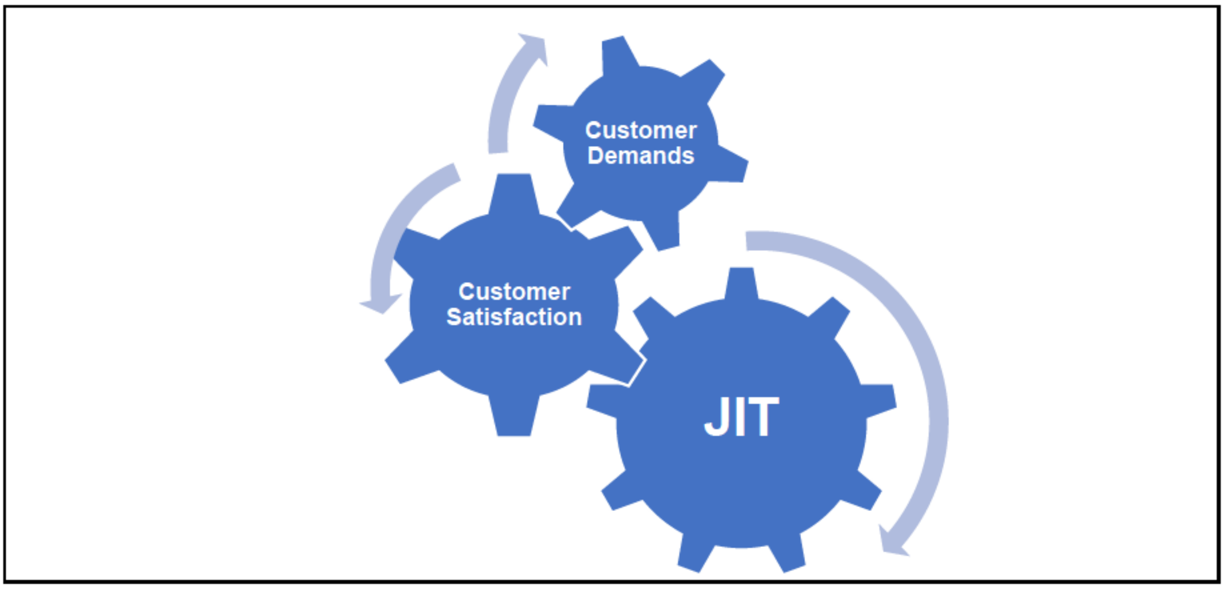


Figure 66: Customer-related theme LM drivers

Source: *Researcher's own construction*

Section 4.7.3 delineates the research findings, while the proposed framework addresses the challenges associated with minimizing perceived effects during the implementation of lean manufacturing, as depicted in Figure 66.

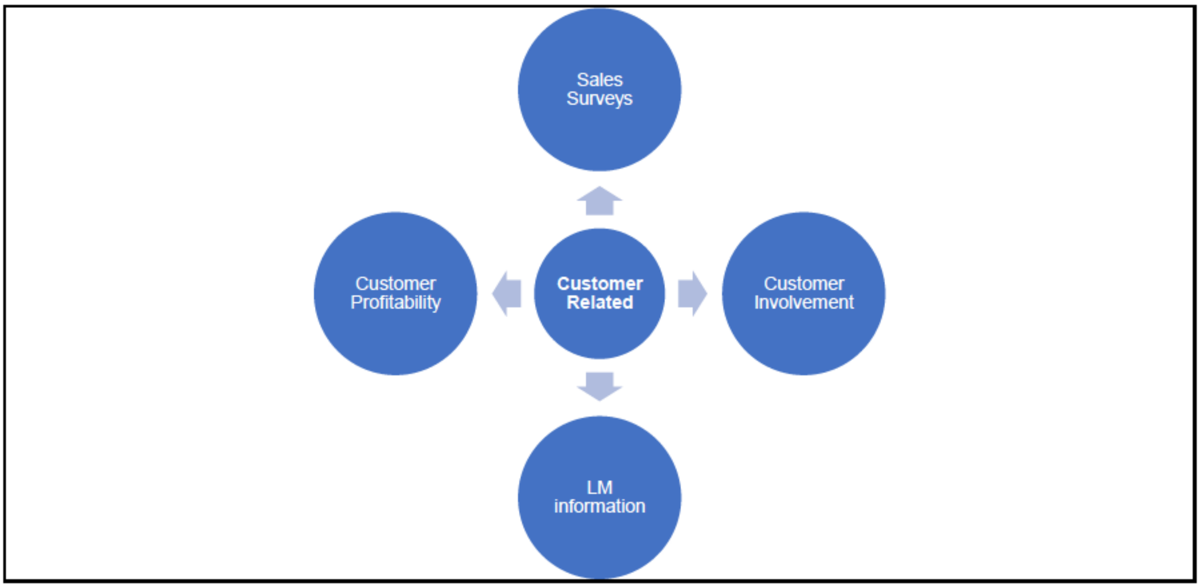


Figure 67: Customer-related theme LM barriers

Source: *Researcher's own construction*

6.6 Chapter summary

This chapter offers an in-depth exploration of the drivers and barriers associated with LM, along with the frameworks that informed this research. The developed LM framework is derived from a diverse array of sources, including conference proceedings, online articles, scholarly papers, individual interviews, focus group discussions, and survey questionnaires. Additionally, the chapter synthesizes insights from the reviewed literature regarding the influence of these drivers and barriers on the implementation of LM.

The chapter explains that from the many available LM frameworks, none is suitable for the South African steering wheel manufacturers and subsequently proposes a suitable framework. The proposed framework identifies six main themes as Supplier, Benchmarking, Cost, Production, Process, and Customer. These themes serve as the foundation for the relationship between the drivers and barriers of LM in the proposed framework. The chapter subsequently elucidates how the constituent elements of the framework are interconnected in functionality.

CHAPTER 7

EMPERICAL VALIDATION OF THE DEVELOPED LEAN FRAMEWORK

This chapter aims to substantiate the Lean Drivers and Barriers Framework by utilizing the Delphi method. The primary goal of implementing the Delphi technique was to evaluate the existence of a consensus concerning the various elements of the Developed Lean Framework.

7.1 Introduction

The focus of this chapter is on the recommendations derived from lean management practices, aimed at bolstering the established framework for the selected manufacturer of steering wheels in South Africa. In the literature review in section 2.4.5, different approaches for framework validation were enumerated by various authors. The Delphi method of validation was selected based on its benefits in line with Shang (2023) enumerated below:

1. The preservation of anonymity for participants.
2. The ability to control feedback mechanisms.
3. Flexibility in choosing statistical analyses.
4. The capacity to engage participants from diverse geographic regions.

Additionally, areas of methodological ambiguity that warrant further examination include the involvement of experts and the intricacies of data management. The Delphi technique depends on gathering expert perspectives to derive a trustworthy consensus through a series of structured questionnaires.

7.2 Methodology

In alignment with Gallota *et al.* (2023), the initial phase of the study was focused on problem definition and the creation of a questionnaire for the lean experts. The subsequent phase involved the selection of experts in sustainability and operations management. The third phase was characterized by the first round of the study, and the final phase was marked by the second round of the study. Upon completion of the study, the findings were disseminated to the experts. According to Shang (2023), studies indicate that extensive expert panels may complicate the processes of data collection and management. It is essential to consider both time and financial limitations when determining the size of Delphi experts, which should optimally consist of between 8 and 23 participants. According to Gallota *et al.* (2023), to qualify as a specialist, an individual must fulfil one of the following criteria:

1) Industry: Possession of over three years of experience in leadership roles, such as Chief Executive Officer (CEO), Managing Director, Executive or Manager within the realms of Lean Manufacturing or Company Operations; or
2) Academia: Engagement in Lean Manufacturing or Operations Management for a minimum of three years, accompanied by relevant publications in the field.

Given that this study focuses on South Africa, the selection of experts was exclusively limited to individuals from South Africa who are predominantly members of the South African OEM council and select academia with automotive research publications. The study therefore identified 22 individuals as potential participants. The identified experts were all contacted by email, 12 responded affirmatively and consented to engage in the research, yielding a response rate of 54.5%.

The composition of participants comprised of experts delineated as follows: CEO from South Africa's eight OEMs.
Senior Executives from South Africa's eight OEMs.
Managing Directors, Executives and Managers from the OEM Suppliers Network
Published Academics and Automotive Leaders.

7.3 Delphi questionnaire

According to Chuenjitwongsa (2017), a Delphi questionnaire can be designed by using primary data, such as pre-existing interviews, or through a literature review. While referencing existing literature can enhance the validity of the questionnaire, it may also inadvertently limit the experts' insights and introduce researcher bias in the choice of items included in the questionnaire.
The five significant factors highlighted in Figure 67 by Khodyakov (2024) were integral to the design process of the Delphi questionnaire.

Figure 68: Critical factors for designing a delphi questionnaire

Source: *Adapted from Khodyakov (2024)*

The construction of the questionnaire was structured around seven distinct sections. The initial section focused on the details of the Lean Manufacturing expert, while the subsequent six sections addressed the six themes of the LM Framework. The following outlines these seven sections.

1. About the expert
2. Supplier
3. Benchmarking
4. Cost
5. Production
6. Process
7. Customer

7.4 Pilot survey

Prior to distributing the questionnaire to the participants, a pilot survey was executed involving four Managers from Toyota South Africa Motors who possess a strong familiarity with LM. Participants in the pilot phase were drawn from departments that did not have any interaction with the case study company and were also isolated from one another. The selection of unbiased participants was intentional, ensuring that the questionnaire was clear, logically structured, and devoid of grammatical errors.

7.5 Delphi iterations

The iterations for this case study were aligned to the literature review section 2.4.5 Figure 30 adapted from Nordin *et. al* (2012) where two iterations were proposed and delineated as Delphi study round 1 and round 2.

7.5.1 Delphi round 1

Upon the completion of the Pilot survey, the results provided by the participants were assessed and incorporated into the questionnaire intended for distribution to the expert's panel. According to Chuenjitwongsa (2017), the first round may be structured as either qualitative, involving open-ended questions, or quantitative, utilizing rating scales. A qualitative round 1 facilitates the generation of ideas and the expression of opinions by experts. For instance, they may offer suggestions regarding necessary alterations or additions to a curriculum or indicate what should be featured in a new framework.

7.5.2 Delphi round 2

According to the guidelines articulated by Hader (2009) cited in Kluge *et al*. (2020), participants were given regulated feedback in the second round. This feedback included histograms and analysis presented on the round 1 results. Additionally, a summary of comments related to each projection was provided, enabling participants to evaluate their own responses against the overall results. In line with the Delphi technique, experts were allowed to revise their estimates based on the supplementary information received.

7.6 Results and discussion

Below is the legend of all the graphs in section 7.6

The legend on the LHS represents the category being investigated.

The numbers in the middle represents the frequency of selection by the experts.

X - axis: categories being investigated.

Y- axis the frequency of selection.

7.6.1 Delphi round 1 results

The iteration round 1 results were delineated in the sections that follow:

7.6.1.1 Section 1: About the experts

The composition of the experts involved in this study, categorized by industry, is as follows: 3 experts from Academia, 1 from a Manufacturing OEM, 5 from Manufacturing OEM Suppliers, 2 from industries unrelated to automotive, 1 from a Service OEM customer or dealership, and no representatives from other sectors. This distribution is depicted graphically in Figure 68.

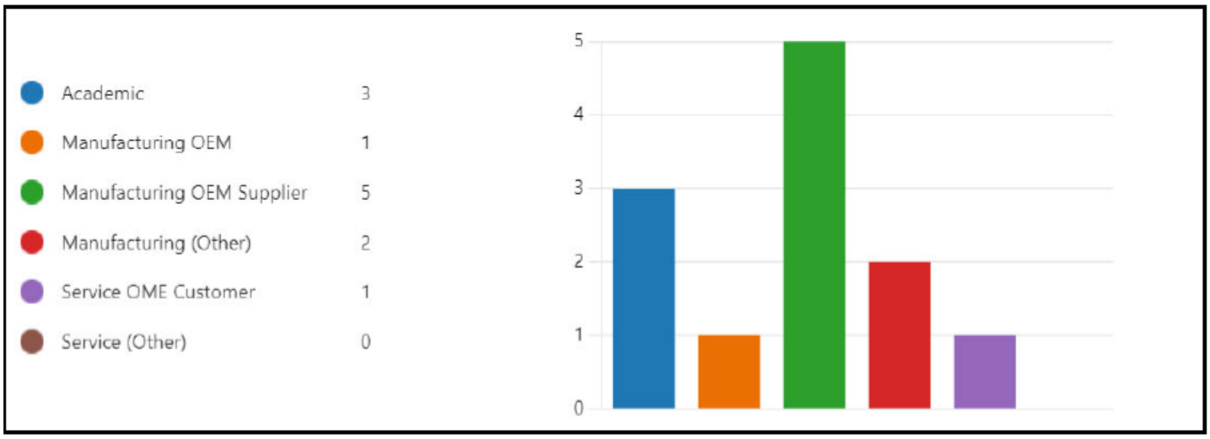


Figure 69: Distribution of experts by industry

7.6.1.2 Distribution by position levels

The position levels of the experts were distributed as follows: 1 expert is designated as CEO/Managing Director, 6 are in Executive Management, 2 are in Senior Management, 2 are in Management/Technical roles, and 2 are categorized in levels not included in the questionnaire. This distribution is illustrated in Figure 69 below.

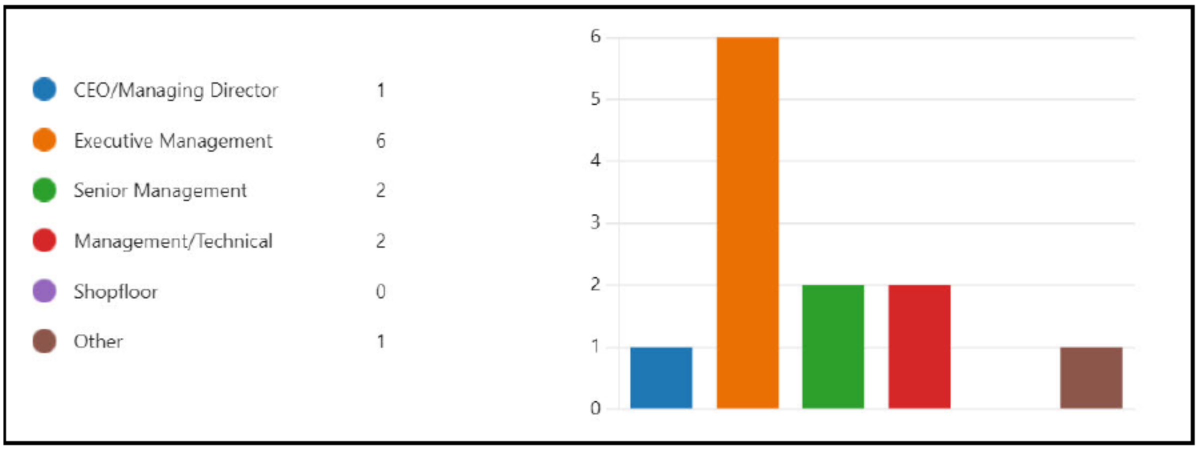


Figure 70: Distribution of experts position levels

7.6.1.3 Distribution by location

Most of the experts were from KZN comprising of 7 experts, the same location where the case study company is, followed by Gauteng with 2, then Western Cape and Eastern Cape each with one. The distribution by location is illustrated graphically in Figure 70.

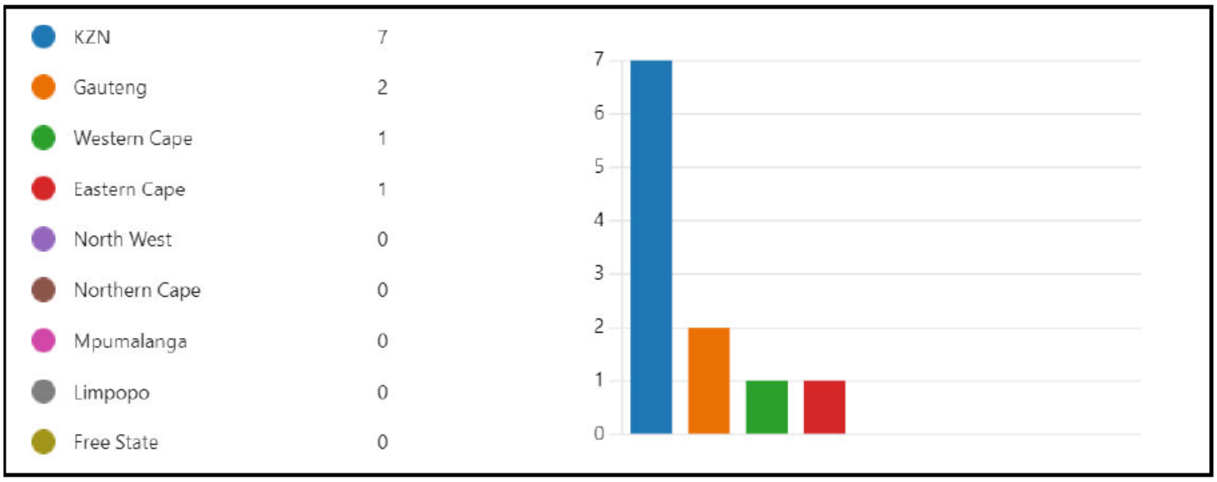


Figure 71: Distribution of experts by location

7.6.1.4 Distribution by years of working experience

In alignment with section 7.2, the experts chosen had lean work experience that exceeded three years. The experience levels are detailed as follows: 0 individuals with 0-5 years, 2 individuals with 6-10 years, 5 individuals with 11-15 years, 2 individuals with 16-20 years, and 3 individuals with over 20 years of experience. The graphical distribution is depicted in Figure 71.

Figure 72: Distribution of experts by years of experience

7.6.1.5 Distribution by years of lean manufacturing experience

The experts were assessed according to their years of experience in Lean Manufacturing, and the results are as follows: 0 individuals had 0-5 years of experience, 2 individuals had 6-10 years, 3 individuals had 11-15 years, 5 individuals had 16-20 years, and 2 individuals had over 20 years of experience. Figure 72 depicts the graphical representation:

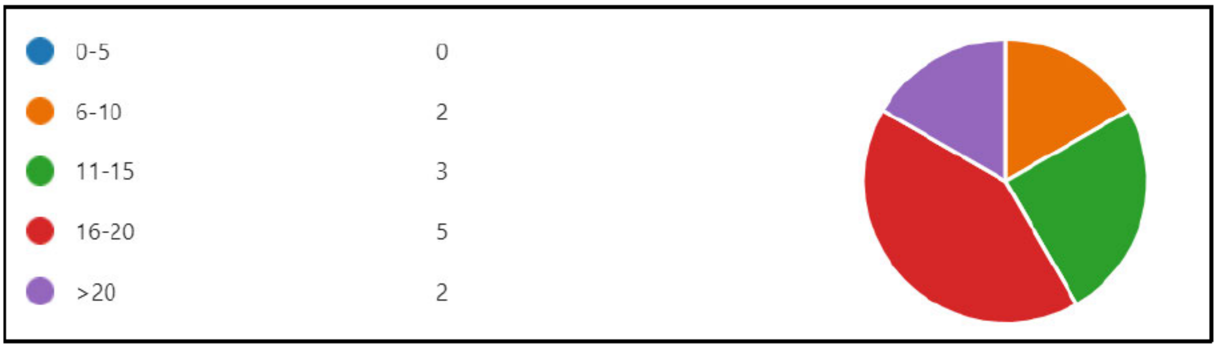


Figure 73: Distribution of experts by years of lean manufacturing experience

7.6.2 Section 2: Delphi analysis of supplier theme

The five LM Supplier subthemes identified in the LM Framework received nearly equal endorsement from the experts, with the analytical results illustrated graphically in Figure 73 below.

Figure 74: Delphi analysis of supplier lean manufacturing drivers

A compilation of expert remarks on the subthemes of Supplier LM is provided below.

Expert 1

Supplier margins are dependent on several other factors like competition, product segment, technological advancements etc. It is ambiguous to assume that they are a driver of Lean Manufacturing.

Expert 2

South African Suppliers for the steering wheel commodity to OEM are very limited, this is not so valid in this environment.

Expert 3

I believe all are essential and valid.

Expert 5

Supplier selection techniques are inherently linked to individual industries and cannot be incorporated into a universal Framework, unless the Framework is specifically intended for that industry.

7.6.2 Supplier LM barrier

The subsequent sections delineate the first round of expert insights that address the barriers encountered by LM, with a particular emphasis on the Supplier theme.

7.6.2.2 Sub-theme : Supplier engagement

All experts concurred that supplier engagement constitutes a substantial barrier to LM practices, with several suggesting that this subtheme should be referred to as "Lack of Supplier Engagement." Below are some of the responses provided by the experts.

Expert 1

If the Supplier is not engaged with the customer, they definitely will not enforce the customer Quality requirements in their own factory.

Expert 6

Yes, the lack of supplier engagement in quality is a significant barrier for several reasons, Continuous Improvement: Supplier engagement fosters a partnership mindset where both parties aim for continuous improvement. Without it, suppliers may not invest in improving their processes or aligning with your quality standards.

Expert 7

When suppliers are not actively involved in quality processes it impacts the overall product quality. Collaboration with suppliers helps ensure that quality standards are met and maintained, allowing for both to be competitive.

Expert 8

Yes, the lack of supplier engagement in quality is a significant barrier for several reasons. Engaging suppliers in quality management helps prevent delays and inefficiencies. When suppliers don't prioritize quality, it can result in material rejections or delays, disrupting production schedules and increasing costs.

Expert 9

Yes, the lack of supplier engagement in quality is a significant barrier. Collaboration and communication: A lack of supplier engagement can result in poor communication, misunderstandings, and failure to meet specifications or compliance requirements.

Expert 10

Yes, the lack of supplier engagement in quality is a significant barrier. Compliance and Risk Management: Many industries have strict regulations, and non-compliant suppliers can expose companies to legal risks. Proactive supplier engagement ensures that all parties understand and meet the necessary quality standards and compliance requirements.

7.6.3 Section 3: Delphi analysis of benchmarking theme

All five subthemes concerning benchmarking in the LM framework, as recognized in the LM Framework, were affirmed by the experts. There were recommendations from some experts to merge the subthemes of Production and Improving Production Volumes, as they are closely related. Furthermore, it was noted that the focus on Improving Production Volumes is particularly suited to the South African context. The survey results for this LM driver are illustrated in Figure 74 below.

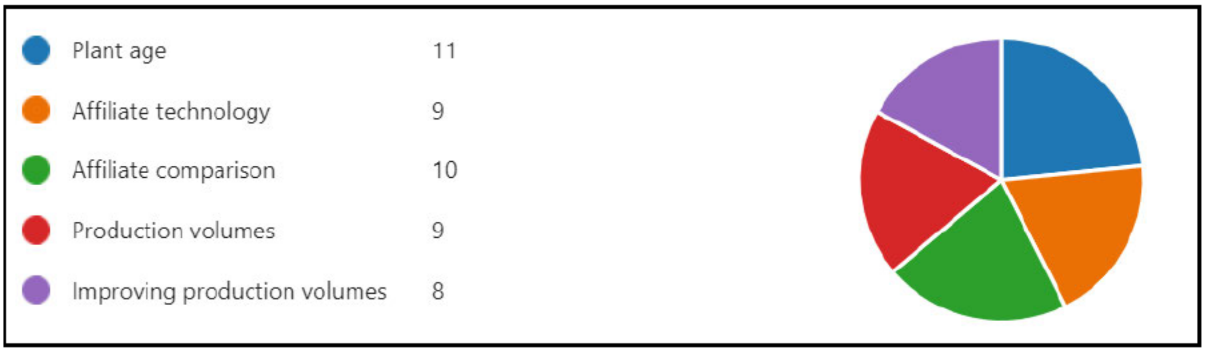


Figure 75: Delphi analysis of benchmarking lean manufacturing drivers

The subsequent section is an assortment of responses that were contributed by the experts.

Expert 1

Production volumes is not conclusive, but improving production volumes is ideal for South Africa at this stage of the economy.

Expert 2

Production volumes is a duplication of improving production volumes.

Expert 12

The classification of South Africa as a third-world nation can impede efforts to improve production volumes, primarily due to resource limitations and a shortfall in technological development.

7.6.3.1 Benchmarking LM barriers

The LM Framework identified two critical barriers associated with this theme: the HQ perception and the decision-making mechanisms. Experts unanimously supported the LM Framework's findings, confirming that these barriers are pertinent to the South African context, as demonstrated by the significant responses outlined below.

Expert 2

Very significant. Bad perception may mean no business allocation, and poor decision-making means poor opinions.

Expert 5

The perceptions of headquarters concerning the South African subsidiary play a pivotal role in shaping their approach, underscoring its importance. Empowering the appropriate decision-makers is essential for fostering improvements in efficiency.

Expert 6

The perception of the South African branch by headquarters is of utmost significance if support from HQ is required. It is essential that decision-making processes do not hinder progress and efficiency.

Expert 7

Yes, HQ (Headquarters) perception and decision-making can be significant barriers to implementing lean practices. HQ often makes decisions based on high-level data or strategic goals, but they may not fully grasp the day-to-day operational challenges at the ground level. This disconnect can lead to decisions that are not aligned with lean principles, such as efficiency, waste reduction, or continuous improvement.

7.6.4 Section 4: Delphi analysis of the cost theme

Within the overarching Cost theme, the LM Framework pinpointed five subthemes or LM drivers. The experts validated all the mentioned LM drivers from a South African perspective, as shown in Figure 75 below.

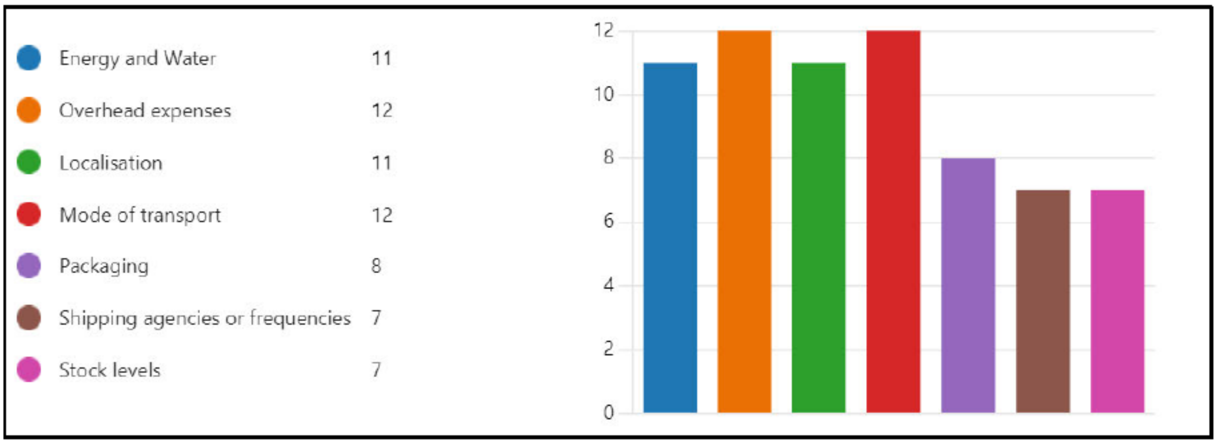


Figure 76: Delphi analysis of cost lean manufacturing drivers

The experts articulated significant insights regarding shipping agencies and stock levels, suggesting that stock levels should be prioritized over shipping agencies or their frequency. Illustrated in the subsequent text are several responses related to shipping agencies and stock levels.

Expert 1

Shipping agencies for automotive are specialized.

Shipping frequencies will be determined by efficient management and tracking of stock levels.

Expert 7

Shipping agencies are not fixed entities; they can be reassessed in accordance with the evolving business parameters.

Expert 9

Stock levels can be determined by sourcing locations and stocking policies in place.

7.6.4.1 Cost LM barriers

The LM Framework identified Profitability, Cost Reduction, and Kaizen as key barriers associated with the Cost theme. The consensus among the experts aligned with these observations, and they also expressed a preference for rewording the barriers as detailed below:

LM framework wording	Experts suggestion
Profitability	Viewing LM as counter profitability methodology
Cost reduction	Poor cost reduction efforts
Kaizen	Low Kaizen drive

A compilation of expert comments is provided below.

Expert 1

Viewing Lean as counter profitability is the barrier, ineffective cost reduction efforts is also the barrier and poor Kaizen activities is the barrier.

Expert 3

Lack of prioritizing lean thinking that it's not profitable.

Poor design of Cost reduction programmes and Kaizen

Expert 5

Perceiving Lean methodologies as detrimental to profitability constitutes a significant barrier. A negative disposition towards cost reduction initiatives represents a considerable barrier. Furthermore, a lack of commitment to Kaizen practices serves as a major barrier to Lean implementation. Collectively, these factors indicate a culture that is resistant to collaboration.

Expert 6

Affirmatively, all are acceptable.
Viewing Lean as counter profitability is the barrier, Ineffective cost reduction efforts is the barrier. Poor Kaizen activities is also the barrier.

7.6.5 Section 5: Delphi analysis of the production related theme

As shown in Figure 76 below, the experts validated all the six subthemes pertaining to Production in the LM framework, as acknowledged in the LM Framework.

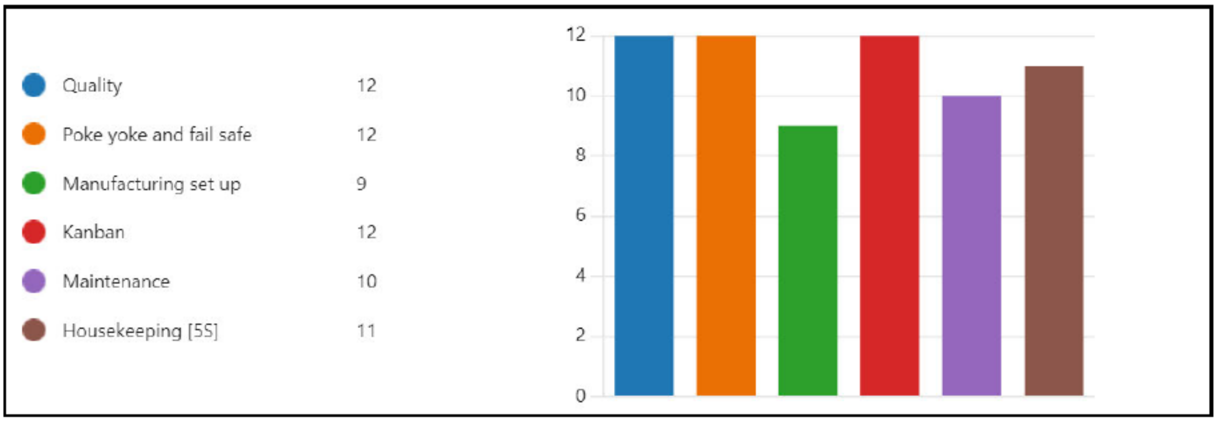


Figure 77: Delphi analysis of production lean manufacturing drivers

7.6.5.1 Production LM barriers

The experts endorsed the Lean barriers proposed in the framework. According to the analysis of Figure 77, Turnover emerged as the least favoured barrier, as experts felt that the other barriers had a more pronounced influence in the South African context.

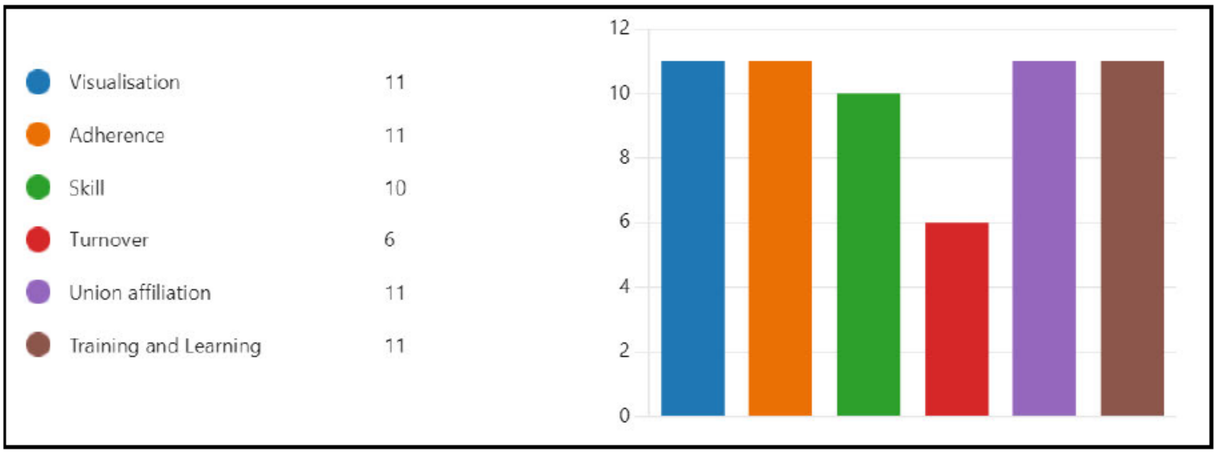


Figure 78: Delphi analysis of process lean manufacturing barriers

7.6.6 Section 6: Delphi analysis of process related theme

The Drivers pertaining to the process were identified through three sub-themes, all of which garnered considerable support from the experts. Among these, commitment was recognized with the highest frequency, as all 12 participants affirmed its importance as significant drivers of LM, as shown in Figure 78 below.

Figure 79: Delphi analysis of process lean manufacturing drivers

7.6.6.1 Process LM barriers

The proposed LM framework identified two critical process barriers, namely muda and bottleneck. Experts reached a consensus that these barriers are particularly applicable to the automotive parts manufacturing sector in South Africa.

Figure 80 Delphi analysis of process lean manufacturing barriers

One of the Experts distinctly mentioned further Process Barriers for examination, which are detailed below.

Expert 3

You can also consider adding the following barriers

1. *Poor process design.*
2. *Lack of Technical knowledge.*
3. *Lack of resources.*

7.6.7 Section 7: Delphi analysis of customer theme

Experts analyzed the customer theme lean drivers, and the results of their analysis are outlined in the ensuing sections.

7.6.7.1 Customer related theme drivers

The experts concurred with the suggested customer theme drivers, which include customer demands, customer satisfaction, and JIT, with the latter receiving a score just two points lower than the former two as depicted in figure 80 below:

Figure 81: Delphi analysis of customer lean manufacturing drivers

A suggestion from one of the experts was to include customer retention, delivery time, and respect for people within the customer-related LM driver.

Expert 8

You can also add some of these:

- *Improving customer retention.*
- *Improving delivery time.*
- *Respect for people.*

7.6.7.2 Customer related theme barriers

The challenges identified in relation to the customer theme were completely supported by the experts, although customer profitability garnered the lowest rating, as depicted in figure 81 below:

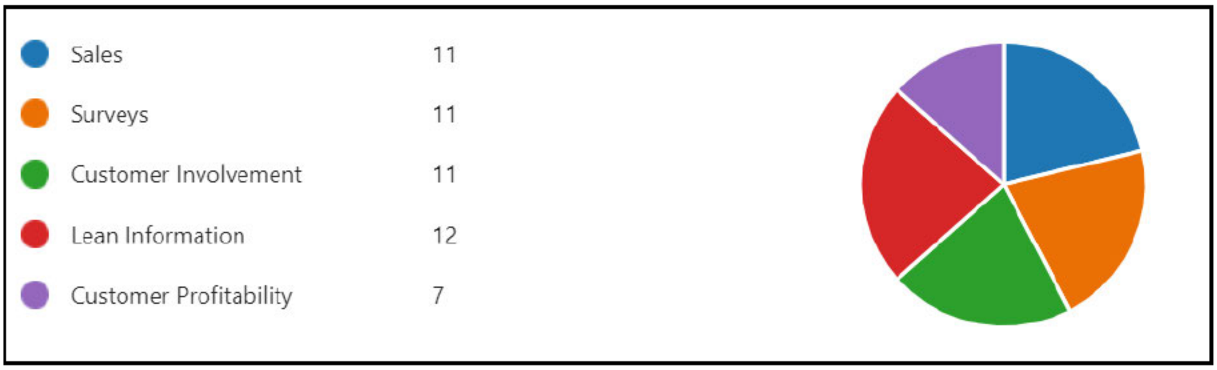


Figure 82: Delphi analysis of customer lean manufacturing barriers

7.7 Actions based on delphi round 1 survey

The subsequent submissions delineate the suggested modifications to the Framework, informed by the contributions of experts.

7.7.1 Drivers

The findings from the Delphi Round 1 survey indicated that all identified themes and subthemes related to drivers were approved with a few suggestions and subsequently put forward for consideration in Round 2 of the Delphi process, as illustrated in Table 38 below:

Table 38: Lean drivers delphi round 1 summary table

MAIN THEME	Identified as enablers and reasons to LMimplementation		Delphi Survey Round 1
	Theme	**Subtheme**	**Proposed Amendments**
SUPPLIER	Factors affecting Supplier selection	Supplier Margins Supplier selection methods Material costs Purchasing policies Supplier location	All Sub Themes were accepted Insights were shared pertaining tothe Supplier selection methods subtheme
BENCHMARKING	Assessing technological capability of the local company	Plant age Affiliate technology Affiliate comparison Production volumes Improving production volumes	All Sub Themes were acceptedSome Experts preferred rather using Improving Production volumes instead of Production volumes.
COST	Indirect costs cutting measures	Energy and Water Overhead	All Sub Themes were accepted
	Localization in comparison to shippingexpenses	Localization Mode of transport Packaging Shipping agencies/Frequencies Stock levels	
PRODUCTION	Production related	Quality Poke yoke and Fail Safe Manufacturing Set Up Kanban Maintenance House Keeping (5S)	All Sub Themes were accepted
PROCESS	Process related	Existing Process/New Process Lean adoption Commitment	All Sub Themes were accepted

Source: *Researcher's own construction*

7.7.2 Barriers

Findings from the first round of the Delphi survey indicated that all themes and subthemes related to the barriers were validated, with a handful of suggestions provided. These were subsequently submitted for review in Round 2 of the Delphi process, as illustrated in Table 39 below:

Table 39: Lean barriers delphi round 1 summary table

MAIN THEME	Identified as impediments to LM implementation		Delphi Survey Round 1
	Theme	**Sub-Theme**	**Proposed Amendments**
SUPPLIER	Supplier involvement	Quality Improvements New Product launch	All Sub Themes accepted
BENCHMARKING	HQ Decision making	HQ Perception	All Sub Themes accepted
COST	Cost Markers	Profitability Cost Reduction Kaizen	All Sub Themes accepted
PRODUCTION	Targets Staff Teamwork	Visualization Adherence Skill Turnover Union Affiliation Training and Learning	Adherence to work Instructionsand Standards
PROCESS	**Bottleneck Muda**	Bottleneck Muda	All Sub Themes accepted
CUSTOMER	**New customers** **Customer** **Customer Complaints** **Surveys**	Number Sales Surveys Customer involvement Lean Information Customer Profitability	Lack of surveys Lack of customer Involvement Lack of Lean Information Customer Profitability views against Lean

Source: *Researcher's own construction*

7.8 Delphi round 2 results

A Likert survey was utilized to measure the extent of agreement among expert opinions based on the results from the Round 1 questionnaire, and the findings are articulated in the subsequent sections.

7.8.1 Delphi round 2 analysis of the supplier drivers theme

The analysis of the Likert survey focused on the Supplier Drivers theme revealed a predominantly strong endorsement of the proposed framework, with the Supplier Selection Method theme being the sole exception to this trend. A mere 22% of the experts expressed strong agreement or agreement regarding this driver, while a significant 33.3% maintained a neutral stance. Notably, 44% of the experts disagreed with this driver. Consequently, the researcher is compelled to exclude this driver from the framework.

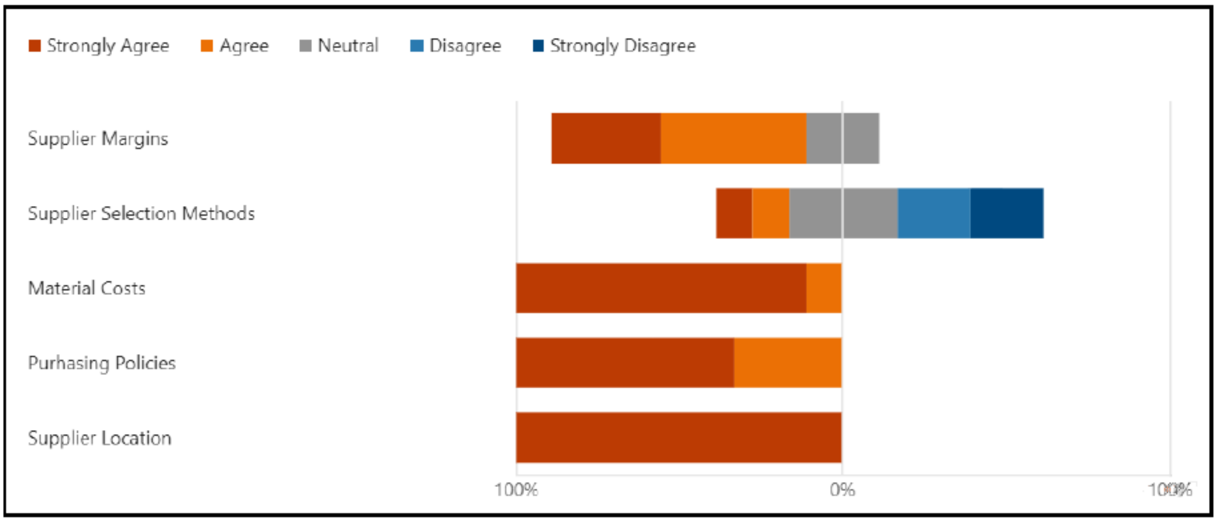


Figure 83: Likert Survey Of The Supplier Drivers Theme

7.8.2 Delphi round 2 analysis of the benchmarking drivers theme

The Likert survey concerning the drivers of the Benchmarking theme indicated a significant consensus among experts regarding the necessity for adoption, with the exception of the Production volume's theme. Feedback from experts during the Delphi Round 1 survey suggested that Improving Production volumes is more relevant to the South African context. Consequently, the researcher proposes to merge these two concepts into a single phrase: Optimization of Production volumes.

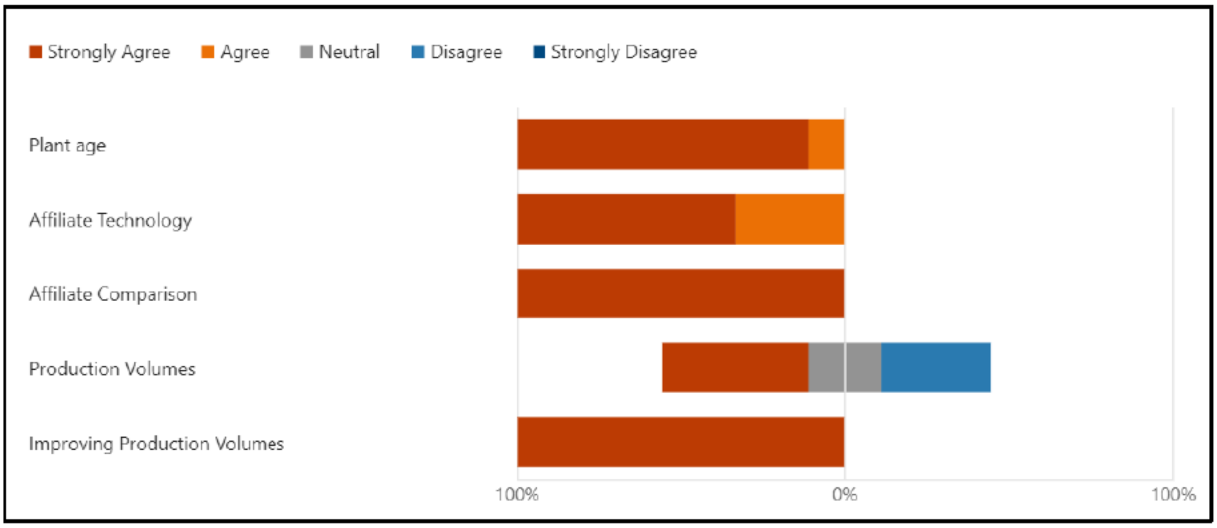


Figure 84: Likert survey of the Benchmarking Drivers theme

7.8.3 Delphi Round 2 Analysis Of The Cost Drivers Theme

The evaluation of the Likert survey focused on the Cost theme drivers indicated a robust agreement among the experts. It is noteworthy that the sub-theme regarding Shipping agencies and frequencies recorded an 11.1% disagreement, which is minimal when juxtaposed with the 89.9% agreement rate. As a result, all identified cost driver themes will be integrated into the LM framework.

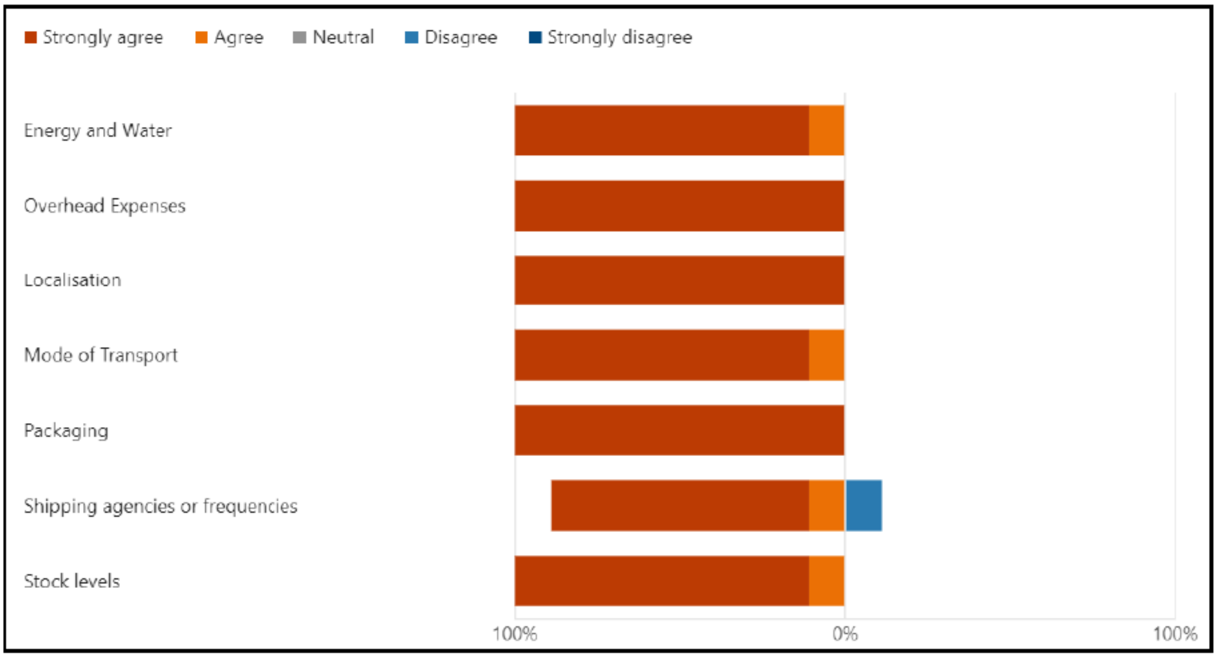


Figure 85: Likert survey of the cost drivers theme

7.8.4 Delphi round 2 analysis of the production drivers theme

The results of the Likert survey on production drivers indicated a strong agreement among experts, with a slight 11.1% neutrality regarding the Poke yoke and fail-safe themes, which is considered trivial. Consequently, the researcher will adopt all sub-theme drivers into the framework.

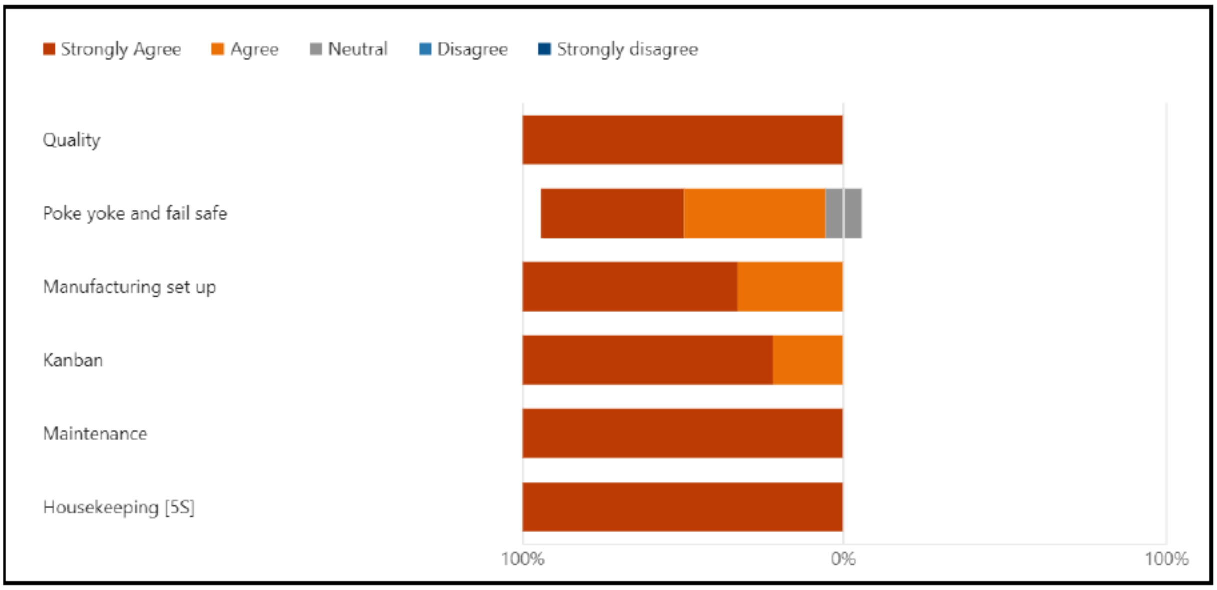


Figure 86: Likert survey of the production drivers theme

7.8.5 Delphi round 2 analysis of the production barriers theme

The experts demonstrated a high level of consensus regarding all the barriers identified within the Cost barrier's theme; consequently, the researcher will incorporate all of these barriers into the study.

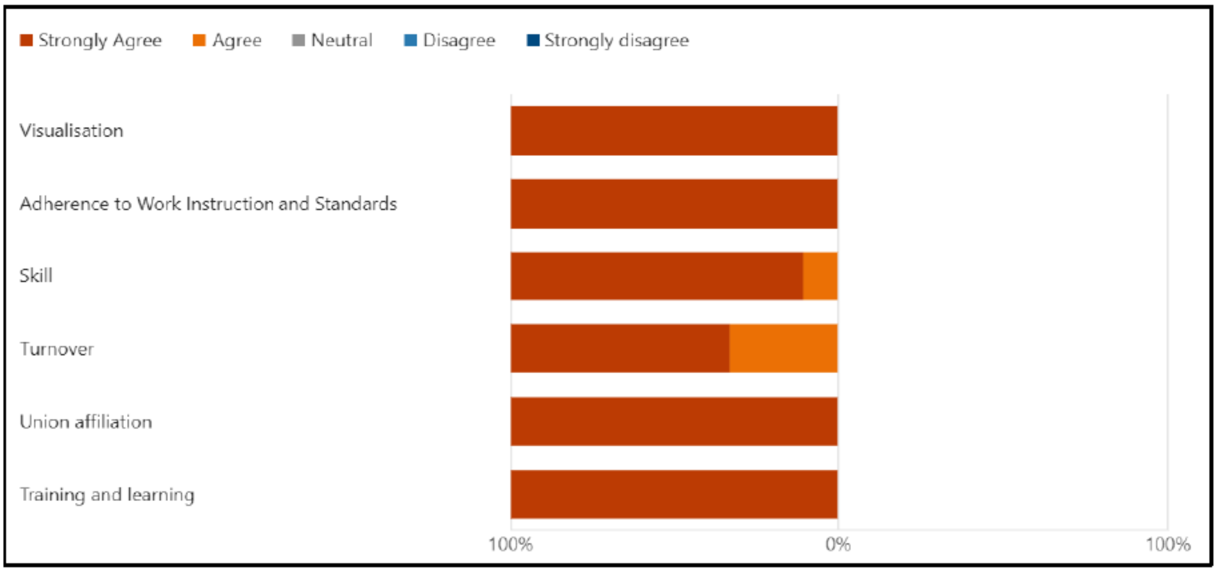


Figure 87: Likert survey of the production barriers theme

7.8.6 Delphi round 2 analysis of the process barriers theme

The researcher incorporated the recommendations provided by experts following the responses from Delphi Round 1 and subsequently revised the wording of the barriers to enhance clarity, as detailed below.

Previous	**Amended**
Surveys	Lack of surveys
Customer Involvement	Lack of customer involvement
Lean Information	Lack of Lean Information
Customer Profitability	Customer Profitability views against Lean

Consequently, there was a pronounced agreement among the experts regarding the Process Barriers specified in the Framework. The Sales theme, however, revealed a slight discrepancy, with 11.1% of responses falling into the neutral category, which is regarded as insignificant. Thus, the researcher will propose the endorsement of all the themes.

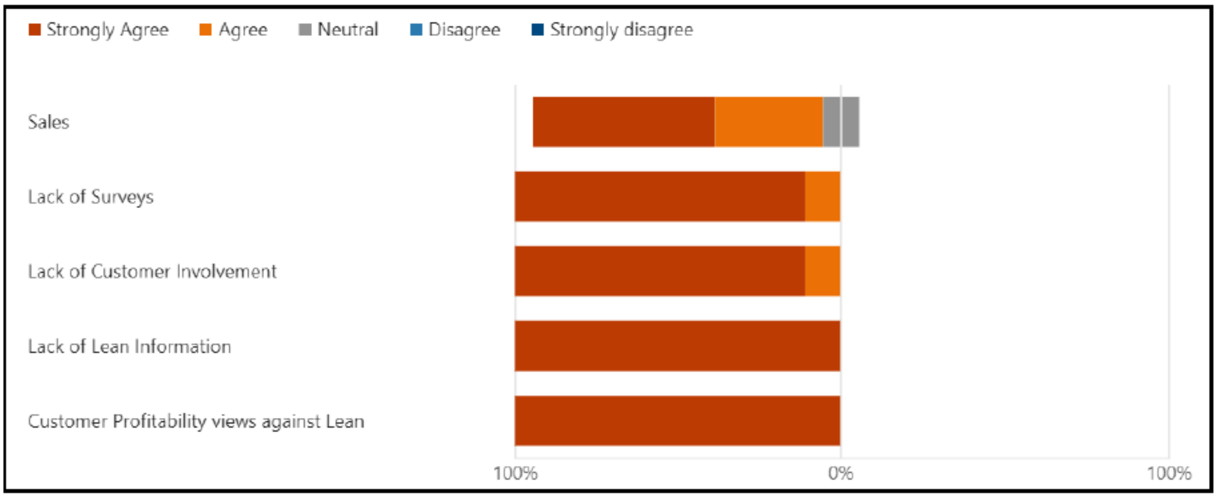


Figure 88: Likert survey of the process barriers theme

7.9 Conclusion and recommendations

The Framework's readiness for implementation in the South African environment for a Steering Wheel Manufacturing company was assessed through a Net Promoter Score (NPS) analysis. The NPS score recorded was 100, as indicated in the NPS Score graph in Figure 88. Therefore, the researcher to adopt the Final Proposed Framework, as the validation process has been deemed complete.

Figure 89: NPS survey for the lean manufacturing drivers and barriers framework adoption

7.10 Proposed lean manufacturing drivers and barriers framework (LDBF)

The final validated framework has been referred to by the researcher as the Lean Manufacturing Drivers and Barriers Framework (LDBF), due to its integration of both drivers and barriers into a unified model. Figure 89 below presents the LDBF.

LEAN MANUFACTURING DRIVERS — LEAN MANUFACTURING BARRIERS

DRIVERS		MAIN THEME	BARRIERS	
Subtheme	**Theme**		**Theme**	**Sub-Theme**
Supplier Margins Supplier selection methods Material costs Purchasing policies Supplier location	Factors affecting Supplier selection	SUPPLIER	Supplier involvement	Quality Improvements New Product launch
Plant age Affiliate technology Affiliate comparison Improving production volumes	Assessing technological capability of the local company	BENCHMARKING	HQ Decision making	HQ Perception
Energy and Water Overhead	Indirect costs cutting measures	COST	Cost Markers	Profitability Cost Reduction Kaizen
Localisation Mode of transport Packaging Shipping agencies/Frequencies Stock levels	Localisation in comparison to shipping expenses			
Quality Poke yoke and Fail Safe Manufacturing Set Up Kanban Maintenance House Keeping (5S)	Production related	PRODUCTION	Targets Staff Teamwork	Visualisation Adherence Skill Turnover Union Affiliation Training and Learning
Existing Process/New Process Lean adoption Commitment	Process related	PROCESS	Bottleneck Muda	Bottleneck Muda
Customer Demands Customer Satisfaction JIT	Customer related	CUSTOMER	New customers Customer Customer Complaints Surveys	Sales Lack of Surveys Lack of Customer involvemment Lack of Lean Information Customer Profitability Profitability views against Lean

LEAN MANUFACTURING

Figure 90: Proposed lean manufacturing drivers and barriers framework (LDBF)

Source: *Researcher's own construction*

7.11 The novelty of the proposed lean manufacturing framework

The framework is synchronized with themes inferred from empirical data in a steering wheel manufacturing setting, and its distinctiveness is articulated for each theme in South Africa, which has not been previously studied.

7.11.1 Supplier theme novelty

Lean manufacturing, in its traditional form, focuses largely on internal processes. By explicitly recognizing supplier drivers and barriers, it acknowledges the extended enterprise, rather than confining itself to the factory floor. The novelty is in transitioning lean practices beyond the manufacturing plant into the supply chain ecosystem.

7.11.2 Benchmarking theme novelty

LM is usually evaluated based on internal metrics, including waste, cycle time, and productivity.

The integration of benchmarking with affiliates, and best practices as a means of fostering improvement is not as widespread. The innovation in this context is that it shifts the focus of LM to be comparative and competitive, rather than merely an internal undertaking.

7.11.3 Cost theme novelty

Cost reduction is often viewed as an incidental result of lean approaches. By specifically framing cost as a key theme (with subthemes material costs, energy, and overheads), the framework integrates cost accounting with the lean drivers and barriers. A significant phenomenon regarding costs is the localization of subcomponents as a lean driver, a phenomenon that has not been examined in the first world despite numerous lean studies. The exploration of this within the South African context renders it distinctive. The uniqueness of this approach is therefore that it connects LM with strategic cost management.

7.11.4 Production theme novelty

The uniqueness is highlighted in the exhibition that Production is simultaneously the foundation and the friction point of LM. The subthemes related to production drivers in the framework facilitate the progression of LM, while the subthemes concerning production barriers in the framework obstruct advancement.

7.11.5 Process theme novelty

The uniqueness is in recognising the process as a paradoxical element, that is as both a driver through existing systems,adaptability and commitment, and also as a barrier through bottlenecks and muda. This dual framing is unique because it challenges the traditional assumption that processes are simply passive LM targets. It shows that processes themselves are involved and shape the out comes of LM implementation.

7.11.6 Customer theme novelty

The uniqueness of the customer theme is found in its assertion that customers are not simply passive endpoints of value; they are vital contributors whose behaviors can either advance or impede LM. No existing framework highlights this all encompassing view of the dual relationship in which customers both drive and obstruct lean initiatives.

CHAPTER 8

RECOMMENDATIONS AND CONCLUSION

This chapter focuses on the recommendations grounded on lean manufacturing to support the Proposed Framework for the selected South African steering wheel manufacturer.

8.1 Introduction

The focus of this chapter is on the recommendations derived from lean management practices, aimed at bolstering the established framework for the selected manufacturer of steering wheels in South Africa.

8.2 Supplier margins

This research underscores the significance of supplier openness in the production of automotive parts. According to Toyota, the recommended profit margin for suppliers is between 7% and 10%, which implies that the purchasing departments of companies producing steering wheels should endeavour to achieve this target.

8.3 Material costs

It is incumbent upon the suppliers of the steering wheel components to procure competitive materials; however, company XYZ, as the manufacturer of steering wheels, must diligently oversee these costs. This oversight should involve monitoring the supply chain and the manufacturing efficiencies of their suppliers, as well as ensuring compliance with pertinent certifications and standards.

8.4 Purchasing policies

The proposed framework endorses the utilization of the Toyota Purchasing Policy, summarized in the points extracted from the article, *Sustainable Purchasing Guidelines Toyota Motor Europe* (2023) presented below.

8.4.1 Open and fair transactions

Company XYZ should provide all suppliers with the opportunity to participate in transactions that are carried out in an open, equitable, and impartial manner, regardless of the suppliers' country of origin. Suppliers should be selected based on fair comparisons and a thorough assessment of numerous criteria, including cost, technical expertise, product quality, and assurance of delivery schedules.

8.4.2 Mutual benefit based on mutual trust

The strategy should focus on fostering mutual growth through commercial interactions with suppliers. It is essential to cultivate reliable, enduring relationships by maintaining consistent communication with suppliers.

8.4.3 Environmentally preferable purchasing

Company XYZ should consider implementing a systematic approach to evaluate suppliers of low-impact parts, materials, and equipment on a regular basis, ensuring that their practices align with the principles of environmental sustainability in the production of eco-friendly products.

8.4.4 Encouragement of local buying as a virtuous business practice

Company XYZ ought to be mindful of its role within the local community and should work diligently to become a model corporate citizen by supporting growth and making significant contributions to the betterment of society.

8.4.5 Conforming to the law and upholding confidentiality

Besides taking all prudent steps to safeguard sensitive data acquired through reciprocal purchasing activities, Company XYZ should ensure compliance with all pertinent laws and social conventions that govern purchasing activities.

8.5 Supplier location

The suggested framework incentivizes supplier XYZ to purchase raw materials from suppliers that are ranked highest within a 100-kilometer radius around them, then from within South Africa, Thailand, Europe, and finally the world.

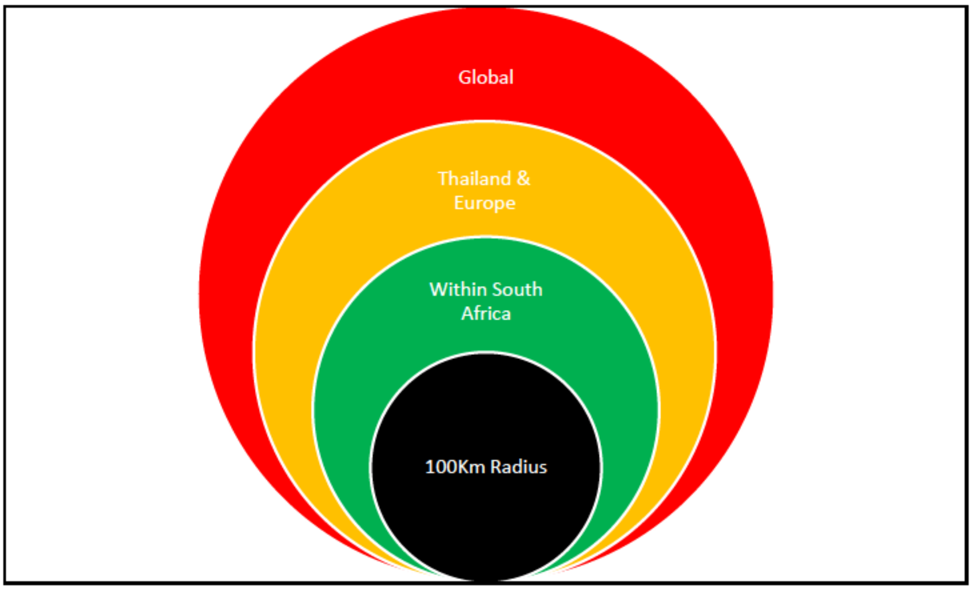


Figure 91: Suggested sourcing priority

Source: *Researcher's own construction*

The Framework acknowledges that certain OEM-controlled special parts are exclusive to the OEM and cannot be obtained from any other source other than that directed by the OEM.

To diminish the repercussions of hindrances on the implementation of LM, this study also recommends the following improvements:

8.6 Supplier involvement barriers

To lessen the effect of barriers on the implementation of LM, this research also suggests improving the following.

8.6.1 Supplier involvement in quality improvements and when launching new products or services

The proposed model is strengthened by the three key pillars of supplier engagement: Communication, Support, and Transparency (Dow, 2024). The figure below demonstrates how the researcher aligned these three pillars towards the development of the proposed model.

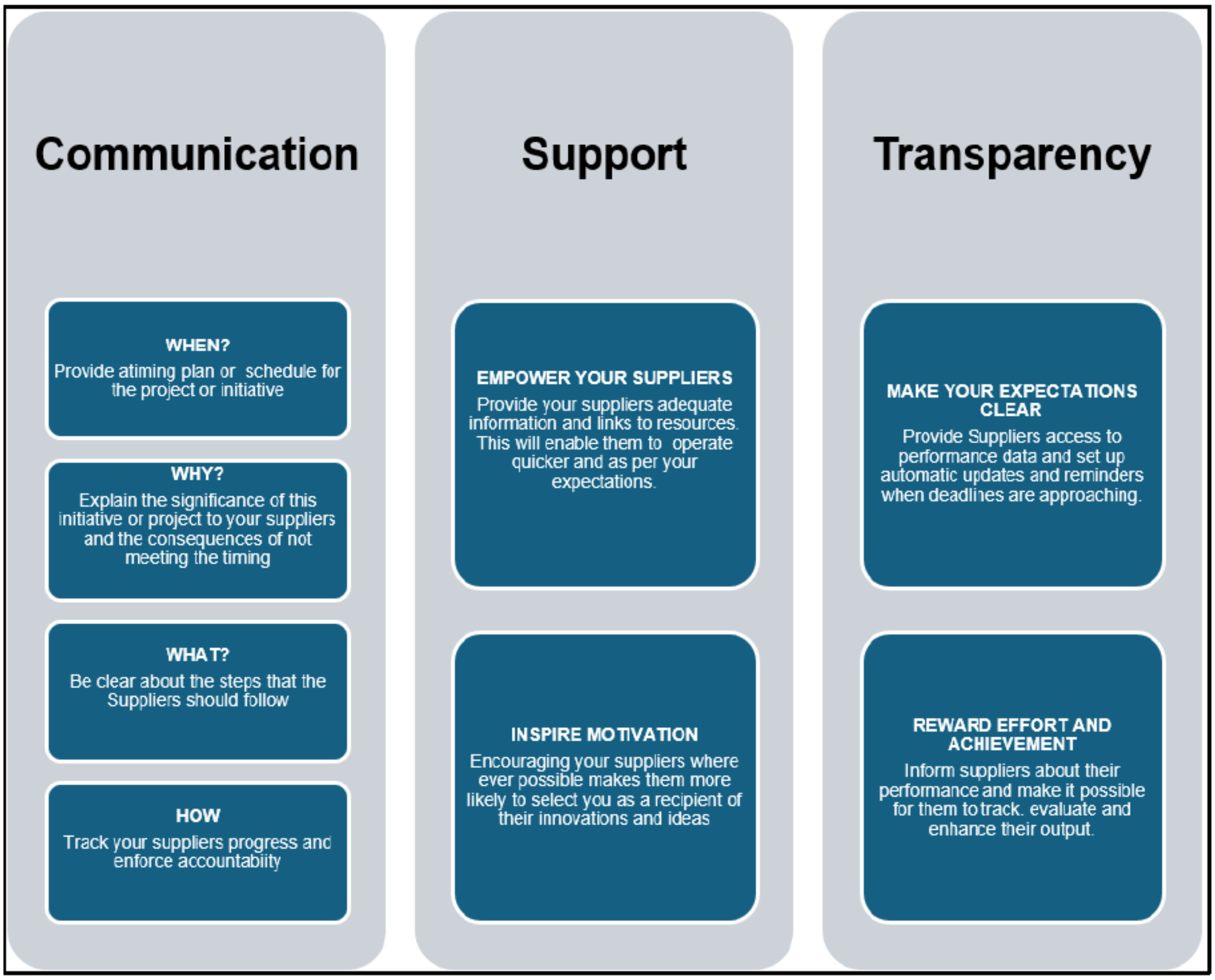


Figure 92: Three pillars of supplier engagement

Source: *Adapted from (Dow, 2024)*

8.7.7 Benchmarking drivers and barriers

This study identified four benchmarking subjects. The proposed benchmarking technique for XYZ Company is taken from Smart (1988). The company doesn't need any capital investments to follow the simple steps that are broken down into four phases as highlighted in Figure 92 below:

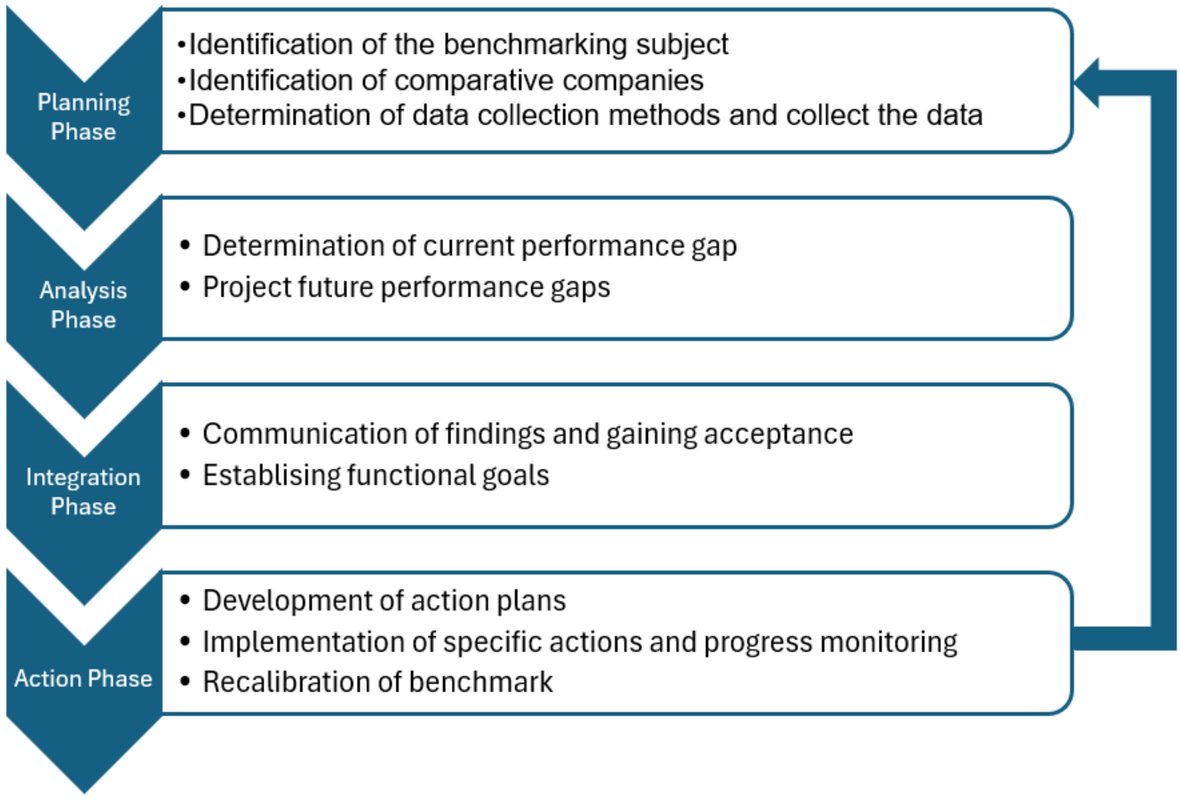


Figure 93: Proposed benchmarking process for company XYZ developed by the researcher

Source: *Reseacher's own construction adapted from Smart (1988)*

8.7.1 HQ Perception

The findings of this study indicate that HQ intended to shut down company XYZ due to their unfavorable perceptions of it. The researcher suggests a rapid solution to assess how company XYZ compares to other affiliates within the same group: utilizing the benchmarking data outlined in section 7.1.6. It is recommended that the company leverage the insights gained from benchmarking to engage in transparent, actionable, and time-sensitive communication with HQ, aimed at bridging the disparity between company XYZ and the benchmarked affiliates.

8.7.2 Decision making

This study has determined that company XYZ is tardy in decision-making, with even trivial decisions being escalated to the highest levels of the organizational structure. To address this issue, it is advisable for company XYZ to implement a Delegation of Authority (DOA) Process, which is summarized in Figure 93 below.

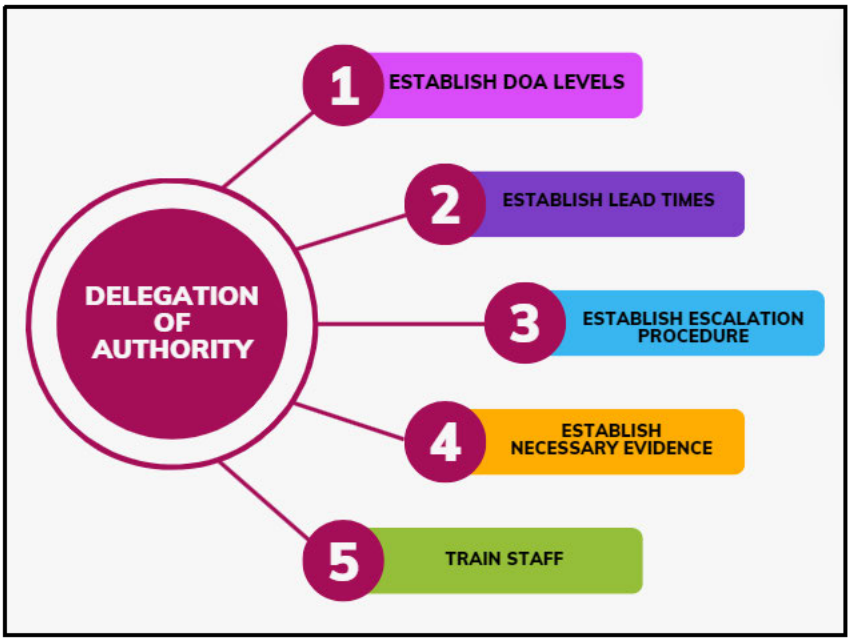


Figure 94: Delegation of authority model developed by the researcher.

Source: *Developed by the researcher*

8.8 Cost drivers and barriers

The following suggestions are postulated for company XYZ for the identified cost drivers and barriers.

8.8.1 Water

1. Implementation of water measurement and reporting practices, including water consumption as a company's key performance indicator (KPI).
2. Sound detection devices available in the market are cheap and useful tools that Company XYZ can use to identify leak locations.
3. As a long-term measure, the company can Install secondary leak detection techniques strategically between flow meters and pressure gauges to investigate any potential pressure differences. The portion of the leak is established where there are variations in the readings. For instance, there is probably a leak between

the beginning and the end of the pipe if the flow rates at each location are noticeably higher.

4. Use JoJo tanks to capture and use rainwater for watering plants and toilet usage during rainy seasons.
5. Using urinal blocks instead of water in male ablutions instead of water for flushing urinary.

8.8.2 Energy

Company XYZ is encouraged to consider the implementation of various ideas that have been developed and proposed in this research, detailed as follows:

1. Adoption of Light Emitting Diode (LED) lights for use in the offices and factory instead of the normal incandescent lighting.
2. Invest in Solar energy. It may be costly to implement this for the whole plant, however, company XYZ can strategically stager the implementation, starting with the offices and administration and then low energy use zones in the plant as a pilot project.
3. Use Sensors for rooms and equipment – These will automatically switch off the room lighting if there is no one in the room and respectively switch off equipment that is not in use.
4. Regular Maintenance and Servicing of Equipment – Company XYZ needs discipline in carrying out scheduled preventative maintenance.
5. Plan activities or production runs that use high energy during off-peak time zones to take advantage of off-peak rates.

8.8.3 Overheads

The findings of this research have identified both fixed and variable overhead costs at company XYZ. Recommendations regarding variable overheads are elaborated in sections 7.8.1 and 7.8.2. It is suggested that the company adopt a meticulous approach to assess its fixed overheads, confirming that all expenses are still relevant to its operations. Moreover, the company should evaluate the effectiveness of all subscriptions and licenses, with a strong recommendation to cancel those that are no longer advantageous without hesitation.

8.9 Localization

The research concluded that several parts and components are available for easy acquisition from local South African vendors, including the following:

1. Leather sewing thread.
2. Airbag cushion.
3. Consider proposing steering frame to be changed from Magnesium to Aluminium.

8.10 Production-related LM drivers and barriers

Company XYZ is encouraged to undertake improvements in the following domains:

8.10.1 Maintenance

This study reveals that company XYZ has a Preventative Maintenance (PM) program, but it's seldom followed.

1. Looking into the discrepancy between the planned PM and the actual PM will be the first step in Company XYZ's implementation of the psychological component of preventative maintenance.
2. Examining the necessary documentation as well as the PM guidelines, standards, and frequency.
3. To make sure employees complete the mandated PM training courses.
4. Consider non-monetary rewards for a division or department that excels at adhering to PM schedules.

8.10.2 5S Housekeeping

The research findings demonstrate that the 5S methodology has been adopted; however, its execution occurs solely during visits from external parties. Considering this, the researcher recommends the establishment of Scheduled Plant Walkarounds to ensure regular application. To begin with, various teams can be rotated to perform daily walkthroughs of the plant, and this frequency may be adjusted to a lesser interval as the 5S standard shows improvement. The team tasked with responsibility is expected to record their observations, which can subsequently be shared during daily management meetings to guarantee responsibility for implementing the necessary corrective measures.

8.11 Process-related lm drivers and barriers

It is recommended that Company XYZ enhance the following aspects:

8.11.1 Lean adoption

Before implementation, the LM understanding must be addressed. Training, research, and implementing comparable tactics from comparable contexts are all necessary. Company XYZ needs to participate in pertinent workshops. In terms LM adoption communication:

1. Create a persuasive communication plan highlighting the urgency of the organization to implement LM.
2. Enumerate the primary SMART goals that need to be met.

8.12 Conclusion

The research study aimed to develop and implement a lean manufacturing framework at a selected South African steering wheel manufacturer. In conducting the research, the study was steered by the objectives and research questions outlined in section 1.9 which are listed below:

Table 40: Recap of objectives and research questions

Objective Number	Objective	Research Questions
1	To explore the key drivers for implementing LM	How do the drivers influence LM implementation?
2	To explore the possible barriers to implementing LM with reference to a systematic literature review.	How do the barriers impede LM implementation?
3	To investigate the manufacturing performance of the current steering wheel manufacturing process with regards to LM drivers and barriers by using focus groups, one-on-one interviews, and participant observation.	How do the identified LM drivers and barriers affect the current manufacturing performance?
4	To explore the prevalence of overcoming the LM barriers and challenges.	How does the prevalence assist in resolving the barriers and challenges?
5	To develop a conceptual LM implementation framework based on the drivers and barriers.	Why is the conceptual framework preferred?
6	To empirically validate the LM implementation framework.	Does the research output address the research problem?

In addressing the objectives and the research questions, a literature review was carried out to identify the drivers and barriers prevalent in LM implementation and the prevalence of overcoming the LM barriers.

Furthermore, focus groups, one-on-one interviews, and participant observations were used as research instruments to investigate the manufacturing performance of a steering wheel manufacturing plant. NVivo was used to conduct data analysis. Findings analyzed in NVivo were further corroborated to test validity through the convergence of information from focus groups, one-on-one interviews, and participant observations using Triangulation, which was then used to develop the Lean Manufacturing Drivers and Barriers Framework (LMDBF).

Based on the data analysis findings of the areas potentially detrimental to implementation, the research then formulates recommendations to adopt during LM implementation for the case study company XYZ.

8.13 Limitations

The case study concentrated on one company because of the non-availability of steering wheel manufacturing companies in South Africa due to cost inefficiencies that led to mother companies being forced to move the operation to more cost-efficient countries.

Data collection comprised focus groups which were predominantly the production shop floor supervision staff with a mix of production support departments, and then one-on-one interviews were carried out with the Managing Director, Production Manager, Quality Manager, Purchasing Manager, and Maintenance Manager. The participant observation was only limited to the processes that were availed during the research.

8.14 Future work

Company XYZ is eager to proceed with the implementation of the LDBF, and it will be crucial to assess the performance of each theme following its execution. The endorsement from experts serves as a confirmation that this Framework is prepared for implementation. The initial groundwork for the LDBF implementation has been established by Company XYZ through efforts to enhance staff awareness and the execution of certain recommendations presented in this study. Therefore, it is recommended that subsequent studies investigate the implementation phase.

8.15 Critical reflection

The research findings highlight a complex interplay between Lean Manufacturing theory and its application in the automotive industry of South Africa. Through the investigation of six empirically derived themes—Supplier, Benchmarking, Cost, Production, Process, and Customer—it is evident that while Lean drivers are observable and theoretically aligned with established models such as Womack and Jones' Five Principles of Lean (Womack and Jones, 1996) and the Toyota Production System (Gershon, 2010), ongoing barriers expose the contextual limitations of these frameworks in the South African context.

8.15.1 Reflection on the themes of the theoretical framework

In the Supplier theme, the LM driver of supplier selection factors reinforces Lean's focus on dependable, quality-oriented suppliers (Taherdoost and Brard, 2019). Nevertheless, the limited involvement of suppliers poses challenges to LM's fundamental philosophy of partnership and integration throughout the value chain. This discrepancy highlights a gap between LM's ideal collaborative supply model and the frequently fragmented multinational supplier networks in South Africa (Barnes *et al*. 2017).

Regarding benchmarking, local technological capabilities are closely aligned with LM's emphasis on continuous improvement and innovation (Fliedner, 2016), (Shang, 2017), and (Meshref *et al*. 2022). However, the perception from headquarters, often influenced by offshore decision-makers, emerges as a significant barrier, indicating a disconnect between global corporate strategies and the practical realities faced in South African operational contexts. This divergence underscores the necessity for decentralised decision-making within multinational automotive operations.

In the context of cost, the application of indirect cost-cutting strategies and a shift towards localisation instead of import dependence exemplifies the LM principle of waste minimization. However, the demands of profitability, inflexible cost reduction targets, and formalized kaizen initiatives can occasionally convert lean from a culture of flexible improvement into a compliance-oriented task, thus diminishing its adaptive characteristics.

In terms of Production, the drivers of Lean Management, particularly those linked to production efficiencies, are observable. However, barriers related to targets, staffing, and teamwork suggest a disconnect between LM's emphasis on respect for individuals and the actual pressures faced by the workforce. LM theory advocates for empowered teams (Van Dun and Wilderom, 2012), yet local implementations frequently lean towards output pressures rather than engaging in participative problem-solving.

In the area of Process, the reduction of costs associated with processes is closely linked to LM's waste elimination efforts (Proenca *et al*. 2022:). However, the presence of bottlenecks and persistent muda (Urban and Rogowska, 2018) indicates that without systemic coordination among departments, isolated LM initiatives often face difficulties in achieving a sustained flow.

In the Customer theme, the acquisition of new customers serves as a key growth driver that aligns with LM's focus on delivering value (van Assen, 2018) and (Schonberger, 2007) as referenced in (van Assen, 2018). Nonetheless, barriers such as customer complaints and survey fatigue suggest a possible disconnect between the value perceived by customers and the outcomes that are delivered.

8.15.2 Policy Implications for South Africa's Automotive Sector

The findings underscore that LM in the South African context necessitates enabling conditions that extend beyond the factory environment. Policies could be directed towards:

- Supplier development programs designed to foster deeper integration and enhance capabilities, thereby reducing the gap in supplier involvement.
- Support for local technological innovation to bolster the relevance of benchmarking and diminish reliance on foreign headquarters' directives.
- Initiatives for skills development aimed at LM leadership, team empowerment, and problem-solving capacity, which address production and process barriers.
- Investment in infrastructure to alleviate logistical bottlenecks, thereby supporting flow and minimizing waste.

By integrating LMreadiness into national industrial policy and sector-level agreements, South Africa can advance towards a competitive and resilient automotive manufacturing ecosystem.

8.16. Contributions of the study to the body of knowledge

The conclusion obtained from the literature review was that from the LM frameworks that have been deployed, none has been applied to a steering wheel manufacturing process globally. Most of them are generic and not industry-specific. None of the global steering wheel manufacturing companies checked has published evidence of LM implementation, and hence no LM frameworks have been developed in line with steering wheel complex processes. Consequently, there was a need for a new LM framework that specifically allowed for investigation and problem-solving in a financially struggling South African steering wheel manufacturing environment. This research led to the successful creation of a Lean Manufacturing Drivers and Barriers Framework (LDBF), which represents a substantial advancement for steering wheel manufacturers and the broader automotive parts sector in South Africa, particularly those that are subsidiaries of multinational corporations.

8.16 Concluding remarks

The research study aimed to develop and implement a lean manufacturing framework at a selected South African steering wheel manufacturer. Table 41 presents a critical overview of how the objectives were achieved and the ways in which the research questions were resolved.

Table 41: Achievement of objectives and answering research questions

Objective Number	Objective	Proof of achievement	Research Questions	Proof of achievement
1	**To explore the key drivers for implementing LM**	The literature review conducted in section 2.3.1 was essential forexploring critical drivers, which were later triangulated to extract six dominant themes that were applied in the formulation of the LDBF	**How do the identified drivers influence LM implementation?**	The review of literature detailed in Section 2.3.1 and encapsulated in Table 5 delivers a comprehensive assessment of the influence of the identified drivers on the execution of LM.
2	**To explore the possible barriers to implementing LM with reference to a systematic literature review.**	The literature review conducted in section 2.3.2 was pivotal in pinpointing significant barriers, which were later triangulated to extract six overarching themes that were applied in the design of the LDBF.	**How do the identified barriers impede LM implementation?**	Section 6.5 delineates the six recognized barriers and their obstructive impact on the implementation of Lean Management within their specific categories.
3	**To investigate the manufacturingperformance of the current steering wheel manufacturing process with regards to LM drivers and barriers by using focus groups, one-on-one interviews, and participant observation.**	The findings from the focus group, individual interviews, and participant observation were examined in sections 4.2 to 4.7. The analysis of the current manufacturing performance indicated a necessity to advance the completion of this research to develop a framework for enhancement.	**How do the identified LM drivers and barriers affect the current manufacturing performance?**	The LM drivers were highlighted as domains that necessitate improvement, while the barriers were identified as issues that require vigilant oversight to reduce their negative impact.
4	**To explore the prevalence of overcoming the LM barriers and challenges.**	The successful execution of this objective was made possible through the literature review outlined in section 2.3.4.	**How does the identified prevalence assist in resolving the barriers and challenges?**	The process of exploring prevalent trends was instrumental in refining and customizing solutions to ensure they corresponded with the unique requirements identified by theSteering Wheel company.
5	**To develop a conceptual LM implementation framework based on the drivers and barriers.**	The initiation of this process can be traced back to the literature review presented in section 2.3.5, followed by the completion of the developed framework in section 6.4, culminating in the proposal of the framework in section 7.10.	**Why is the conceptual framework preferred?**	Numerous Lean Manufacturing frameworks have been established; however, none have been specifically tailored for the South African Steering Wheel Manufacturing sector, which has witnessed the departure of several multinational corporations seeking more competitive markets.
6	**To empirically validate the LM implementation framework.**	The identification of the Delphi method occurred during the literature review in section 2.3.6, and it was subsequently utilized as a validation mechanism in chapter 7. This chapter incorporated insights from experts in the South African automotive industry and academia. The validation efforts resulted in the proposal of the LDBF, which is outlined in section 7.10.	**Does the research output address the research problem?**	The LDBF is recognized as a financially prudent strategy for the enhancement of manufacturing performance in South Africa's steering manufacturing sector, as affirmed by the LM experts in section 7.9.

Source: *Researcher's own construction*

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APPENDIX 1: ANALYSIS OF IMPROVEMENT TECHNIQUES

Analysis of Improvement Techniques (Adapted from Gershon 2010: 61)

Improvement Methodology	Definition	Advantage	Major Disadvantage	Applicability with Toyota	Ranking
Lean Manufacturing	Lean methodology strives to cut costs by eliminating waste.	Improves quality, reduces waste and saves costs	Relies on human resources and can weary the staff.	Very high	1
Toyota Production System (TPS)/JIT	Methodology centered around reducing inventory costs, manufacturing products only as they're needed.	Effective inventory reduction	Rewards may take long	Very high	2
Total Quality Management (TQM)	An organization-wide effort focused on continuous improvement to improve customer quality.	Improves quality	Relies on human resources and can weary the staff.	Very high	3
Lean Six Sigma	A combination of Lean and Six Sigma methodologies.	Improves quality, reduces waste and saves costs	Relies on human resources and can weary the staff. Regarded as complicated and requires rigorous training.	High	4
ISO 9000/1 (XYZ is ISO 9001:2015) certified	More of an administrative system than process imoprovement system that relies more on documentation	Excellent documentation of the process and organisation	Assumes that once certified the company is good enough	High	5
Six Sigma	A data-driven approach to reduce defects to improve an organization's performance.	Six Sigma is a proactive methodology that can identify and provide recommendation s for potential	Six sigma goal is quality improvement, and the adoption of protocols sometimes lead to an increase in costs	Medium	6
Theory of Constraints (TOC)	A systematic process focused on finding and eliminating constraints.	Process improvement and cost reduction	Assumes that bottlenecks are generally the problem	Low	7
Business Process Re-engineering (BPR)	Business process reengineering is the act of recreating a core business process with the goal of improving product output, quality, or reducing costs.	Saves costs	May require subtantial capital investment to make the changes	Low	8

APPENDIX 2: FOCUS GROUP INTERVIEW QUESTIONS

Outcome	Metric/Category of Evaluation	Interview/Focus Group Question	Notes
Investigation of the manufacturing performance of the current steering wheel manufacturing process with respect to lean manufacturing metrics	**Financial perspective**	1. Are you informed about the perceptions of the Headquarters with regards to the South African branch? 2. How often do you get informed? 3. Are you aware if the company is making a loss or profit? 4. Are efforts to make profit being shared with staff in a way that you understand what you are supposed to do as an individual?	
	Customer perspective	Does your performance measurement system enable you to have the following? information? 1. Customer satisfaction survey reports 2. Number of new customers referred by existing customers 3. Sales to new customers 4. Number of complaints from customers 5. Customer profitability 6. New customer surveys 7. Customer preference surveys 8. Number of scraps and reworks returned by the customers 9. Sales representative feedback reports	
	Internal perspective	1. Are daily production plans communicated and understood? 2. Is cycle time of each product strictly monitored? 3. What are the actions that you do should you not meet the cycle times? 4. In your opinion, what are the things that slow you down when working 5. How can they be improved? 6. Are you aware of the company's cost reduction initiatives? 7. Does your department keep track of departmental cost reduction ideas? 8. Are these ideas practised by each operator where necessary? 9. What are some of the kaizen ideas that you can contribute?	
	Learning and growth perspective	1. Does the organisation offer training of any kind to staff? 2. Name the areas where staff is trained. 3. Which area do you wish training may be done for you? 4. How do you wish to be recognised after successfully passing some training?	
Evaluation of the current efficiency in the steering wheel manufacturing process through	**Current Culture and Leadership**	Name the system(s) that are currently being used to encourage improvement activities within the organisation.	
		Are you aware of the process improvement targets in terms of monetary value?	

value stream mapping.		Are the targets tracked by Departments over a period and visualised for every employee to see?	
		Do you think administrative processes are efficient in your opinion?	
		Is there a platform for the shop flow to make suggestions to Management?	
		Does Management follow up on shop floor suggestions and implement or give reasons why not?	
		Is there a process flow to show the flow of material from the start to finish?	
		As an employee do you support continuous improvements efforts?	
	Process and Equipment	Is there a process flow to show the flow of material from the start to finish?	
		Has waste in the process been quantified?	
		Are the bottlenecks defined?	
		Do you practise any housekeeping activities?	
		Is reduction in set up time managed and tracked?	
Evaluation of the current efficiency in the steering wheel manufacturing process through value stream mapping.	**Process and Equipment**	The process and equipment are arranged by process type (cellular).	
		Does the process and equipment allow an easy flow of materials from start to finish.	
		Equipment layout makes it easy to work effectively.	
		Are the steps followed when running a new process always clear?	
		Are there error proofing systems in your processes?	
		Are there fail safe systems in your processes?	
		Is there a preventative maintenance plan that is followed effectively?	
	Manufacturing planning and control	Are targets and performance in the plant visualised in a clear manner?	
		Are daily processes and targets adhered to?	
		The Kanban/pull production system is very much used	
		Does current workload per operator plan ensure that there are no amnecks?	
	Human resources	Do you think that newly recruited employees are given enough training for the job?	
		Is Staff well trained for new processes and procedures?	

		Is group problem solving encouraged?	
		Do you think cross functional teams work well together?	
		Do you feel that you are involved in decisions that pertain to process and quality?	
		Do you think that the workforce is very committed to ensuring organisational success?	
Evaluation of the current efficiency in the steering wheel manufacturing process through value stream mapping.	**Supplier relationships**	Is Just In Time delivery practised	
		Are your suppliers involved in quality improvements activities?	
		Are your suppliers involved when you launch a new product or process?	
	Customer relationships	Is your company involved in customers quality improvement programs	
		Do you think customer demands are a priority?	
		Are your customers involved in your quality improvement programs?	
		Is your company involved when your customer launches a new product or process?	
		Do you practise Just In Time Delivery to your customers?	
	`Lean Barriers	Do you think South African companies can easily adopt lean manufacturing?	
		Do you think your company will easily adopt lean manufacturing?	
		Would you say there is enough information about lean manufacturing that has been shared with all staff?	
		Would you say lean manufacturing and its benefits are well understood by the shop floor?	
		Do you think lean will easily be supported by the shop floor workers?	
		Do you think lean will easily be supported by middle management?	
		Do you think lean will easily be supported by senior management?	
		Do you think that the current manufacturing set up will make it easy for lean manufacturing to be implemented	

APPENDIX 3: ONE-ON-ONE INTERVIEW QUESTIONS

The following interview questions are only restricted to one-on-one interviews relevant management adapted from Fries *et al*. (2017: 2)

To critically analyse the cost factors in the steering wheel manufacturing process	**Material Costs**	What influences sourcing policies?	
		Where are the Suppliers Located?	
		How is Supplier selection carried out?	
		What is the breakdown of your procurement sources by country?	
		Is there any raw material that is currently imported that can be sourced locally?	
	Energy Costs	What are the main forms of energy used?	
		Are there any cheaper alternatives explored?	
		Are there any energy consumption reduction activities?	
	Production Volumes	What are the volume ratios in comparison with your affiliate?	
		Any outlook plans to increase the volumes?	
	Margins of Suppliers	Does XYZ have set margins for the Suppliers?	
		Do the suppliers conform to the set margins?	
	Shipping Costs	Is import raw materials by sea or air?	
		What is the frequency of the shipment?	
		Which shipping agencies are used?	
		Can there be improvements in packaging?	
		How is the raw material transported from the port to the premises of XYZ	
		How much stock do you keep? Any Warehouse/Insurance related costs?	
	Learning	Are there any costly learning curves that have been experienced? Give examples.	
		From work experience, what skills do you wish to be considered for training on?	
		How old is the plant and facilities?	

	Matureness of Manufacturing Technology	How different is the Technology to that of the affiliates?	
		Are there a lot of Maintenance costs due to age?	
To critically analyse the cost factors in the steering wheel manufacturing process	**Labour**	Is skilled manpower for steering wheel manufacturing easily available?	
		What is the average staff turnover rate?	
		What is the union affiliation?	
	Overheads	What are the main inputs of the overhead costs	
		Is factory building rented or owned?	
		Is there a water usage reduction plan	
		Electrical energy reduction plan?	

APPENDIX 4: LETTER OF INFORMATION

LETTER OF
INFORMATION

Title of the Research Study: The development and implementation of a lean manufacturing framework at a selected South African steering wheel manufacturer.

Principal Investigator/s/researcher: Kamukhelo Nyathi

Co-Investigator/s/supervisor/s: Professor K. Ramdass

Brief Introduction and Purpose of the Study:

Hello. I am a PhD student at the Durban University of Technology currently conducting a research for my Doctor of Philosophy (PhD) in Quality Management. I would like to invite you to participate in the research.

A research is a systematic search or enquiry for generalized new knowledge. To decide to participate, you have the freedom to ask as many questions as you wish, and you are free to take this letter of information home and discuss it with your family and friends and you are under no obligation to commit to the study at this stage

Outline of the Procedures:
The vehicle manufacturing industry is facing a challenge of investors pulling out of South Africa due to high cost of the parts that are being manufactured locally and are preferring to invest in countries where the cost of producing those parts is lower. This research is to focus on the areas where the costs are high due to wasting of resources in the steering wheel manufacturing process and then find a way to reduce those wastes. The study will focus on the seven types of wastes, that is transportation, inventory, motion, waiting, overproduction, overprocessing and defects.

The number of employees expected to participate in the survey questionnaire are 105 employees from the entire company. Your company management has approved this research; however, this questionnaire will be shared with management for adoption and due clearance. The expected duration of the questionnaire will not be more than ten minutes of your precious time.

Research Objectives
1. To identify the key drivers for implementing LM.
2. To identify the possible barriers to implementing LM with reference to a systematic literature review.
3. To develop a conceptual LM implementation framework based on the drivers and barriers.
4. To empirically validate the LM implementation framework.

Risks or Discomforts to the Participant:
The items in the questionnaire does not contain any information that may cause any discomfort, diminish your self-esteem, or cause you any embarrassment or regret. There are no potential risks or discomforts that you will experience after completing the questionnaire.

Explain to the participant the reasons he/she may be withdraw from the Study:
You are free to withdraw from the study at any time that you wish to. When withdrawing from the study, please let me know that you would like to do so. You are not obligated to give me a reason(s) for leaving the study, but you are free to do so if you wish. If by any chance the researcher thinks that it is best to have you excluded from the research, you will be notified and thanked for your support, and the reasons why the decision is taken will be explained to you.

Benefits:
You will not have a direct benefit from this study. However, if this study is completed, the expectation is that it will improve the efficiency of your organisation resulting in reduced pricing, greater profitability, and attraction of investment and increased opportunities for you within the organisation.

Remuneration:
There is no direct benefit or remuneration for participating in this research.

Costs of the Study:
The only costs that you may incur is the data usage for completing the online questionnaire for about ten minutes.

Confidentiality:
The questionnaire does not include any content that will reveal your identity as well as that of your company. Please be assured that you will remain anonymous, and no one will ever know that you even participated in the research, unless you wish not to remain anonymous.

Results:
After approval and agreement ha been granted by the Durban University of Technology, I will convey the writings, findings, and recommendations of this research to your company for implementation.

Research-related Injury:
There is no expected physical, emotional, or psychological injury to you.

Storage of all electronic and hard copies including tape recordings
Your responses will be password protected and will only be accessible by I and my Supervisor for a maximum of 5 years, after which they will be discarded.

Persons to contact in the Event of Any Problems or Queries:
Please contact the researcher Kamukhelo Nyathi on (0729462281) or email KamukheloN@dut.ac.za or 22176176@dut4life.ac.za or my supervisor, Professor Kemlall Ramdass on (0824173545) or e-mail ramdakr@unisa.ac.za or the Institutional

Research Ethics Administrator on 031 373 2375. Complaints can be reported to the Director: Research and Postgraduate Support Acting Director Professor K. Motaung on 031 373 2577 or researchdirector@dut.ac.za.

APPENDIX 5: GATE KEEPER'S APPROVAL

Rechnungsadresse / Billing Address:

TAKATA South Africa (Pty) Ltd.
2 Power Drive, Prospecton
Durban 4133
South Africa

JOYSON SAFETY SYSTEMS

02 August 2022

To: DUT Research Committee

Dear Sir/Madam

RE: CONSENT TO CONDUCT POSTGRADUATE RESEARCH

Consent is hereby granted to Mr. Kamukhelo Nyathi, ID Number 7711155971182 and Student Number 22176176 to conduct his research on Quality Management in our plant for his Doctor of Philosophy degree in Quality Management at the Durban University of Technology.

The company will support Mr. Kamukhelo Nyathi in obtaining the information that he requires for the study as we are looking forward to benefiting and improving our quality systems from this study. Please feel free to contact the undersigned if there is any further information that you may require.

Yours Faithfully

Kervin Pillay
Managing Director

APPENDIX 6: IREC FULL APPROVAL

DUT
DURBAN UNIVERSITY OF TECHNOLOGY

INSTITUTIONAL RESEARCH ETHICS COMMITTEE

Institutional Research Ethics Committee
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court
Gate 1, Steve Biko Campus
Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

www.dut.ac.za

25 August 2022

Mr K Nyathi
10 Villas Del Mar
13 Maude Road
Warner Beach
Durban

Dear Mr Nyathi

The development and implementation of a lean manufacturing framework at a selected South African steering wheel manufacturer

I am pleased to inform you that Full Approval has been granted to your proposal.

The Proposal has been allocated the following Ethical Clearance number **IREC 183/22**. Please use this number in all communication with this office.

Approval has been granted for a period of **ONE YEAR**, before the expiry of which you are required to apply for safety monitoring and annual recertification. Please use the Safety Monitoring and Annual Recertification Report form which can be found in the Standard Operating Procedures [SOP's] of the DUT-IREC. This form must be submitted to the DUT-IREC at least 3 months before the ethics approval for the study expires.

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 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.

Yours Sincerely

Professor J K Adam
Chairperson: DUT-IREC

APPENDIX 7: DELPHI ROUND 1 QUESTIONAIRE

25/09/2024, 13:47 The Lean Manufacturing Drivers and Barriers Framework (LMDBF) Delphi Survey Round 1

The Lean Manufacturing Drivers and Barriers Framework (LMDBF) Delphi Survey Round 1

10 August 2024

The purpose of this survey is to improve and validate the LMDBF Framework developed for a Steering wheel manufacturing plant in South Africa.

* Required

About the expert

1. Please select the Industry that you are in

- ◯ Academic
- ◯ Manufacturing OEM
- ◯ Manufacturing OEM Supplier
- ◯ Manufacturing (Other)
- ◯ Service OME Customer
- ◯ Service (Other)

2. Please indicate your position level

- ◯ CEO/Managing Director
- ◯ Executive Management
- ◯ Senior Management
- ◯ Management/Technical
- ◯ Shopfloor

https://forms.office.com/Pages/DesignPageV2.aspx?origin=NeoPortalPage&subpage=design&id=gH8ITAceck-eQdfZdl0PTKstzTQBXL5Aq_gltjvz... 1/9

3. Please indicate your Location

- ◯ KZN
- ◯ Gauteng
- ◯ Western Cape
- ◯ Eastern Cape
- ◯ North West
- ◯ Northern Cape
- ◯ Mpumalanga
- ◯ Limpopo
- ◯ Free State

4. Please indicate the number of years of work experience

- ◯ 0-5
- ◯ 6-10
- ◯ 11-15
- ◯ 16-20
- ◯ >20

5. How many years experience with Lean Manufacturing?

- ◯ 0-5
- ◯ 6-10
- ◯ 11-15
- ◯ 16-20
- ◯ >20

Main theme - Supplier

Sub theme - Factors affecting Supplier Selection

6. The following are Supplier Lean drivers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment.

- ☐ Supplier Margins
- ☐ Supplier Selection Methods
- ☐ Material Costs
- ☐ Purchasing Policies
- ☐ Supplier Location

7. If you did not select any of the above, please explain your reasoning below *

8. In your opinion, please select the top three Lean drivers under the Supplier selection theme *

Please select 3 options.

- ☐ Supplier Margins
- ☐ Supplier Selection Methods
- ☐ Material Costs
- ☐ Purchasing Policies
- ☐ Supplier Location

9. In your opinion, do you think lack of Supplier Engagement in Quality is a significant barrier? *

Main theme - Benchmarking

Sub theme - Assessing technological capacity of the local company

10. The following are Benchmarking Lean drivers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Plant age
- [ ] Affiliate technology
- [ ] Affiliate comparison
- [ ] Production volumes
- [ ] Improving production volumes

11. If you did not select any of the above, please explain your reasoning below *

12. In your opinion, please select the top three Lean drivers under the Benchmarking theme *

Please select 3 options.

- [ ] Plant age
- [ ] Affiliate technology
- [ ] Affiiate comparison
- [ ] Production volumes
- [ ] Improving production volumes

13. In your opinion, do you think HQ perception and Decision making are significant lean barriers. Please explain your opinion. *

Main theme - Cost

Sub theme - Localisation in comparison to shipping expenses

14. The following are cost theme Lean drivers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Energy and Water
- [ ] Overhead expenses
- [ ] Localisation
- [ ] Mode of transport
- [ ] Packaging
- [ ] Shipping agencies or frequencies
- [ ] Stock levels

15. If you did not select any of the above, please explain your reasoning below *

16. In your opinion, please select the top five Lean drivers under the cost theme *

Please select 5 options.

- [ ] Energy and water
- [ ] Overhead expenses
- [ ] Localisation
- [ ] Mode of transport
- [ ] Packaging
- [ ] Shipping agencies or frequencies
- [ ] Stock levels

17. Profitability, Cost reduction and Kaizen were identified as Lean Manufacturing barriers. In your opinion are they all valid? What is your contribution to the Cost theme if they are not sufficient? *

Main theme - Production

Sub theme - Indirect Cost Cutting Measures and Localisation in comparison to shipping expenses

18. The following are Production related theme Lean drivers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Quality
- [ ] Poke yoke and fail safe
- [ ] Manufacturing set up
- [ ] Kanban
- [ ] Maintenance
- [ ] Housekeeping (5S)

19. If you did not select any of the above, please explain your reasoning below *

20. In your opinion, please select the top four Lean drivers under the cost theme *

Please select 4 options.

- [ ] Quality
- [ ] Poke yoke and fail safe
- [ ] Manufacturing set up
- [ ] Kanban
- [ ] Maintenance
- [ ] Housekeeping (5S)

21. The following are Production related theme Lean barriers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Visualisation
- [ ] Adherence
- [ ] Skill
- [ ] Turnover
- [ ] Union affiliation
- [ ] Training and Learning

22. If you did not select any of the above, please explain your reasoning below *

23. In your opinion, please select the top five Lean barriers under the Production related theme *

Please select 5 options.

- [ ] Visualisation
- [ ] Adherence
- [ ] Skill
- [ ] Turnover
- [ ] Union affiliation
- [ ] Training and Learning

Main theme - Process

Sub theme - Process related

24. The following are Process related theme Lean drivers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Existing Process/New Process
- [ ] Lean adoption
- [ ] Commitment

25. If you did not select any of the above, please explain your reasoning below *

26. The following are Process related theme Lean barriers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Bottleneck
- [ ] Muda

27. If you did not select any of the above, please explain your reasoning below *

25/09/2024, 13:47 The Lean Manufacturing Drivers and Barriers Framework (LMDBF) Delphi Survey Round 1

Main theme - Customer

Sub theme - Customer related

28. The following are Customer related theme Lean drivers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Customer Demands
- [ ] Customer Satisfaction
- [ ] JIT

29. If you did not select any of the above, please explain your reasoning below *

30. The following are Customer related theme Lean barriers that were identified in the case study. In your experience please select the ones that you consider as ideal for the South African environment. *

- [ ] Sales
- [ ] Surveys
- [ ] Customer Involvement
- [ ] Lean Information
- [ ] Customer Profitability

31. If you did not select any of the above, please explain your reasoning below *

https://forms.office.com/Pages/DesignPageV2.aspx?origin=NeoPortalPage&subpage=design&id=gH8ITAceck-eQdfZdl0PTKstzTQBXL5Aq_gltjvz... 9/9

APPENDIX 8: DELPHI ROUND 2 QUESTIONAIRE

The Lean Manufacturing Drivers and Barriers Framework (LMDBF) Delphi Survey
Round 2

The purpose of this survey is to improve and validate the LMDBF Framework developed for a Steering wheel manufacturing plant in South Africa

Reseacher: Kamukhelo Nyathi (Durban University of Technology), Student No 22176176

* Required

Main theme - Supplier

Sub theme - Factors affecting Supplier Selection

1. Based on expert agreement, the subsequent themes have been deemed significant for the Supplier Theme in Round 1. Please indicate your opinion regarding each of them. *

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Supplier Margins	○	○	○	○	○
Supplier Selection Methods	○	○	○	○	○
Material Costs	○	○	○	○	○
Purhasing Policies	○	○	○	○	○
Supplier Location	○	○	○	○	○

Main theme - Benchmarking

Sub theme - Assessing technological capacity of the local company

2. Based on expert agreement, the subsequent themes have been deemed significant for the Benchmarking Theme in Round 1. Please indicate your opinion regarding each of them. *

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Plant age	○	○	○	○	○
Affiliate Technology	○	○	○	○	○
Affiliate Comparison	○	○	○	○	○
Production Volumes	○	○	○	○	○
Improving Production Volumes	○	○	○	○	○

Main theme - Cost

Sub theme - Localisation in comparison to shipping expenses

3. Based on expert agreement, the subsequent themes have been deemed significant for the Cost Theme in Round 1. Please indicate your opinion regarding each of them. *

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Energy and Water	○	○	○	○	○
Overhead Expenses	○	○	○	○	○
Localisation	○	○	○	○	○
Mode of Transport	○	○	○	○	○
Packaging	○	○	○	○	○
Shipping agencies or frequencies	○	○	○	○	○
Stock levels	○	○	○	○	○

Main theme - Production

Sub theme - Indirect Cost Cutting Measures and Localisation in comparison to shipping expenses

4. Based on expert agreement, the subsequent themes have been deemed significant for the Production Theme in Round 1. Please indicate your opinion regarding each of them. *

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Quality	○	○	○	○	○
Poke yoke and fail safe	○	○	○	○	○
Manufacturing set up	○	○	○	○	○
Kanban	○	○	○	○	○
Maintenance	○	○	○	○	○
Housekeeping [5S]	○	○	○	○	○

5. Based on expert agreement, the subsequent themes have been deemed significant for the Production Theme in Round 1. Please indicate your opinion regarding each of them. *

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Visualisation	○	○	○	○	○
Adherence to Work Instruction and Standards	○	○	○	○	○
Skill	○	○	○	○	○
Turnover	○	○	○	○	○
Union affiliation	○	○	○	○	○
Training and learning	○	○	○	○	○

Main theme - Process

Sub theme - Process related

Main theme - Customer

Sub theme - Customer related

6. Based on expert agreement, the subsequent themes have been deemed significant for the Process Theme in Round 1. Please indicate your opinion regarding each of them. *

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
Sales	○	○	○	○	○
Lack of Surveys	○	○	○	○	○
Lack of Customer Involvement	○	○	○	○	○
Lack of Lean Information	○	○	○	○	○
Customer Profitability views against Lean	○	○	○	○	○

7. What is your ranking for adoption of this Framework based on the Drivers and Barriers on this questionaire *

0	1	2	3	4	5	6	7	8	9	10

Not for adoption — Recommended for ad option

APPENDIX 9: ETHICS CERTIFICATE

TRREE

Zertifikat

Certificat

Certificado

Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
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Clinical Trials Centre
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Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Kamukhelo Nyathi

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: 2021/07/26
CID : GS9FbLv2Xe

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

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[REV : 20170310]

APPENDIX 10: STATISTICIAN LETTER (NVIVO)

Dr. Maleni Rookmoney Thakur
B. Tech: Journalism, M. Phil: Quality Management; Ph.D. Public Admin (DUT)

43 College Road, Overport, Durban, 4091
Tel: 078 5442461
maleni.thakur@gmail.com

STATISTICIAN LETTER (NVIVO)

Date: 29 October 2024

MR. KAMUKHELO NYATHI
STUDENT NUMBER: 22176176

TITLE OF THESIS: THE DEVELOPMENT AND IMPLEMENTATION OF A LEAN MANUFACTURING FRAMEWORK AT A SELECTED SOUTH AFRICAN STEERING WHEEL MANUFACTURER

I confirm that I have consulted with Mr. Kamukhelo Nyathi on the qualitative analyses phase of his work. The NVIVO 12 software was used to analyse the primary data from his interview scripts

Sincerely,

……………………
Dr. Maleni Thakur

APPENDIX 11: EDITING CERTIFICATE

CERTIFICATE OF LANGUAGE EDITING

This is to certify that the paper titled:

The development and implementation of a lean manufacturing framework at a selected South African steering wheel manufacturer

Study Submitted in fulfilment of the requirements of
The Degree: Doctor of Philosophy in Management Sciences
Specializing in Quality Management

By

Student number:22176176

Has been edited for language by PEACE OASIS INTERNATIONAL, Language Editor. Neither the research content nor the author's intentions were altered.
The editor guarantees the quality of the English Language in this paper. The following issues were corrected: grammar, spelling, punctuation, sentence structure, and phrasing.

Date issued. 12 October 2024

Dr. K. Shonhiwa: Head

POII003
Certificate number

Peace Oasis INTERNATIONAL

APPENDIX 12: TURNITIN REPORT

Kamu_PhD Thesis_0924_Final.docx

Signed by the Supervisor on 31/10/2024

ORIGINALITY REPORT

5%	4%	3%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Strathclyde Student Paper	<1%
2	docplayer.net Internet Source	<1%
3	Submitted to University of Warwick Student Paper	<1%
4	Eirin Lodgaard, Jonas A. Ingvaldsen, Inger Gamme, Silje Aschehoug. "Barriers to Lean Implementation: Perceptions of Top Managers, Middle Managers and Workers", Procedia CIRP, 2016 Publication	<1%
5	www.mdpi.com Internet Source	<1%
6	uir.unisa.ac.za Internet Source	<1%
7	Submitted to University Tun Hussein Onn Malaysia Student Paper	<1%

JOURNAL 1 SUBMISSION ACKNOWLEDGEMENT

[SAJIE] Submission Acknowledgement

Prof Corne Schutte <scholar@sun.ac.za> Sun, Oct 13, 2024 at 3:54 PM
To: Mr Kamukhelo Nyathi <nyathikamu@gmail.com>

Mr Kamukhelo Nyathi:

Thank you for submitting the manuscript, "DRIVERS FOR DEVELOPING A LEAN MANUFACTURING FRAMEWORK FOR A SOUTH AFRICAN STEERING WHEEL MANUFACTURER" to the The South African Journal of Industrial Engineering.

With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://sajie.journals.ac.za/pub/authorDashboard/submission/3119
Username: kamukhelo

Please note that your article will now be reviewed for suitability, language usage and formatting. It will also be tested for plagiarism. If accepted, you will be informed and will be required to pay a submission fee before the article is entered into the review process. The current submission fee is R1375 plus 15% VAT for South African articles and $192,50 plus 15% VAT for non-South African articles.

Once your submission fee has been paid, a section editor will be appointed, who will then appoint two reviewers to conduct a blind peer review. (Please ensure that you had followed the instructions for blind reviews, by removing identifying information from your submission.)

Follow these guidelines for a speedy review:
- Make sure that you fill in all author / co-author details completely when you registered. Use Capitals for first letter in Name and Surname, and small letters for the rest - this information is used as is in the online version.
- Use your institution email address in the article meta data. If you have not done so, update the information now.
- If any author must use a personal email address, please upload a supplementary document with a letter from the institution, or id/passport to proof your identification. We unfortunately had a bad situation a few years ago where a co-author was misrepresented.
- Follow the Word template provided rigorously - a submission not confirming to our style results not only in additional work and delays, but may leading to rejection.

You should also note that a publication fee is charged upon final acceptance and final publication. The publication fee is R2 475 plus 15% VAT for South African articles and $302,5 plus 15% VAT for non South African articles.

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Prof Corne Schutte

____ South African Journal of Industrial Engineering http://sajie.journals.ac.za sajie@saiie.co.za

JOURNAL 2 SUBMISSION ACKNOWLEDGEMENT

[SAJIE] Submission Acknowledgement

Prof Corne Schutte <scholar@sun.ac.za> Tue, Oct 29, 2024 at 1:19 PM
To: Mr Kamukhelo Nyathi <nyathikamu@gmail.com>

Mr Kamukhelo Nyathi:

Thank you for submitting the manuscript, "Mr BARRIERS THAT IMPEDE THE IMPLEMENTATION OF LEAN IMPLEMENTATION: TO BE CONSIDERED IN THE DEVELOPMENT OF A LEAN FRAMEWORK FOR A SOUTH AFRICAN STEERING WHEEL MANUFACTURER" to the The South African Journal of Industrial Engineering.

With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

Manuscript URL: https://sajie.journals.ac.za/pub/authorDashboard/submission/3127
Username: kamukhelo

Please note that your article will now be reviewed for suitability, language usage and formatting. It will also be tested for plagiarism. If accepted, you will be informed and will be required to pay a submission fee before the article is entered into the review process. The current submission fee is R1375 plus 15% VAT for South African articles and $192,50 plus 15% VAT for non-South African articles.

Once your submission fee has been paid, a section editor will be appointed, who will then appoint two reviewers to conduct a blind peer review. (Please ensure that you had followed the instructions for blind reviews, by removing identifying information from your submission.)

Follow these guidelines for a speedy review:
- Make sure that you fill in all author / co-author details completely when you registered. Use Capitals for first letter in Name and Surname, and small letters for the rest - this information is used as is in the online version.
- Use your institution email address in the article meta data. If you have not done so, update the information now.
- If any author must use a personal email address, please upload a supplementary document with a letter from the institution, or id/passport to proof your identification. We unfortunately had a bad situation a few years ago where a co-author was misrepresented.
- Follow the Word template provided rigorously - a submission not confirming to our style results not only in additional work and delays, but may leading to rejection.

You should also note that a publication fee is charged upon final acceptance and final publication. The publication fee is R2 475 plus 15% VAT for South African articles and $302,5 plus 15% VAT for non South African articles.

If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

Prof Corne Schutte

____ South African Journal of Industrial Engineering http://sajie.journals.ac.za sajie@saiie.co.za